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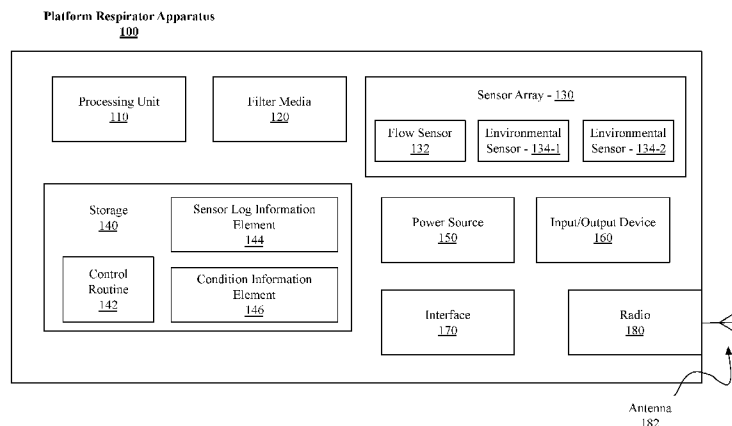


FIG. 1

(57) Abstract: A platform respiration protection device associated techniques are provided. A respiration protection apparatus can include a platform computing device and a filter media to be worn by a user to protect the user from environmental hazards. The platform computing device can include flow and environmental sensors to determine a condition of the filter, a condition of the user, and exposure to environmental hazards.

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## DYNAMIC SENSING SYSTEM FOR WEARABLE SAFETY DEVICES

### BACKGROUND

Some safety equipment is worn by a user as a protective device. For example, a user may wear a respirator device to protect the user from environmental hazards. More specifically, a device may be designed to be worn over a user's mouth and nose. The device may have some filter media designed to protect the user's respiratory tract from hazards in the environment (e.g., gas, fumes, vapors, particulate material, or the like).

It is noted, that respirator filter media is typically designed for a particular hazard. For example, one filter media may be designed to protect against asbestos while another filter media may be designed to protect against paint fumes. A filter media designed to protect against asbestos may not provide protection against paint fumes. Furthermore, filter media typically has a lifespan over which it is designed to operate. For example, a filter media may be designed to operate for a specific amount of time. As another example, a filter media may be designed to protect against a specific level of exposure. Use of the filter media beyond these limits may reduce the amount of protection provided.

### BRIEF DESCRIPTION OF THE DRAWINGS

**FIG. 1** illustrates an example first platform respirator device according to an embodiment.

**FIG. 2** illustrates an example second platform respirator device according to an embodiment.

**FIG. 3** illustrates an example first platform respirator cartridge according to an embodiment.

**FIG. 4** illustrates an example second platform respirator cartridge according to an embodiment.

**FIGS. 5A-5B** illustrate configurations of an example third platform respirator cartridge according to an embodiment.

**FIGS. 6-9** illustrate examples of logic flows according to embodiments.

**FIGS. 10** illustrates a storage medium according to an embodiment.

**FIG. 11** illustrates an example device according to an embodiment.

### DETAILED DESCRIPTION

Various embodiments are generally directed to a dynamic system for wearable respirators. In particular, the present disclosure provides a filter media and a dynamic sensing platform that may be implemented as respiratory protective equipment (RPE). For example, RPE according to the present disclosure may include a platform comprising a filter media, one or more sensors, a radio, a battery, and a processing unit. The RPE may be implemented in a wearable device, such that during use, air may be drawn into the RPE and

pass through the filter media before exiting the RPE at a user's mouth. The platform may be configured (e.g., based on the one or more sensors and the processing unit, or the like) to determine an environment in which the RPE is currently exposed, the user's breathing pattern, a rate of change of contamination of the filter media, a rate of change of  
5 contamination of post-filtered air quality, a level of pollution exposure, or the like.

The platform may also include a memory storage unit to log sensor measurements and/or determined conditions (e.g., pollutant exposure, user breathing, etc.). Additionally, the platform may be communicatively coupled (e.g., via the radio, or the like) to a remote system, such as, for example, a remote monitoring facility, or the like.

10 Reference is now made to the drawings, wherein like reference numerals are used to refer to like elements throughout. In the following description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding thereof. It may be evident, however, that the novel embodiments can be practiced without these specific details. In other instances, well known structures and devices are shown in  
15 block diagram form in order to facilitate a description thereof. The intention is to cover all modifications, equivalents, and alternatives within the scope of the claims.

**FIG. 1** is a block diagram of an embodiment of an apparatus 100, arranged according to at least one example of the present disclosure. The apparatus 100 incorporates one or more of a processing unit 110, a filter media 120, a sensor array 130, a storage 140, a  
20 power source 150, an input/output device 160, an interface 170, a radio 180, and an antenna 182. The sensor array 130 can include a flow sensor 132 and one or more environmental sensors 134-a, where "a" is a positive integer. It is noted, that environmental sensors 134-1 and 134-2 are depicted. However, this number is selected for purposes of clarity of presentation only and not to be limiting. The storage 140 stores one or more of a  
25 control routine 142, a sensor log information element 144, and a condition information element 146. In some examples, the apparatus 100 may be implemented as a wearable device, such as, for example, RPE (e.g., refer to **FIGS. 2-3**). The apparatus 100 can be implemented for use in a variety of environments and/or applications, such as, for example, industrial, pharmaceutical, hazardous cleanup, air travel, medical, urban activities, etc.

30 In the apparatus 100, the control routine 142 incorporates a sequence of instructions operative on the processing unit 110 in its role as a main processor component to implement logic to perform various functions. It is noted, that the control routine 142 may be implemented, at least partially, in hardware. More particularly, the processing unit 110 may incorporate at least part of the control routine in hardware. In some examples, the

processing unit can include any of a wide variety of commercially available processor components. Further, one or more of these processor components may include multiple processors, a multi-threaded processor, a multi-core processor (whether the multiple cores coexist on the same or separate dies), and/or a multi-processor architecture of some other variety  
5 by which multiple physically separate processors are in some way linked. In some examples, the processing unit 110 may include any of a wide variety of specially designed processor components, such as, for example, Application Specific Integrated Circuits (ASICs), Field-Programmable-Gate Arrays (FPGAs), or any a combination of logical components (e.g., gates, registers, etc.) configured to implement the logic described for apparatus 100.

10 In executing the control routine 142, the processor unit 110 can determine a condition of the filter media 120. For example, the processing unit 110 can receive a control signal from the flow sensor 132, the control signal to include an indication of a volume of material transmitted through the flow sensor 132. As a specific example, if the apparatus 100 is implemented as RPE, the processing unit 110 may receive a control signal from the  
15 flow sensor 132 indicating an air flow detected by the flow sensor 132.

In executing the control routine 142, the processing unit 110 can receive a control signal from an environmental sensor (e.g., 134-1, 134-2, or the like) to include an indication of an environmental condition. For example, the processing unit can receive a control signal from one of the environmental sensors 134-a indicating a detected  
20 environmental condition, such as, for example, the presence of a particular hazard in the environment (e.g., paint fumes, gas vapors, or the like).

In executing the control routine 142, the processing unit 110 can determine a condition of the filter media 120 based at least in part on the volume of material transmitted through the flow sensor 120 and the environmental condition detected by the  
25 environmental sensor 134-a. For example, the processing unit 110 can determine whether the the filter media 120 is suitable for the environment in which the apparatus 100 is operating. As a specific example, for a filter media 120 suited to protecting against paint fumes; the processing unit 110 can determine whether paint fumes are detected (e.g., based on the control signal received from the environmental sensor) or whether other hazards are  
30 detected (e.g., gas vapors, or the like). The processing unit 110 can determine the filter media 120 is suited to the environment based on a determination that paint fumes are detected. Alternatively, the processing unit 110 can determine the filter media 120 is not suited to the environment based on a determination that other hazards are detected (e.g., gas vapors, or the like).

With some examples, the processing unit 110 can determine a rate of change of one or more detected environmental conditions. For example, the processing unit 110 can receive multiple control signals from the environmental sensors 134-a, each of the control signals to include an indication an indication of an environmental condition. In executing  
5 the control routine 142, the processing unit 110 can determine a rate of change of the environmental condition. For example, the processing unit 110 can determine a rate of change of exposure to a detected environmental hazard.

With some examples, the processing unit 110 can determine a condition of a wearer of the device. This is described in greater detail below with reference to **FIGS. 2-5**.

10 However, in general, in executing the control routine 142, the processing unit 110 can determine whether a user's breathing (e.g., as indicated by the flow sensor 132, or the like) indicates the user is in distress.

In executing the control routine 142, the processing unit 110 can store a sensor log information element 144 to the storage 140. The sensor log information element 144 may  
15 include indications of readings from the sensors of the sensor array 130 (e.g., the flow sensor 132, the environmental sensors 134-a, or the like). For example, the sensor log information element 144 can include a historical log of control signals and/or output received from the sensors in the array 130.

In executing the control routine 142, the processing unit 110 can store a condition  
20 information element 146 to the storage 140. The condition information element 146 can include indication of determined environmental conditions and/or determined conditions of the filter media 120. For example, the condition information element 146 can include a historical log of the condition of the filter media 120 and/or environments to which the apparatus 100 have been exposed.

25 In executing the control routine 142, the processing unit 110 can send a control signal to the input/output device 150, the control signal to cause the input/output device emit a signal indicative of a condition of the filter media 120 and/or an environmental condition. For example, in executing the control routine 142, the processing unit 110 can determine a condition of the filter media 120 (e.g., that the filter media has a short lifespan, or the like).  
30 Accordingly, the processing unit 110 can send a control signal to the input/output device to cause the input/output device to output an alert (e.g., visual queue, audible queue, or the like) to indicate the condition of the filter media 120.

In executing the control routine 142, the processing unit 110 can send an information element to a remote system (not shown). For example, the processing unit 110 can send the

sensor log information element 144, including the historical log of the sensor readings, to a remote system via the radio 180 and antenna 182. As another example, the processing unit 110 can send the condition information element 146, including the historical log of the environmental conditions, to a remote system via the radio 180 and antenna 182.

5 In executing the control routine 142, the processing unit 110 can alert a remote system to a potentially distressed user. For example, as detailed above, the processing unit 110 can determine whether a user is in distress (e.g., via breathing pattern matching techniques based on the flow sensor 132, or the like) and can alert a remote system to the potential distress. In some examples, the one of the environmental sensors 134-1 can be a  
10 carbon monoxide sensor to measure a carbon monoxide output of a user. The processing unit 110 can determine a distress of the user based on the carbon monoxide output.

In various examples, the filter media can be any of a variety of filters, such as, for example membrane filters, particle filters, carbon filters, charcoal filters, liquid filters, etc. Furthermore, the filter media may be configured to remove elements from air passed  
15 through the filter (e.g., vapors, gasses, particles, or the like).

The sensor array 130 can include any of a variety of types of sensors. These sensors can be electromechanical sensors, piezoelectric sensors, microelectromechanical systems (MEMS) sensors, or the like. For example, the flow sensor 132 can be any of a variety of flow sensors, such as, for example, an air flow sensor. In some examples, the flow sensor  
20 132 can be a hot wire flow sensor, a cold wire flow sensor, a vane flow sensor, or the like. The environmental sensors 134-a can be any of a variety of sensors configured to detect various elements, for example, gasses, vapors, acids, particles, or the like. Additionally, the sensors 130 may include a temperature sensor, a light sensor, an accelerometer, a gyroscope, a GPS sensor, a magnetic sensor, a capacitive sensor, a biometric sensor, or the  
25 like. It is important to note, that the apparatus 100 can be implemented to protect and/or detect against any of a variety of environmental hazards. As such, example sensors 130 and filter media 120 are not limited to those given here.

The storage 140 can be based on any of a wide variety of information storage technologies, possibly including volatile technologies requiring the uninterrupted provision  
30 of electric power, and possibly including technologies entailing the use of machine-readable storage media that may or may not be removable. Thus, each of these storages may include any of a wide variety of types (or combination of types) of storage device, including without limitation, read-only memory (ROM), random-access memory (RAM), dynamic RAM (DRAM), Double-Data-Rate DRAM (DDR-DRAM), synchronous DRAM

(SDRAM), static RAM (SRAM), programmable ROM (PROM), erasable programmable ROM (EPROM), electrically erasable programmable ROM (EEPROM), flash memory, polymer memory (e.g., ferroelectric polymer memory), ovonic memory, phase change or ferroelectric memory, silicon-oxide-nitride-oxide-silicon (SONOS) memory, magnetic or optical cards, one or more individual ferromagnetic disk drives, or a plurality of storage devices organized into one or more arrays (e.g., multiple ferromagnetic disk drives organized into a Redundant Array of Independent Disks array, or RAID array). It should be noted that although each of these storages is depicted as a single block, one or more of these may include multiple storage devices that may be based on differing storage technologies. Thus, for example, one or more of each of these depicted storages may represent a combination of an optical drive or flash memory card reader by which programs and/or data may be stored and conveyed on some form of machine-readable storage media, a ferromagnetic disk drive to store programs and/or data locally for a relatively extended period, and one or more volatile solid state memory devices enabling relatively quick access to programs and/or data (e.g., SRAM or DRAM). It should also be noted that each of these storages may be made up of multiple storage components based on identical storage technology, but which may be maintained separately as a result of specialization in use (e.g., some DRAM devices employed as a main storage while other DRAM devices employed as a distinct frame buffer of a graphics controller).

20 The power source 150 can be based on any of a variety of power source technology, such as, for example, batteries (e.g., including rechargeable batteries).

The input/output device 160 can include any of a variety of input and/or output devices configured to receive input and/or to provide an output (e.g., an alert). In some examples, the input/output device 160 can include a button, a switch, a touch screen, a microphone, a keyboard, a mouse, a touchpad, or the like. In some examples, the input/output device 160 can include one or more light emitting diodes (LEDs), a speaker, a display, a haptic feedback device, or the like. In some examples, the input/output device 160 can include more than one device, such as, for example, an input device (e.g., button, a microphone, a touchpad, or the like) and an output device (e.g., LEDs, speaker, or the like).

30 The interface 170 employ any of a wide variety of signaling technologies enabling computing devices to be coupled to other devices as has been described. Each of these interfaces may include circuitry providing at least some of the requisite functionality to enable such coupling. However, each of these interfaces may also be at least partially implemented with sequences of instructions executed by corresponding ones of the

processor components (e.g., to implement a protocol stack or other features). Where electrically and/or optically conductive cabling is employed, these interfaces may employ signaling and/or protocols conforming to any of a variety of industry standards, including without limitation, RS-232C, RS-422, USB, Ethernet (IEEE-802.3) or IEEE-1394. Where  
5 the use of wireless signal transmission is entailed, these interfaces may employ signaling and/or protocols conforming to any of a variety of industry standards, including without limitation, IEEE 802.11a, 802.11b, 802.11g, 802.11n, 802.16, 802.20 (commonly referred to as "Mobile Broadband Wireless Access"); Bluetooth; ZigBee; or a cellular  
10 radiotelephone service such as GSM with General Packet Radio Service (GSM/GPRS), CDMA/1xRTT, Enhanced Data Rates for Global Evolution (EDGE), Evolution Data Only/Optimized (EV-DO), Evolution For Data and Voice (EV-DV), High Speed Downlink Packet Access (HSDPA), High Speed Uplink Packet Access (HSUPA), 4G LTE, etc.

The radio 180 may be any radio configured to communicate signals via a wireless broadcast. For example, the radio 180 may be a Wi-Fi Direct radio, a Bluetooth radio, a  
15 BLE radio, an RFID radio, a ZigBee radio, an Ultrasound radio, or the like. The radio 180 may be operably coupled to the antenna 182 to communicate wireless signals via the antenna.

**FIGS. 2-5** depict an implementation of an apparatus 200, arranged according to at least one example of the present disclosure. In particular, these figures depict the apparatus  
20 200 implemented as RPE. It is noted, that these figures are described in conjunction with each other, and with reference to the apparatus 100 of **FIG. 1**. However, the apparatus 200 may include the same, or different, elements than those depicted for the apparatus 100. Examples are not limited in this context. In general **FIG. 2** depicts the apparatus 200 while  
25 **FIGS. 3-5** depict examples of a portion of the apparatus 200.

Turning more specifically to **FIG. 2**, the apparatus 200 is depicted in a perspective view worn by a user 300. In general, the apparatus 200 includes a cartridge 201 and a  
30 frame 203. The cartridge 201 is operably coupled to the frame 203, which can be worn by the user 300 as RPE as depicted. Accordingly, during use, air from an environment can be drawn into the cartridge 201, processed as described below, and exit the apparatus 200 at the mouth of the user 300. Note, the mouth of the user 300 is hidden in this view behind the frame 203.

It is noted, **FIG. 2** depicts the platform respirator device implemented as respirator protection equipment. However, examples are not limited in this context. In particular, a platform respirator device according to the present disclosure could be implemented in, for

example, the hood of an extractor fan, a vacuum cleaner, an air conditioning unit, or the like.

Turning more specifically to **FIG. 3**, the cartridge 201 is depicted in an exploded view. As depicted, the cartridge 201 includes an air inlet 210 an air passageway 220, and  
5 an air outlet 230. During operation, or more specifically, when the apparatus 200 is worn by the user 300, air 303 from the environment 301 can be drawn into the air inlet 210, through the air passageway 220, and exit the apparatus 200 through the air outlet 230 as post processed air 305.

The cartridge 201 can include a filter media cavity 121, in which can be disposed  
10 filter media, such as the media 120. The cartridge 201 also includes the flow sensor 132, the environmental sensors 134-1 and 134-2, and a System-on-Chip (SoC) 240. The SoC 240 can include the processing unit 110, the storage 140, the power source 150, the output device 160, the interface 170, and/or the radio 180 and antenna 182. It is important to note, that the details of the SoC 240 are not depicted for purposes of clarity. However, an  
15 example block diagram of such elements are depicted in **FIG. 1**. As depicted, the flow sensor 132 is proximate to the filter media cavity 121, where filter media 120 may be disposed. In some examples, the cartridge 201 can also include an analog front-end (AFE) 242 and an analog-to-digital converter (ADC) 244 operably coupled to the sensors 130 (e.g., the flow sensor 132, the environmental sensors 134-a, or the like) and the SoC 240.  
20 In some examples, the AFE 242 and/or the ADC 244 can include logic, for example, gates, registers, operational amplifiers, filters, ASICs, or the like to condition the control signals from the sensors 130 and/or to convert the control signals from a continuous time domain to a discrete time domain.

Turning more particularly to **FIG. 4**, an example cartridge 401 is depicted. With  
25 some examples, the cartridge 401 can be implemented as the cartridge 201 of **FIG. 2**. As depicted, the cartridge 401 is implemented as a polygon, in particular, a hexagon. However, examples are not limited in this context. In particular, the cartridge 401 can be implemented as any of a variety of geometric shapes, for example, a circle, a square, a rectangle, a triangle, a different polygon than a hexagon, or the like.

In general, the cartridge 401 can be a platform for the elements of the apparatus 100  
30 and/or 200 depicted above. For example, the cartridge 401 can include a substrate 411 onto which, the environmental sensors 134-1 and 134-1 are disposed. Additionally, the flow sensor 132, the AFE 242, the ADC 244, the processing unit 110, the storage 140, the power source 150, the interface 170, and/or the radio 180 can be disposed on the substrate 411.

In some examples, the filter media 120 can be disposed in the center of the substrate 411. In some examples, filter media 120 can be provided that is the same shape as the substrate 411 and can be disposed behind and/or in front of the substrate 411, depending on the implementation.

5 Turning more particularly to **FIGS. 5A-5B**, an example reconfigurable platform respirator cartridge 501 is depicted. More specifically, **FIG. 5A** depicts the example cartridge 501 in a first configuration while **FIG. 5B** depicts the example cartridge 501 in a second, different, configuration. With some examples, the cartridge 501 can be implemented as the cartridge 201 of **FIG. 2**. As depicted, the cartridge 501 is implemented  
10 as a polygon, in particular, a hexagon. However, examples are not limited in this context. In particular, the cartridge 501 can be implemented as any of a variety of geometric shapes, for example, a circle, a square, a rectangle, a triangle, a different polygon than a hexagon, or the like.

Like the cartridge 401, the cartridge 501 can be a platform for the elements of the  
15 apparatus 100 and/or 200 depicted above. For example, the cartridge 501 can include a substrate 411 onto which, the elements are disposed. However, unlike the cartridge 401, the cartridge 501 includes a detachable substrate portion 513. The detachable substrate portion 513 can be removed to replace and/or change environmental sensors 134-a. For example, **FIG. 5A**, depicts the cartridge 501 including a detachable substrate portion 513-1 with  
20 environmental sensors 134-1 and 134-2. This detachable substrate portion 513-1 can be removed and a different (or similarly) configured detachable substrate portion 513-b, where “b” is a positive integer, with environmental sensors 134-a attached to provide for detection of different environmental hazards, or to replace aged, used, defective, or the like sensors. For example, **FIG. 5B**, depicts the cartridge 501 including a  
25 detachable substrate portion 513-2 with with environmental sensors 134-1 and 134-2. Operably coupled to the substrate 511 to form the cartridge 501.

It is noted, the cartridge 501 may be implemented with a different filter media (e.g., to protect against a different gas, or the like), depending upon the detachable substrate portion 513-b operably coupled to the substrate 511. As another example, the  
30 environmental sensors 134-a may have a particular life span, as such, the detachable portion 513-b can be removed and a new, similarly configured detachable portion attached to provide new environmental sensors 134-a.

**FIGS. 6-9** illustrate example embodiments of logic flows that may be implement by the apparatus 100 and /or the apparatus 200. These illustrated logic flows may be

representative of some or all of the operations executed by one or more implementations described herein. More specifically, the logic flows may illustrate operations performed by the processing unit 110 in executing at least the control routine 142. Although the logic flows are described with reference to **FIGS. 1-5**, examples are not limited in this context.

5 Turning more specifically to **FIG. 6**, a logic flow 600 is depicted. The logic flow 600 may begin at block 610. At block 610 “receive a control signal to include an indication to report a current pollution level,” the processing unit 110, in executing the control routine 142 can receive a control signal to include an indication to report a current pollution level. For example, a user of the platform respirator apparatus (e.g., the user 300 of the apparatus  
10 200, or the like) can request an indication of the current pollution level, for example, by activating the input/output device 160. As a specific example, the input/output device 160 can include a button, the user 300 may depress the button to indicate the request to receive a report on the current pollution level. The processing unit 110 can receive the control signal from the input/output device 160. It is important to note, that the “pollution” level is  
15 used in a broad sense to indicate a detectable environmental hazard. For example, the pollution level can correspond to a level of a particular hazard (e.g., paint fumes, gas vapors, particulate matter, or the like) in the environment. Examples however, are not limited in this context.

Continuing to block 620 “determine the current pollution level,” the processing unit  
20 110, in executing the control routine 142, can determine the current pollution level. For example, the processing unit 110 can send a control signal to one or more of the environment sensors 134-a to include an indication to measure the current pollution level. The processing unit 110, in executing the control routine 142, can receive a control signal from the one or more of the environmental sensors 134-a to include an indication of the  
25 current pollution level. For example, if the environmental sensor 134-1 were configured to detect ammonia vapor, the processing unit 110 could send a control signal to the environmental sensor 134-1 to include an indication to measure the level of ammonia in the environment. The processing unit 110 could also receive a control signal from the environmental sensor 134-1 to include a level of ammonia detected by the sensor.

30 In some examples, the processing unit 110, in executing the control routine 142, can determine the level of pollution based at least in part on the sensor log information element 144. For example, as noted above, the sensor log information element 144 can include indication of output from the environmental sensors 134-a. Accordingly, the processing

unit 110 can determine a level of pollution (e.g., as measured by the environmental sensors 134-a) based on the sensor log information element 144.

Continuing to block 630 “provide an alert corresponding to the current pollution level,” the processing unit 110, in executing the control routine 142, can provide an alert  
5 corresponding to the current pollution level. For example, if the input/output device 160 includes an LED, the processing unit 110 can send a control signal to the LED to cause the LED to illuminate (e.g., at a particular brightness, in a particular color, or the like) to indicate the determined level of pollution, for example, via a visual alert. As another example, the processing unit 110, in executing the control routine 142, can send an  
10 information element (e.g., via the interface 170, via the radio 180, or the like) to a remote device, the information element to include an indication of the current pollution level.

Turning more specifically to **FIG. 7**, a logic flow 700 is depicted. The logic flow 700 may begin at block 710. At block 710 “determine a toxicity level,” the processing unit 110, in executing the control routine 142 can determine a level of toxicity in the environment in  
15 which the platform respirator apparatus is disposed and/or operating. It is important to note, that the “toxicity” level is used in a broad sense to indicate a detectable environmental hazard. For example, the toxicity level can correspond to a level of a particular hazard (e.g., radiation, asbestos, gas vapors, or the like) in the environment. Examples however, are not limited in this context.

20 With some examples, the processing unit 110, in executing the control routine 142 can determine a level of toxicity over a particular time period. For example, the processing unit 110 can determine an instantaneous level of toxicity based on measurements from the environmental sensors 134-a. This instantaneous toxicity level can be monitored over a period of time (e.g., 1 minute, 5 minutes, 10 minutes, device lifetime, or the like). An  
25 average toxicity level over the period or an aggregate toxicity level over the period can be determined.

Continuing to decision block 720 “toxicity level above a threshold level?” the processing unit 110, in executing the control routine 142, can determine whether the determined toxicity level (e.g., instantaneous, average, lifetime exposure or the like) is  
30 above a threshold level. From decision block 720, the logic flow 700 can continue to either block 730 or return to block 710. In particular, the logic flow 700 can continue from decision block 720 to block 730 based on a determination that the level of toxicity is above the threshold level while the logic flow 700 can continue from decision block 720 to block 710 based on a determination that the level of toxicity is not above the threshold level.

At block 730 “provide an alert indicating a toxic environment,” the processing unit 110, in executing the control routine 142, can provide an alert indicating a toxic environment. For example, if the input/output device 160 includes an LED, the processing unit 110 can send a control signal to the LED to cause the LED to illuminate (e.g., at a particular brightness, in a particular color, or the like) to indicate the toxic environment. As another example, the processing unit 110, in executing the control routine 142, can send an information element (e.g., via the interface 170, via the radio 180, or the like) to a remote device, the information element to include an indication of the toxic environment. In some examples, logic flow 700 can further include determining whether the toxicity level is increasing, remaining constant, or decreasing and provide additional alerts based on whether the toxicity level is increasing, decreasing, or staying the same. For example, if the toxicity level increases, the processing unit 110, in executing the control routine 142, can send a control signal to the input/output device 160 to provide additional alerts (e.g., audible alerts, emergency alert broadcast to a remote device, or the like).

It is important to note, the the logic flow 700 can be implemented to determine instantaneous exposure to a toxic environment, acute exposure to a toxic environment, or chronic exposure to a toxic environment. The processing unit 110, in executing the control routine 142, can store an indication of the determined exposure to a toxic environment (e.g., instant, over a period of time, or the like) as a condition in the condition information element 146. Alerts corresponding to the determined exposure can be provided (e.g., to a user, to a remote system, or the like) based on the recorded exposure in the condition information element 146. Examples are not limited in this context.

Turning more specifically to **FIG. 8**, a logic flow 800 is depicted. The logic flow 800 may begin at block 810. At block 810 “determine a loading level of the filter media,” the processing unit 110, in executing the control routine 142 can determine a level of loading of the filter media 120. It is important to note, that the “loading” level is used in a broad sense to indicate a level of exposure of the filter to hazards (e.g., corrosive chemicals, particle loading, or the like.) Examples however, are not limited in this context.

Continuing to decision block 820 “loading level above a threshold level?” the processing unit 110, in executing the control routine 142, can determine whether the determined loading level is above a threshold level. From decision block 820, the logic flow 800 can continue to either block 830 or return to block 810. In particular, the logic flow 800 can continue from decision block 820 to block 830 based on a determination that the level of loading is above the threshold level while the logic flow 800 can continue from

decision block 820 to block 810 based on a determination that the level of loading is not above the threshold level.

At block 830 “provide an alert indicating a need to replace the filter element,” the processing unit 110, in executing the control routine 142, can provide an alert indicating a need to change the filter element 120. It is important to note, the the logic flow 800 can be implemented to determine a loading level for each of the environmental sensors 134-a also. For example, the environmental sensors 134-a can be limited use electrochemical sensors with a particular life span. Accordingly, the logic flow 800 can be implemented to determine whether ones of the environmental sensors 134-a are needing changed. Examples are not limited in this context.

Turning more specifically to **FIG. 9**, a logic flow 900 is depicted. The logic flow 900 may begin at block 910. At block 910 “determine a respiratory level of a user,” the processing unit 110, in executing the control routine 142 can determine a respiratory level of a user. For example, the processing unit 110 can receive control signals from the flow sensor 132 to include an indication of a breathing pattern of a user. In particular, the flow sensor 132 can record the volume of air and/or the force of air inhaled and/or exhaled through the flow sensor 132. This volume and/or force of air can correspond to the breathing pattern of the user 300.

Continuing to decision block 920 “does respiratory level indicate distress?” the processing unit 110, in executing the control routine 142, can determine whether the respiratory level indicates distress. For example, the processing unit 110, in executing the control routine 142, can determine a normal respiratory level (e.g., for the user, for a human, or the like) and determine whether the respiratory level determined at block 910 deviates from the normal respiratory level. As a specific example, the apparatus 200 may be provisioned for the user 300. During provisioning, the processing unit 110 can record a normal respiratory level of the user 300 in an unstressed environment and store an indication of the normal respiratory level as a condition in the condition information element 146. During operation, at decision block 920, the processing unit 110 can compare the normal respiratory level to a current respiratory level (e.g., as measured by the flow sensor 132, or the like). For example, the processing unit 110 can apply pattern matching techniques to the respiratory level of the user 300 to determine whether the user 300 is distressed.

From decision block 920, the logic flow 900 can continue to either block 930 or return to block 910. In particular, the logic flow 900 can continue from decision block 920

to block 930 based on a determination that the respiratory level of the user indicates the user is distressed while the logic flow 900 can continue from decision block 920 to block 930 based on a determination that the respiratory level of the user indicates the user is not distressed.

5           At block 930 “provide an alert indicating a distressed user,” the processing unit 110, in executing the control routine 142, can provide an alert indicating a distressed user. For example, the processing unit 110, in executing the control routine 142, can send a control signal to radio to cause the radio to send an alert signal indication a distressed user to a remote system (e.g., a safety monitoring system, or the like).

10           **FIG. 10** illustrates an embodiment of a storage medium 2000. The storage medium 2000 may comprise an article of manufacture. In some examples, the storage medium 2000 may include any non-transitory computer readable medium or machine readable medium, such as an optical, magnetic or semiconductor storage. The storage medium 2000 may store various types of computer executable instructions 2001, such as instructions to implement  
15 logic flows 600, 700, 800, and/or 900. Examples of a computer readable or machine readable storage medium may include any tangible media capable of storing electronic data, including volatile memory or non-volatile memory, removable or non-removable memory, erasable or non-erasable memory, writeable or re-writable memory, and so forth. Examples of computer executable instructions may include any suitable type of  
20 code, such as source code, compiled code, interpreted code, executable code, static code, dynamic code, object-oriented code, visual code, and the like. The examples are not limited in this context.

**FIG. 11** illustrates an embodiment of a device 3000. In some examples, device 3000 may be configured or arranged for wireless communications. In some examples, one of the  
25 apparatuses 100 and/or 200 may be implemented in the device 3000. The logic circuits may include physical circuits to perform operations described for the apparatus 100, apparatus 200, storage medium 2000, logic flow 600, logic flow 700, logic flow 800, and/or logic flow 900. As shown in this figure, device 3000 may include a radio interface 3110, baseband circuitry 3120, and computing platform 3130, although examples are not limited to this configuration.

30           The device 3000 may implement some or all of the structure and/or operations for the apparatus 100, the apparatus 200, the storage medium 2000, the logic circuit 600, logic circuit 700, logic circuit 800, and/or logic circuit 900 in a single computing entity, such as entirely within a single device. The embodiments are not limited in this context.

Radio interface 3110 may include a component or combination of components adapted for transmitting and/or receiving single carrier or multi-carrier modulated signals (e.g., including complementary code keying (CCK) and/or orthogonal frequency division multiplexing (OFDM) symbols and/or single carrier frequency division multiplexing (SC-FDM symbols) although the  
5 embodiments are not limited to any specific over-the-air interface or modulation scheme. Radio interface 3110 may include, for example, a receiver 3112, a transmitter 3116 and/or a frequency synthesizer 3114. Radio interface 3110 may include bias controls, a crystal oscillator and antennas 3118-1 to 3118-f. In another embodiment, radio interface 3110 may use external voltage-controlled oscillators (VCOs), surface acoustic wave filters, intermediate frequency (IF)  
10 filters and/or RF filters, as desired. Due to the variety of potential RF interface designs an expansive description thereof is omitted.

Baseband circuitry 3120 may communicate with radio interface 3110 to process receive and/or transmit signals and may include, for example, an analog-to-digital converter 3122 for down converting received signals, a digital-to-analog converter 3124 for up converting signals  
15 for transmission. Further, baseband circuitry 3120 may include a baseband or physical layer (PHY) processing circuit 3126 for PHY link layer processing of respective receive/transmit signals. Baseband circuitry 3120 may include, for example, a processing circuit 3128 for medium access control (MAC)/data link layer processing. Baseband circuitry 3120 may include a memory controller 3132 for communicating with MAC processing circuit 3128 and/or a  
20 computing platform 3130, for example, via one or more interfaces 3134.

In some embodiments, PHY processing circuit 3126 may include a frame construction and/or detection module, in combination with additional circuitry such as a buffer memory, to construct and/or deconstruct communication frames (e.g., containing subframes). Alternatively, or in addition, MAC processing circuit 3128 may share processing for certain of these functions  
25 or perform these processes independent of PHY processing circuit 3126. In some embodiments, MAC and PHY processing may be integrated into a single circuit.

Computing platform 3130 may provide computing functionality for device 3000. As shown, computing platform 3130 may include a processing component 3140. In addition to, or alternatively of, baseband circuitry 3120 of device 3000 may execute processing operations or  
30 logic for the apparatus 100-a, storage medium 2000, and logic circuits 1200 using the processing component 3130. Processing component 3140 (and/or PHY 3126 and/or MAC 3128) may comprise various hardware elements, software elements, or a combination of both. Examples of hardware elements may include devices, logic devices, components, processors, microprocessors, circuits, processor circuits, circuit elements (e.g., transistors, resistors,

capacitors, inductors, and so forth), integrated circuits, application specific integrated circuits (ASIC), programmable logic devices (PLD), digital signal processors (DSP), field programmable gate array (FPGA), memory units, logic gates, registers, semiconductor device, chips, microchips, chip sets, and so forth. Examples of software elements may include software components, programs, applications, computer programs, application programs, system programs, software development programs, machine programs, operating system software, middleware, firmware, software modules, routines, subroutines, functions, methods, procedures, software interfaces, application program interfaces (API), instruction sets, computing code, computer code, code segments, computer code segments, words, values, symbols, or any combination thereof. Determining whether an example is implemented using hardware elements and/or software elements may vary in accordance with any number of factors, such as desired computational rate, power levels, heat tolerances, processing cycle budget, input data rates, output data rates, memory resources, data bus speeds and other design or performance constraints, as desired for a given example.

Computing platform 3130 may further include other platform components 3150. Other platform components 3150 include common computing elements, such as one or more processors, multi-core processors, co-processors, memory units, chipsets, controllers, peripherals, interfaces, oscillators, timing devices, video cards, audio cards, multimedia input/output (I/O) components (e.g., digital displays), power supplies, and so forth. Examples of memory units may include without limitation various types of computer readable and machine readable storage media in the form of one or more higher speed memory units, such as read-only memory (ROM), random-access memory (RAM), dynamic RAM (DRAM), Double-Data-Rate DRAM (DDRAM), synchronous DRAM (SDRAM), static RAM (SRAM), programmable ROM (PROM), erasable programmable ROM (EPROM), electrically erasable programmable ROM (EEPROM), flash memory, polymer memory such as ferroelectric polymer memory, ovonic memory, phase change or ferroelectric memory, silicon-oxide-nitride-oxide-silicon (SONOS) memory, magnetic or optical cards, an array of devices such as Redundant Array of Independent Disks (RAID) drives, solid state memory devices (e.g., USB memory, solid state drives (SSD) and any other type of storage media suitable for storing information.

Computing platform 3130 may further include a network interface 3160. In some examples, network interface 3160 may include logic and/or features to support network interfaces operated in compliance with one or more wireless broadband technologies such as those described in one or more standards associated with IEEE 802.11 such as IEEE 802.11u or with technical specification such as WFA Hotspot 2.0.

Device 3000 may be part of a device in a network and may be included in various types of computing devices to include, but not limited to, user equipment, a computer, a personal computer (PC), a desktop computer, a laptop computer, a notebook computer, a netbook computer, a tablet computer, an ultra-book computer, a smart phone, embedded electronics, a gaming console, a server, a server array or server farm, a web server, a network server, an Internet server, a work station, a mini-computer, a main frame computer, a supercomputer, a network appliance, a web appliance, a distributed computing system, multiprocessor systems, processor-based systems, or combination thereof. Accordingly, functions and/or specific configurations of device 2000 described herein; may be included or omitted in various embodiments of device 2000, as suitably desired. In some embodiments, device 2000 may be configured to be compatible with protocols and frequencies associated with IEEE 802.11 Standards or Specification and/or 3GPP Standards or Specifications for MIMO systems, although the examples are not limited in this respect.

The components and features of device 3000 may be implemented using any combination of discrete circuitry, application specific integrated circuits (ASICs), logic gates and/or single chip architectures. Further, the features of device 3000 may be implemented using microcontrollers, programmable logic arrays and/or microprocessors or any combination of the foregoing where suitably appropriate. It is noted that hardware, firmware and/or software elements may be collectively or individually referred to herein as “logic” or “circuit.”

It should be appreciated that the exemplary device 3000 shown in the block diagram of this figure may represent one functionally descriptive example of many potential implementations. Accordingly, division, omission or inclusion of block functions depicted in the accompanying figures does not infer that the hardware components, circuits, software and/or elements for implementing these functions would necessarily be divided, omitted, or included in embodiments.

**FIG. 12** illustrates an embodiment of a wireless network 4000. As shown in this figure, wireless network 4000 comprises an access point 4100 and nodes 4210, 4220, and 4230. In various embodiments, wireless network 4000 may comprise an Internet-of-Things (IoT) network. In various examples, the nodes 4210, 4220, and/or 4230 may comprise RPE apparatuses, such as, for example, the apparatuses 100 and/or 200. During operation, the nodes may send information elements (e.g., information elements 144, 146, or the like) and/or alerts (e.g., alerts as described above) to a remote system (e.g., monitoring system, or the like) via the network 4000.

In some embodiments, wireless network 4000 may implement one or more broadband wireless communications standards, such as 3G or 4G standards, including their revisions, progeny, and variants. Examples of 3G or 4G wireless standards may include without limitation any of the IEEE 802.16m and 802.16p standards, 3rd Generation Partnership Project (3GPP) Long Term Evolution (LTE) and LTE-Advanced (LTE-A) standards, and International Mobile Telecommunications Advanced (IMT-ADV) standards, including their revisions, progeny and variants. Other suitable examples may include, without limitation, Global System for Mobile Communications (GSM)/Enhanced Data Rates for GSM Evolution (EDGE) technologies, Universal Mobile Telecommunications System (UMTS)/High Speed Packet Access (HSPA) technologies, Worldwide Interoperability for Microwave Access (WiMAX) or the WiMAX II technologies, Code Division Multiple Access (CDMA) 2000 system technologies (e.g., CDMA2000 1xRTT, CDMA2000 EV-DO, CDMA EV-DV, and so forth), High Performance Radio Metropolitan Area Network (HIPERMAN) technologies as defined by the European Telecommunications Standards Institute (ETSI) Broadband Radio Access Networks (BRAN), Wireless Broadband (WiBro) technologies, GSM with General Packet Radio Service (GPRS) system (GSM/GPRS) technologies, High Speed Downlink Packet Access (HSDPA) technologies, High Speed Orthogonal Frequency-Division Multiplexing (OFDM) Packet Access (HSOPA) technologies, High-Speed Uplink Packet Access (HSUPA) system technologies, 3GPP Rel. 8-12 of LTE/System Architecture Evolution (SAE), and so forth. The embodiments are not limited in this context.

In various embodiments, nodes 4210, 4220, and 4230 may communicate with access point 4100 in order to obtain connectivity to one or more external data networks. In some embodiments, for example, nodes 4210, 4220, and 4230 may connect to the Internet 4400 via access point 4100 and access network 4300. In various embodiments, access network 4300 may comprise a private network that provides subscription-based Internet-connectivity, such as an Internet Service Provider (ISP) network. The embodiments are not limited to this example.

In various embodiments, two or more of nodes 4210, 4220, and 4230 may communicate with each other directly by exchanging peer-to-peer communications. For example, as depicted in this figure, nodes 4210 and 4220 communicate with each other directly by exchanging peer-to-peer communications 4500. In some embodiments, such peer-to-peer communications may be performed according to one or more standards, such as, for example, the Bluetooth standard referenced above. The embodiments, however, are not limited to these examples.

Various embodiments may be implemented using hardware elements, software elements, or a combination of both. Examples of hardware elements may include processors,

microprocessors, circuits, circuit elements (e.g., transistors, resistors, capacitors, inductors, and so forth), integrated circuits, application specific integrated circuits (ASIC), programmable logic devices (PLD), digital signal processors (DSP), field programmable gate array (FPGA), logic gates, registers, semiconductor device, chips, microchips, chip sets, and so forth. Examples of software may include software components, programs, applications, computer programs, application programs, system programs, machine programs, operating system software, middleware, firmware, software modules, routines, subroutines, functions, methods, procedures, software interfaces, application program interfaces (API), instruction sets, computing code, computer code, code segments, computer code segments, words, values, symbols, or any combination thereof. Determining whether an embodiment is implemented using hardware elements and/or software elements may vary in accordance with any number of factors, such as desired computational rate, power levels, heat tolerances, processing cycle budget, input data rates, output data rates, memory resources, data bus speeds and other design or performance constraints.

One or more aspects of at least one embodiment may be implemented by representative instructions stored on a machine-readable medium which represents various logic within the processor, which when read by a machine causes the machine to fabricate logic to perform the techniques described herein. Such representations, known as “IP cores” may be stored on a tangible, machine readable medium and supplied to various customers or manufacturing facilities to load into the fabrication machines that actually make the logic or processor. Some embodiments may be implemented, for example, using a machine-readable medium or article which may store an instruction or a set of instructions that, if executed by a machine, may cause the machine to perform a method and/or operations in accordance with the embodiments. Such a machine may include, for example, any suitable processing platform, computing platform, computing device, processing device, computing system, processing system, computer, processor, or the like, and may be implemented using any suitable combination of hardware and/or software. The machine-readable medium or article may include, for example, any suitable type of memory unit, memory device, memory article, memory medium, storage device, storage article, storage medium and/or storage unit, for example, memory, removable or non-removable media, erasable or non-erasable media, writeable or re-writable media, digital or analog media, hard disk, floppy disk, Compact Disk Read Only Memory (CD-ROM), Compact Disk Recordable (CD-R), Compact Disk Rewriteable (CD-RW), optical disk, magnetic media, magneto-optical media, removable memory cards or disks, various types of Digital Versatile Disk (DVD), a tape, a cassette, or the like. The instructions may include any suitable type of

code, such as source code, compiled code, interpreted code, executable code, static code, dynamic code, encrypted code, and the like, implemented using any suitable high-level, low-level, object-oriented, visual, compiled and/or interpreted programming language.

Numerous specific details have been set forth herein to provide a thorough understanding  
5 of the embodiments. It will be understood by those skilled in the art, however, that the embodiments may be practiced without these specific details. In other instances, well-known operations, components, and circuits have not been described in detail so as not to obscure the embodiments. It can be appreciated that the specific structural and functional details disclosed herein may be representative and do not necessarily limit the scope of the embodiments.

10 Some embodiments may be described using the expression "coupled" and "connected" along with their derivatives. These terms are not intended as synonyms for each other. For example, some embodiments may be described using the terms "connected" and/or "coupled" to indicate that two or more elements are in direct physical or electrical contact with each other. The term "coupled," however, may also mean that two or more elements are not in direct contact  
15 with each other, but yet still co-operate or interact with each other.

Unless specifically stated otherwise, it may be appreciated that terms such as "processing," "computing," "calculating," "determining," or the like, refer to the action and/or processes of a computer or computing system, or similar electronic computing device, that manipulates and/or transforms data represented as physical quantities (e.g., electronic) within the computing  
20 system's registers and/or memories into other data similarly represented as physical quantities within the computing system's memories, registers or other such information storage, transmission or display devices. The embodiments are not limited in this context.

It should be noted that the methods described herein do not have to be executed in the order described, or in any particular order. Moreover, various activities described with respect to  
25 the methods identified herein can be executed in serial or parallel fashion.

Although specific embodiments have been illustrated and described herein, it should be appreciated that any arrangement calculated to achieve the same purpose might be substituted for the specific embodiments shown. This disclosure is intended to cover any and all adaptations or variations of various embodiments. It is to be understood that the above description has been  
30 made in an illustrative fashion, and not a restrictive one. Combinations of the above embodiments, and other embodiments not specifically described herein will be apparent to those of skill in the art upon reviewing the above description. Thus, the scope of various embodiments includes any other applications in which the above compositions, structures, and methods are used.

It is emphasized that the Abstract of the Disclosure is provided to comply with 37 C.F.R. § 1.72(b), requiring an abstract that will allow the reader to quickly ascertain the nature of the technical disclosure. It is submitted with the understanding that it will not be used to interpret or limit the scope or meaning of the claims. In addition, in the foregoing Detailed Description, it  
5 can be seen that various features are grouped together in a single embodiment for the purpose of streamlining the disclosure. This method of disclosure is not to be interpreted as reflecting an intention that the claimed embodiments require more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive subject matter lies in less than all features of a single disclosed embodiment. Thus the following claims are hereby incorporated  
10 into the Detailed Description, with each claim standing on its own as a separate preferred embodiment. In the appended claims, the terms "including" and "in which" are used as the plain-English equivalents of the respective terms "comprising" and "wherein," respectively. Moreover, the terms "first," "second," and "third," etc. are used merely as labels, and are not intended to impose numerical requirements on their objects.

15 The disclosure now turns to providing various example implementations. Although the subject matter has been described in language specific to structural features and/or methodological acts, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims.  
20 The disclosure now turns to providing additional examples.

Example 1. An apparatus, comprising: a filter media; a flow sensor disposed proximate to the filter media; an environmental sensor; and logic, at least a portion of which is implemented in hardware, the logic to: receive a first control signal from the flow sensor, the first control signal to include an indication of a volume of material transmitted through the flow sensor; receive a  
25 second control signal from the environmental sensor, the second control signal to include an indication of an environmental condition; and determine a condition of the filter media based at least in part on the volume of material transmitted through the flow sensor and the environmental condition.

Example 2. The apparatus of example 1, comprising a radio, the logic to send an  
30 information element to a remote system, the information element to include an indication of the condition of the filter media.

Example 3. The apparatus of example 1, comprising an output device, the logic to send an output control signal to the output device, the output control signal to cause the output device to provide an alert to include an indication of the condition of the filter.

Example 4. The apparatus of example 3, the output device comprising a light emitting diode, a speaker, or a display and the alert comprising a visual alert or an audible alert.

Example 5. The apparatus of example 1, the logic to determine whether the volume of material transmitted through the flow sensor exceeds a threshold value.

5 Example 6. The apparatus of example 5, the logic to send a power control signal to the environmental sensor based on a determination that the volume of material transmitted through the flow sensor does not exceed the threshold value, the power control signal to include an indication to reduce a power consumption.

10 Example 7. The apparatus of example 5, the logic to place the apparatus in a sleep state based on a determination that the volume of material transmitted through the flow sensor does not exceed the threshold value.

Example 8. The apparatus of example 1, the second control signal a one of a plurality of second control signals received from the environmental sensor, each one of the plurality of second control signals to include an indication of an environmental condition, the logic to  
15 determine a rate of change of the environmental condition based at least in part on the plurality of second control signals.

Example 9. The apparatus of any one of examples 1 to 8, comprising: a frame comprising an air inlet, an air outlet, and an air passageway coupling the air inlet and the air outlet, the filter media and the flow sensor disposed within the air passageway, the frame to be worn by a user  
20 and the air outlet to be positioned proximate to the user's mouth.

Example 10. The apparatus of example 9, the environmental sensor disposed in the air passageway between the filter media and the air outlet, wherein the environmental condition is indicative of an exposure of a user to an environmental hazard.

Example 11. The apparatus of example 9, the first control signal a one of a plurality of first  
25 control signals received from the flow sensor, each one of the plurality of first control signals to include an indication of a volume of material transmitted through the flow sensor, the logic to: determine a pattern to the volume of air transmitted through the flow sensor based on the plurality of first control signals; determine whether the pattern matches a distress pattern; and send a distress signal to a remote system based on a determination that the pattern matches the  
30 distress pattern, the distress signal to include an indication that a user of the apparatus may be in distress.

Example 12. A respirator comprising: a frame comprising an air inlet, an air outlet, and an air passageway coupling the air inlet and the air outlet; and a platform respirator cartridge disposed in the air passageway, the platform respirator cartridge comprising: a filter media; a

flow sensor disposed proximate to the filter media; an environmental sensor; and logic, at least a portion of which is implemented in hardware, the logic to: receive a first control signal from the flow sensor, the first control signal to include an indication of a volume of material transmitted through the flow sensor; receive a second control signal from the environmental sensor, the  
5 second control signal to include an indication of an environmental condition; and determine a condition of the filter media based at least in part on the volume of material transmitted through the flow sensor and the environmental condition.

Example 13. The respirator of example 12, the platform respirator cartridge comprising an output device, the logic to send an output control signal to the output device, the output control  
10 signal to cause the output device to provide an alert to include an indication of the condition of the filter.

Example 14. The respirator of example 13, the output device comprising a light emitting diode, a speaker, or a display and the alert comprising a visual alert or an audible alert.

Example 15. The respirator of example 12, the logic to determine whether the volume of  
15 material transmitted through the flow sensor exceeds a threshold value.

Example 16. The respirator of example 15, the logic to send a power control signal to the environmental sensor based on a determination that the volume of material transmitted through the flow sensor does not exceed the threshold value, the power control signal to include an indication to reduce a power consumption.

Example 17. The respirator of example 15, the logic to place the apparatus in a sleep state  
20 based on a determination that the volume of material transmitted through the flow sensor does not exceed the threshold value.

Example 18. The respirator of example 12, the second control signal a one of a plurality of  
25 second control signals received from the environmental sensor, each one of the plurality of second control signals to include an indication of an environmental condition, the logic to determine a rate of change of the environmental condition based at least in part on the plurality of second control signals.

Example 19. The respirator of any one of examples 12 to 18, the environmental sensor  
30 disposed in the air passageway between the filter media and the air outlet, wherein the environmental condition is indicative of an exposure of a user to an environmental hazard.

Example 20. The respirator of any one of examples 12 to 18, the first control signal a one of a plurality of first control signals received from the flow sensor, each one of the plurality of first control signals to include an indication of a volume of material transmitted through the flow sensor, the logic to: determine a pattern to the volume of air transmitted through the flow sensor

based on the plurality of first control signals; determine whether the pattern matches a distress pattern; and send a distress signal to a remote system based on a determination that the pattern matches the distress pattern, the distress signal to include an indication that a user of the apparatus may be in distress.

5 Example 21. The respirator of any one of examples 12 to 18, the platform respirator cartridge comprising a radio, the logic to send an information element to a remote system, the information element to include an indication of the condition of the filter media.

Example 22. The respirator of example 21, comprising an antenna, the radio to send and receive signals via the antenna, wherein the radio is a WiFi radio, a Bluetooth radio, a Bluetooth  
10 Low Energy radio, or a ZigBee radio.

Example 23. A method comprising: receive a first control signal from a flow sensor disposed in a respirator protection apparatus, the first control signal to include an indication of a volume of material transmitted through the flow sensor; receive a second control signal from an environmental sensor disposed in the respirator protection apparatus, the second control signal to  
15 include an indication of an environmental condition; and determine a condition of a filter media disposed in the respirator protection device based at least in part on the volume of material transmitted through the flow sensor and the environmental condition.

Example 24. The method of example 23, comprising sending an output control signal to an output device of the respirator protection apparatus, the output control signal to cause the output  
20 device to provide an alert to include an indication of the condition of the filter.

Example 25. The method of example 24, the output device comprising a light emitting diode, a speaker, or a display and the alert comprising a visual alert or an audible alert.

Example 26. The method of example 23, comprising determining whether the volume of material transmitted through the flow sensor exceeds a threshold value.

25 Example 27. The method of example 26, comprising sending a power control signal to the environmental sensor based on a determination that the volume of material transmitted through the flow sensor does not exceed the threshold value, the power control signal to include an indication to reduce a power consumption.

Example 28. The method of example 26, comprising placing the respirator protection  
30 apparatus in a sleep state based on a determination that the volume of material transmitted through the flow sensor does not exceed the threshold value.

Example 29. The method of example 23, the second control signal a one of a plurality of second control signals received from the environmental sensor, each one of the plurality of second control signals to include an indication of an environmental condition, the method

comprising determining a rate of change of the environmental condition based at least in part on the plurality of second control signals.

5 Example 30. The method of any one of examples 23 to 29, the environmental sensor disposed in an air passageway between the filter media and the air outlet, wherein the environmental condition is indicative of an exposure of a user to an environmental hazard.

10 Example 31. The method of any one of examples 23 to 29, the first control signal a one of a plurality of first control signals received from the flow sensor, each one of the plurality of first control signals to include an indication of a volume of material transmitted through the flow sensor, the method comprising: determining a pattern to the volume of air transmitted through the flow sensor based on the plurality of first control signals; determining whether the pattern matches a distress pattern; and sending a distress signal to a remote system based on a determination that the pattern matches the distress pattern, the distress signal to include an indication that a user of the apparatus may be in distress.

15 Example 32. The method of any one of examples 23 to 29, comprising sending an information element to a remote system, the information element to include an indication of the condition of the filter media.

Example 33. At least one machine readable medium comprising a plurality of instructions that in response to being executed on a wearable device causes the wearable computing device to perform the method of any of examples 23 to 32.

20 Example 34. An apparatus for respiration protection equipment, the apparatus comprising means for performing the method of any one of examples 23 to 32.

**CLAIMS****What is claimed is:**

1. An apparatus, comprising:
  - a filter media;
  - 5 a flow sensor disposed proximate to the filter media;
  - an environmental sensor; and
  - logic, at least a portion of which is implemented in hardware, the logic to:
    - receive a first control signal from the flow sensor, the first control signal to
    - include an indication of a volume of material transmitted through the flow sensor;
    - 10 receive a second control signal from the environmental sensor, the second control
    - signal to include an indication of an environmental condition; and
    - determine a condition of the filter media based at least in part on the volume of
    - material transmitted through the flow sensor and the environmental condition.
2. The apparatus of claim 1, comprising a radio, the logic to send an information element to a
- 15 remote system, the information element to include an indication of the condition of the filter media.
3. The apparatus of claim 1, comprising an output device, the logic to send an output control signal to the output device, the output control signal to cause the output device to provide an alert to include an indication of the condition of the filter.
- 20 4. The apparatus of claim 3, the output device comprising a light emitting diode, a speaker, or a display and the alert comprising a visual alert or an audible alert.
5. The apparatus of claim 1, the logic to determine whether the volume of material transmitted through the flow sensor exceeds a threshold value.
6. The apparatus of claim 5, the logic to send a power control signal to the environmental sensor
- 25 based on a determination that the volume of material transmitted through the flow sensor does not exceed the threshold value, the power control signal to include an indication to reduce a power consumption.
7. The apparatus of claim 5, the logic to place the apparatus in a sleep state based on a determination that the volume of material transmitted through the flow sensor does not exceed
- 30 the threshold value.
8. The apparatus of claim 1, the second control signal a one of a plurality of second control signals received from the environmental sensor, each one of the plurality of second control signals to include an indication of an environmental condition, the logic to determine a rate of

change of the environmental condition based at least in part on the plurality of second control signals.

9. The apparatus of claim 1, comprising:

a frame comprising an air inlet, an air outlet, and an air passageway coupling the air inlet and the air outlet, the filter media and the flow sensor disposed within the air passageway, the frame to be worn by a user and the air outlet to be positioned proximate to the user's mouth.

10. The apparatus of claim 9, the environmental sensor disposed in the air passageway between the filter media and the air outlet, wherein the environmental condition is indicative of an exposure of a user to an environmental hazard.

11. The apparatus of claim 9, the first control signal a one of a plurality of first control signals received from the flow sensor, each one of the plurality of first control signals to include an indication of a volume of material transmitted through the flow sensor, the logic to:

determine a pattern to the volume of air transmitted through the flow sensor based on the plurality of first control signals;

determine whether the pattern matches a distress pattern; and

send a distress signal to a remote system based on a determination that the pattern matches the distress pattern, the distress signal to include an indication that a user of the apparatus may be in distress.

12. A respirator comprising:

a frame comprising an air inlet, an air outlet, and an air passageway coupling the air inlet and the air outlet; and

a platform respirator cartridge disposed in the air passageway, the platform respirator cartridge comprising:

a filter media;

a flow sensor disposed proximate to the filter media;

an environmental sensor; and

logic, at least a portion of which is implemented in hardware, the logic to:

receive a first control signal from the flow sensor, the first control signal to include an indication of a volume of material transmitted through the flow sensor;

receive a second control signal from the environmental sensor, the second control signal to include an indication of an environmental condition; and

determine a condition of the filter media based at least in part on the volume of material transmitted through the flow sensor and the environmental condition.

13. The respirator of claim 12, the platform respirator cartridge comprising an output device, the logic to send an output control signal to the output device, the output control signal to cause the output device to provide an alert to include an indication of the condition of the filter, wherein the output device comprises a light emitting diode, a speaker, or a display and the alert comprising a visual alert or an audible alert.

14. The respirator of claim 12, the logic to determine whether the volume of material transmitted through the flow sensor exceeds a threshold value, the logic to place the apparatus in a sleep state based on a determination that the volume of material transmitted through the flow sensor does not exceed the threshold value.

15. The respirator of claim 12, the second control signal a one of a plurality of second control signals received from the environmental sensor, each one of the plurality of second control signals to include an indication of an environmental condition, the logic to determine a rate of change of the environmental condition based at least in part on the plurality of second control signals.

16. The respirator of claim 12, the first control signal a one of a plurality of first control signals received from the flow sensor, each one of the plurality of first control signals to include an indication of a volume of material transmitted through the flow sensor, the logic to:

determine a pattern to the volume of air transmitted through the flow sensor based on the plurality of first control signals;

determine whether the pattern matches a distress pattern; and

send a distress signal to a remote system based on a determination that the pattern matches the distress pattern, the distress signal to include an indication that a user of the apparatus may be in distress.

17. The respirator of claim 12, the platform respirator cartridge comprising a radio, the logic to send an information element to a remote system, the information element to include an indication of the condition of the filter media, wherein the radio is a cellular radio, a WiFi radio, a Bluetooth radio, a Bluetooth Low Energy radio, or a ZigBee radio.

18. A method comprising:

receive a first control signal from a flow sensor disposed in a respirator protection apparatus, the first control signal to include an indication of a volume of material transmitted through the flow sensor;

receive a second control signal from an environmental sensor disposed in the respirator protection apparatus, the second control signal to include an indication of an environmental condition; and

determine a condition of a filter media disposed in the respirator protection device  
5 based at least in part on the volume of material transmitted through the flow sensor and the environmental condition.

19. The method of claim 18, comprising sending an output control signal to an output device of the respirator protection apparatus, the output control signal to cause the output device to provide an alert to include an indication of the condition of the filter.

10 20. The method of claim 19, the output device comprising a light emitting diode, a speaker, or a display and the alert comprising a visual alert or an audible alert.

21. The method of claim 18, comprising determining whether the volume of material transmitted through the flow sensor exceeds a threshold value.

22. The method of claim 18, the second control signal a one of a plurality of second control  
15 signals received from the environmental sensor, each one of the plurality of second control signals to include an indication of an environmental condition, the method comprising determining a rate of change of the environmental condition based at least in part on the plurality of second control signals.

23. The method of claim 18, the environmental sensor disposed in an air passageway between  
20 the filter media and the air outlet, wherein the environmental condition is indicative of an exposure of a user to an environmental hazard.

24. The method of claim 18, the first control signal a one of a plurality of first control signals received from the flow sensor, each one of the plurality of first control signals to include an indication of a volume of material transmitted through the flow sensor, the method comprising:

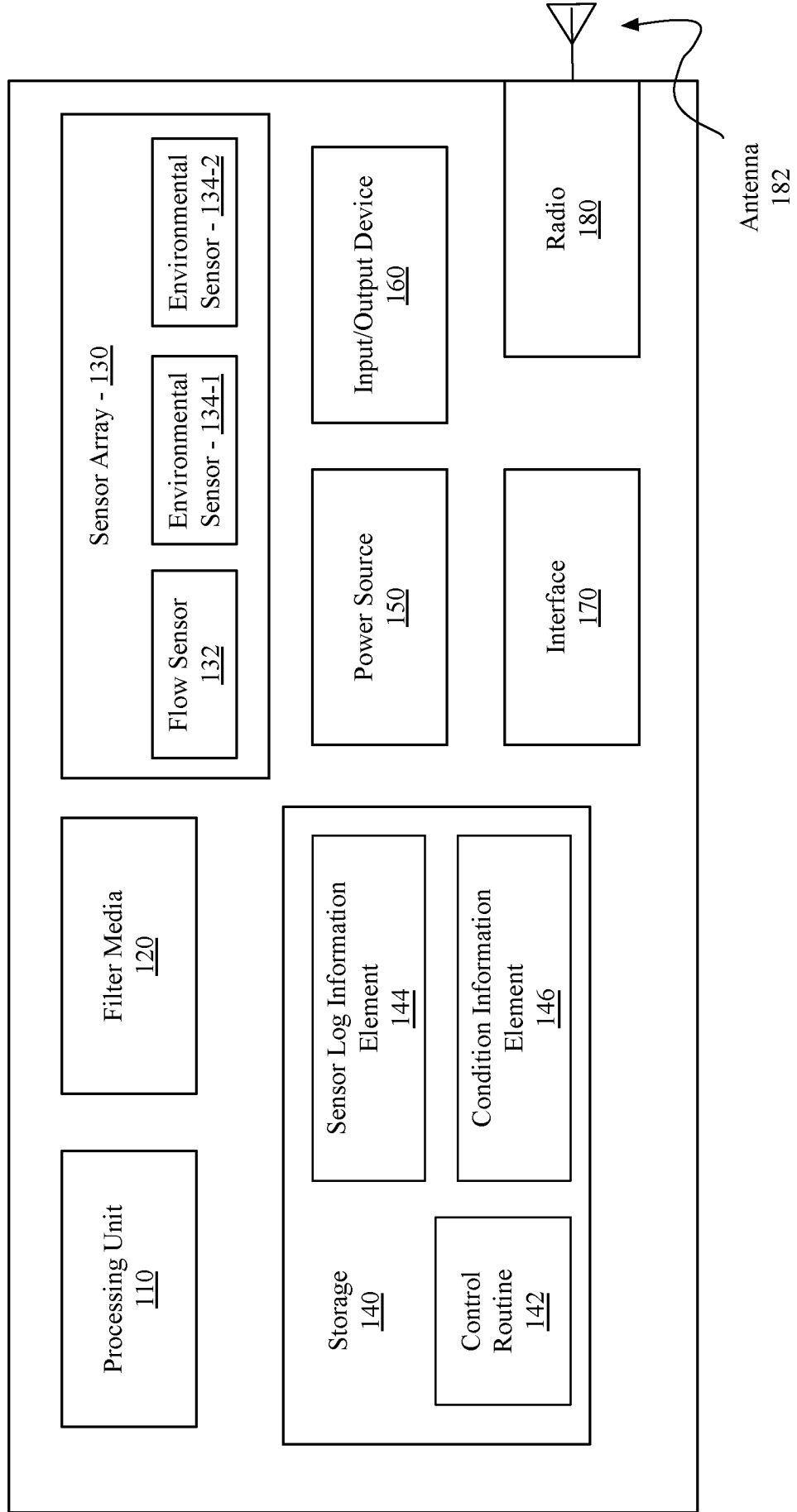
25 determining a pattern to the volume of air transmitted through the flow sensor based on the plurality of first control signals;

determining whether the pattern matches a distress pattern; and

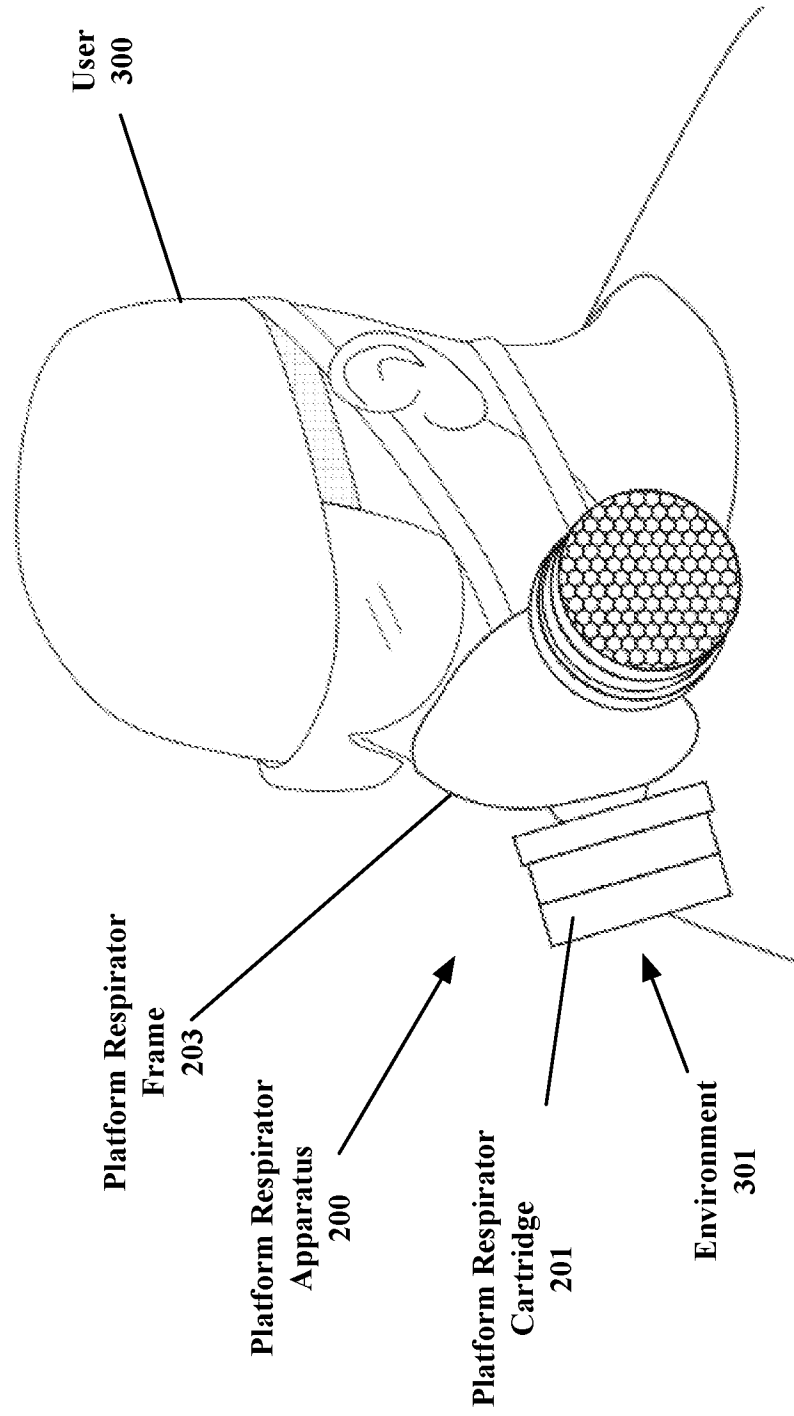
30 sending a distress signal to a remote system based on a determination that the pattern matches the distress pattern, the distress signal to include an indication that a user of the apparatus may be in distress.

25. The method of claim 18, comprising sending an information element to a remote system, the information element to include an indication of the condition of the filter media.

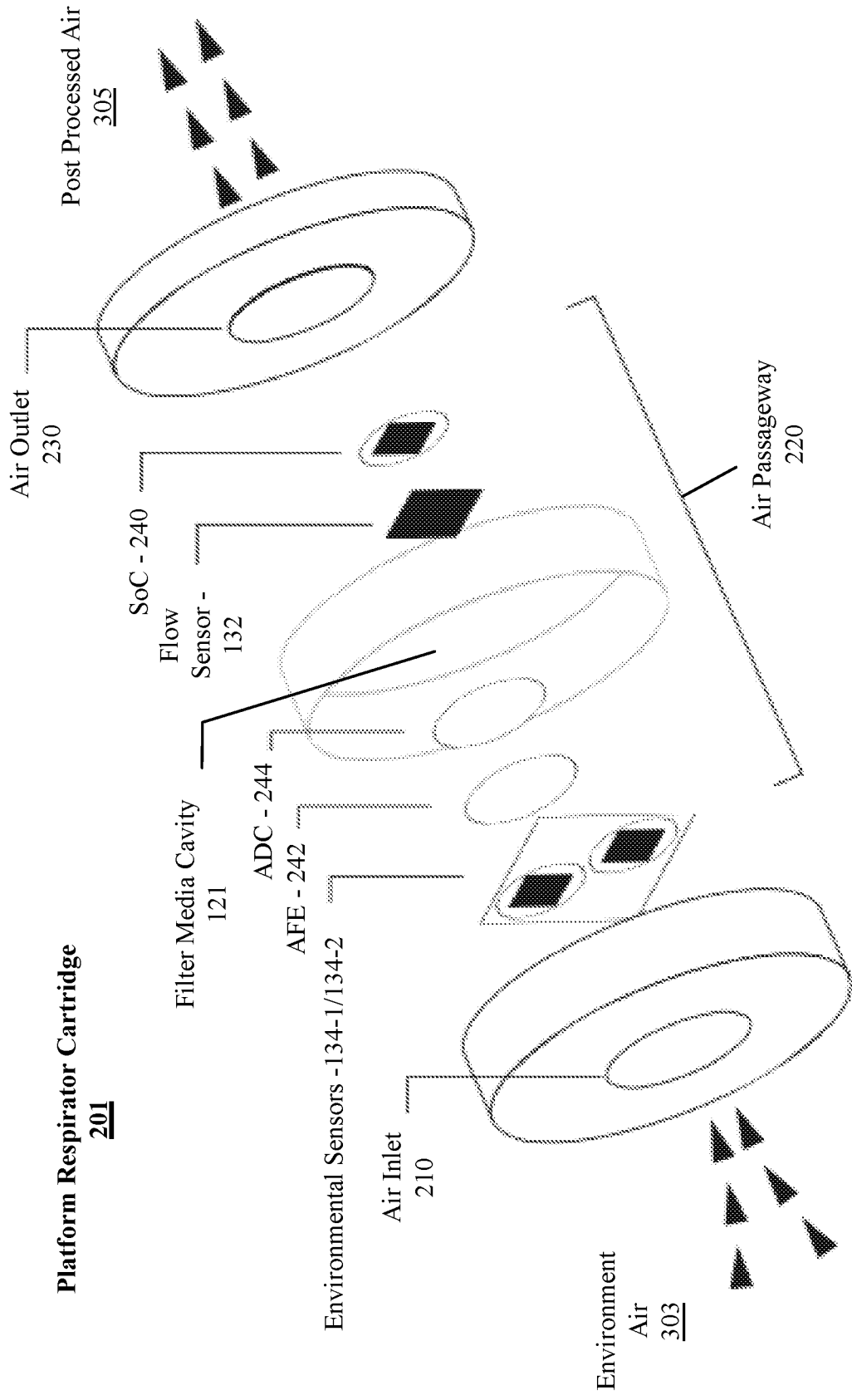
**Platform Respirator Apparatus  
100**



**FIG. 1**

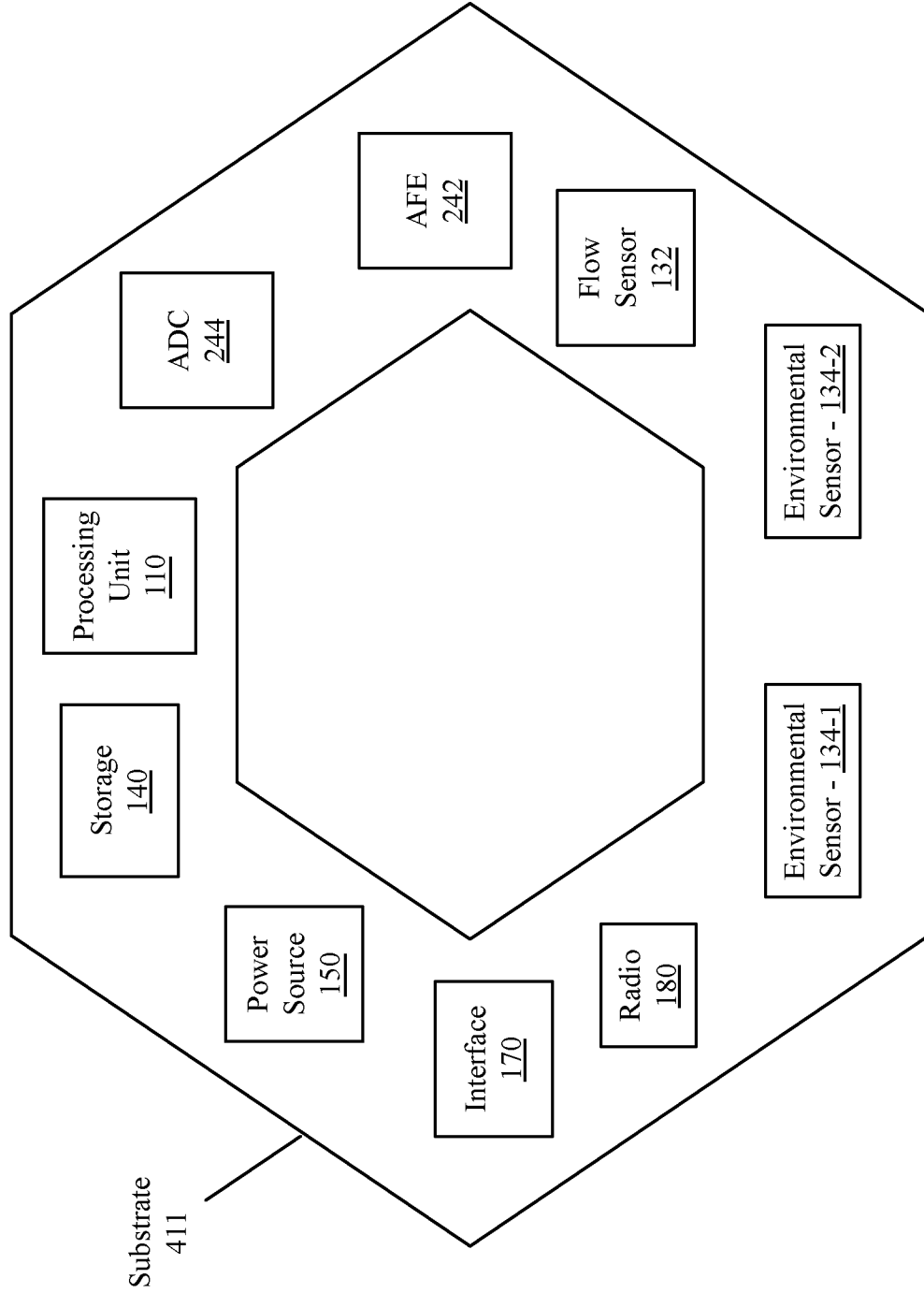


**FIG. 2**



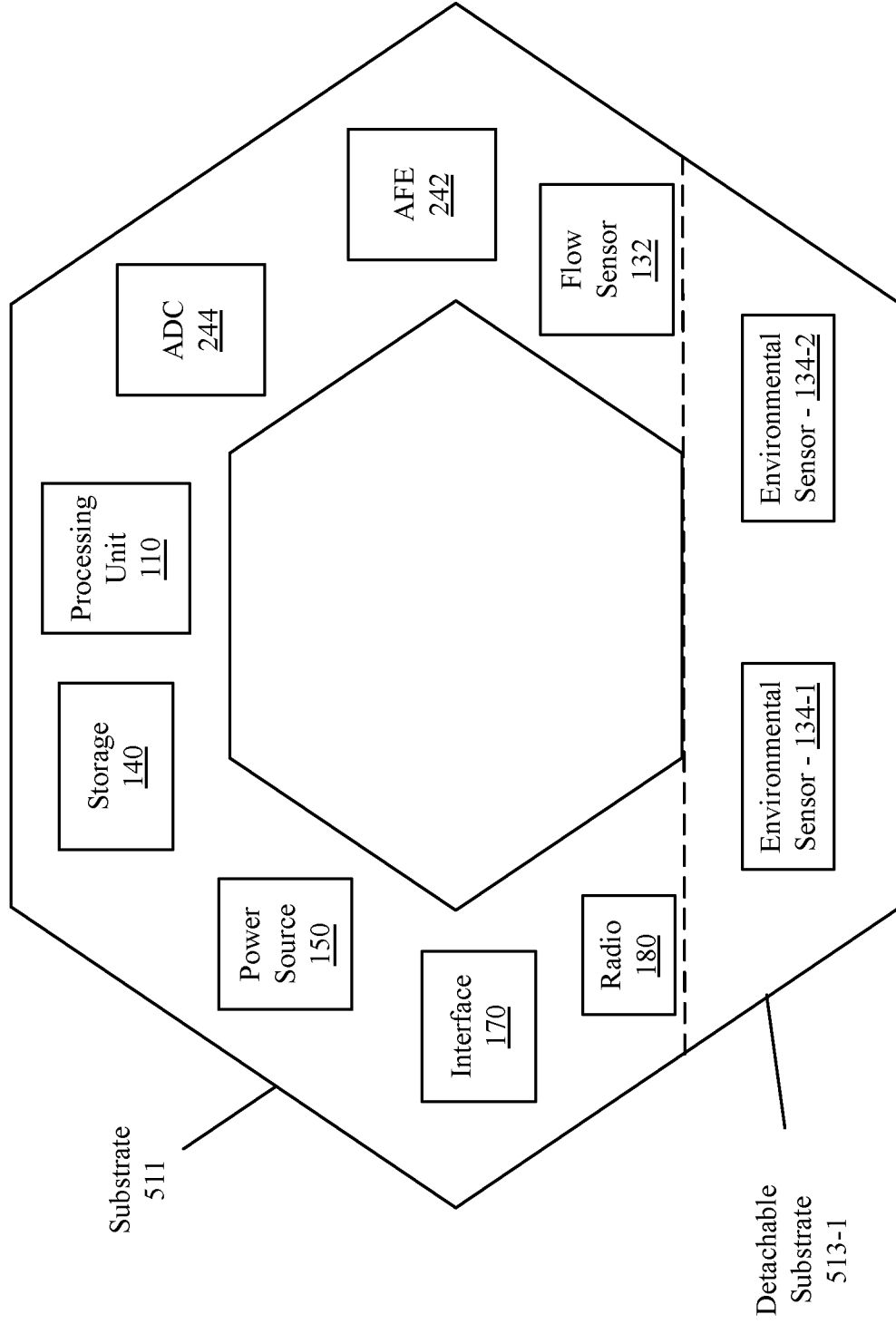
**FIG. 3**

**Platform Respirator Cartridge**  
**401**



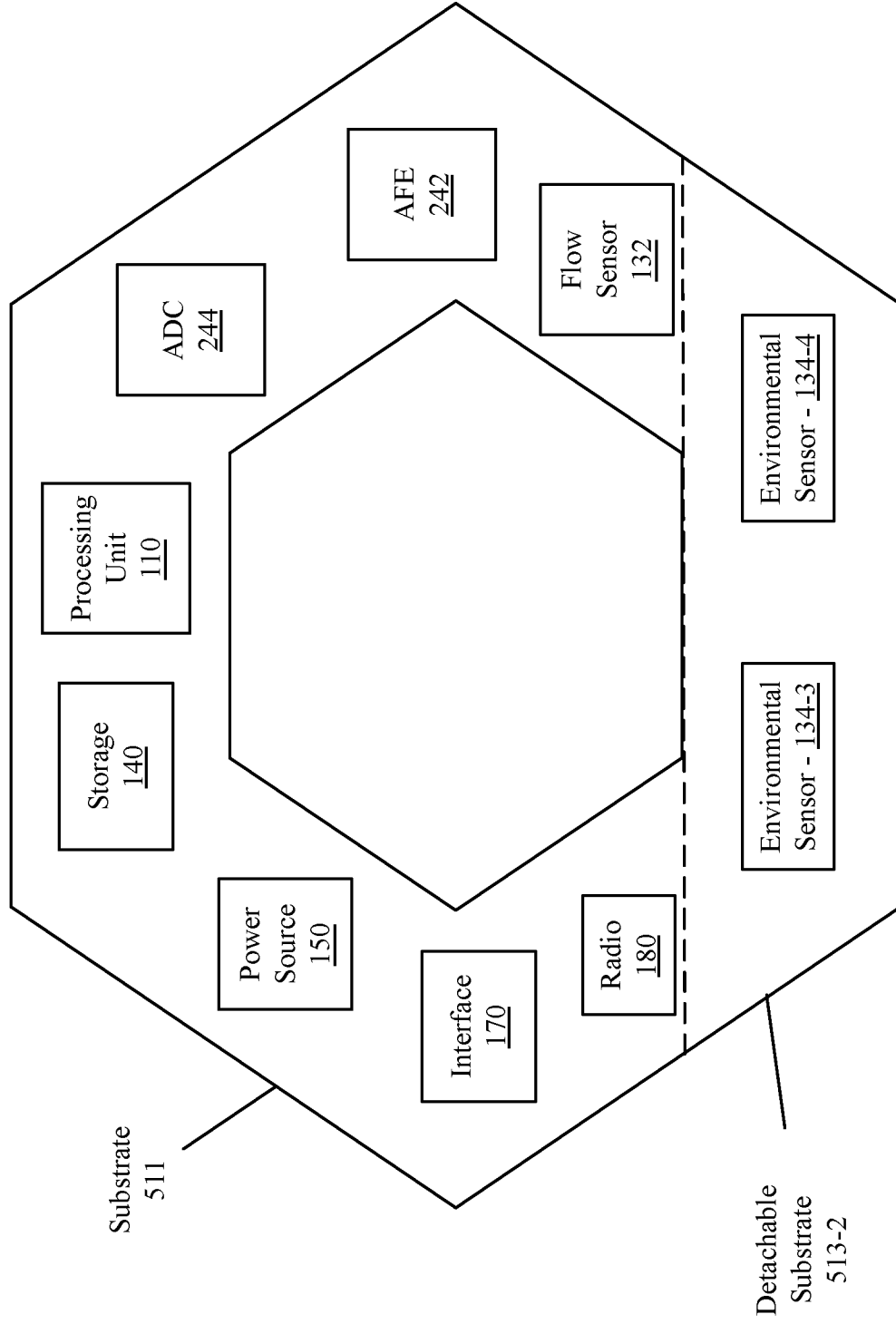
**FIG. 4**

**Platform Respirator Cartridge**  
**501**

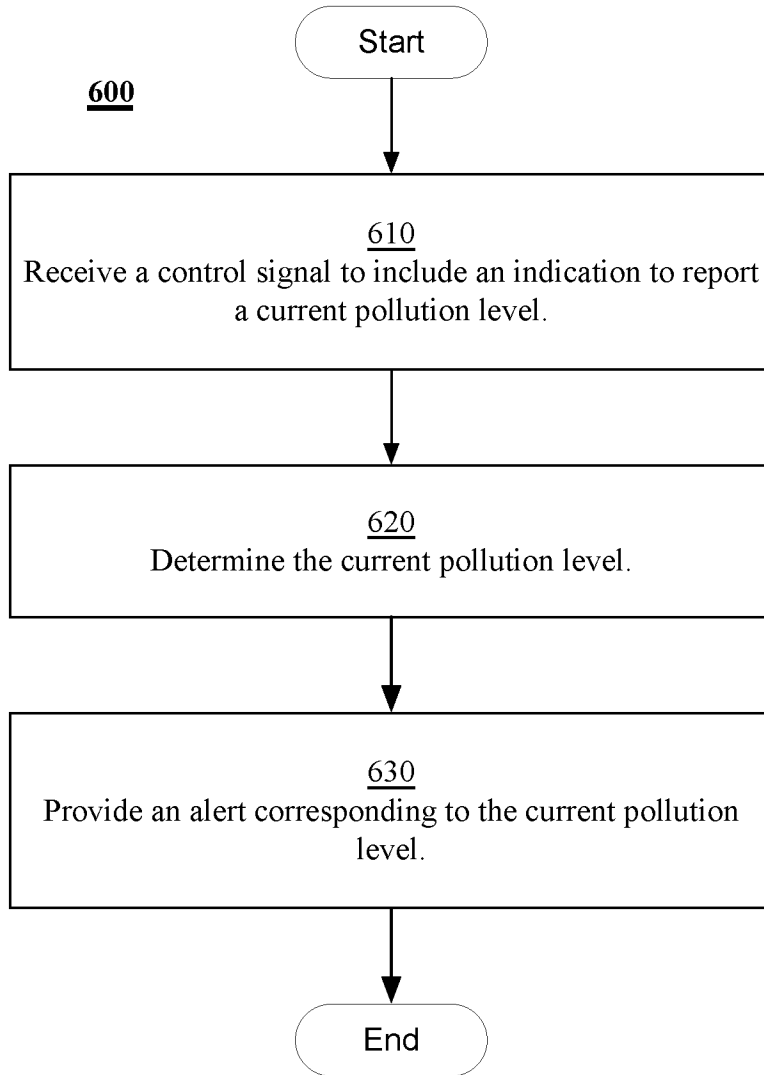


**FIG. 5A**

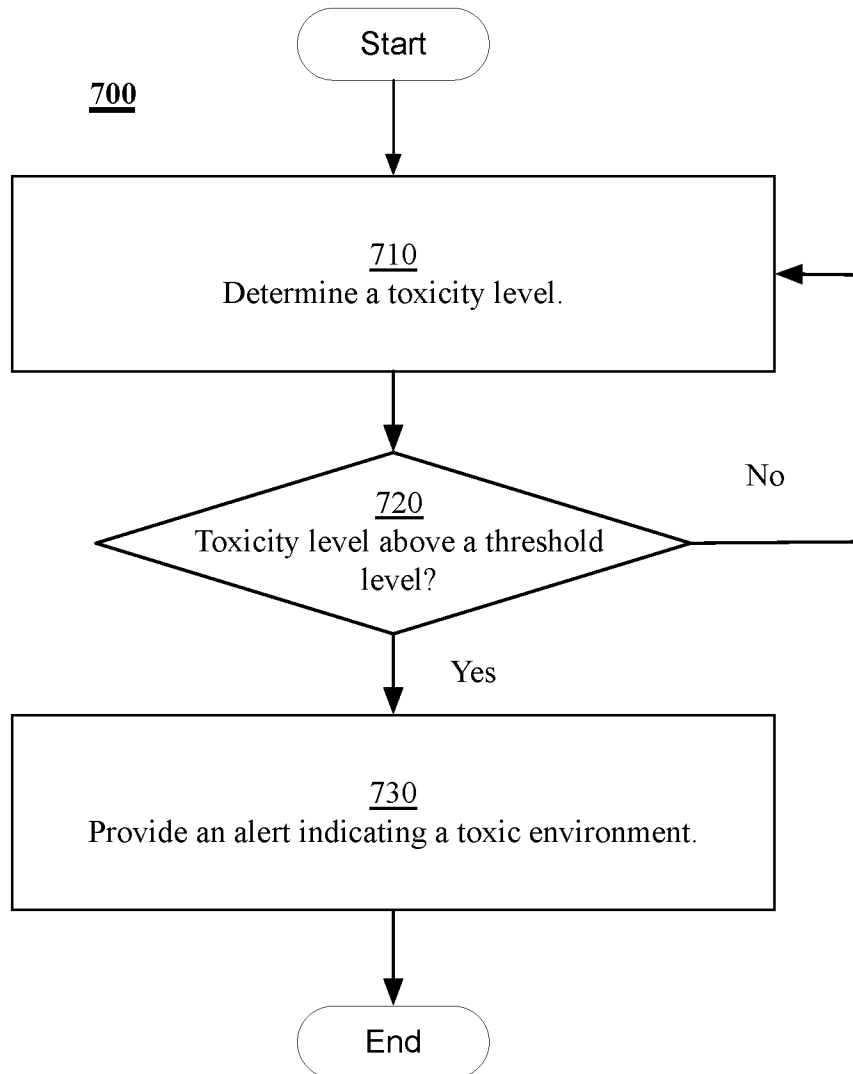
**Platform Respirator Cartridge**  
**501**



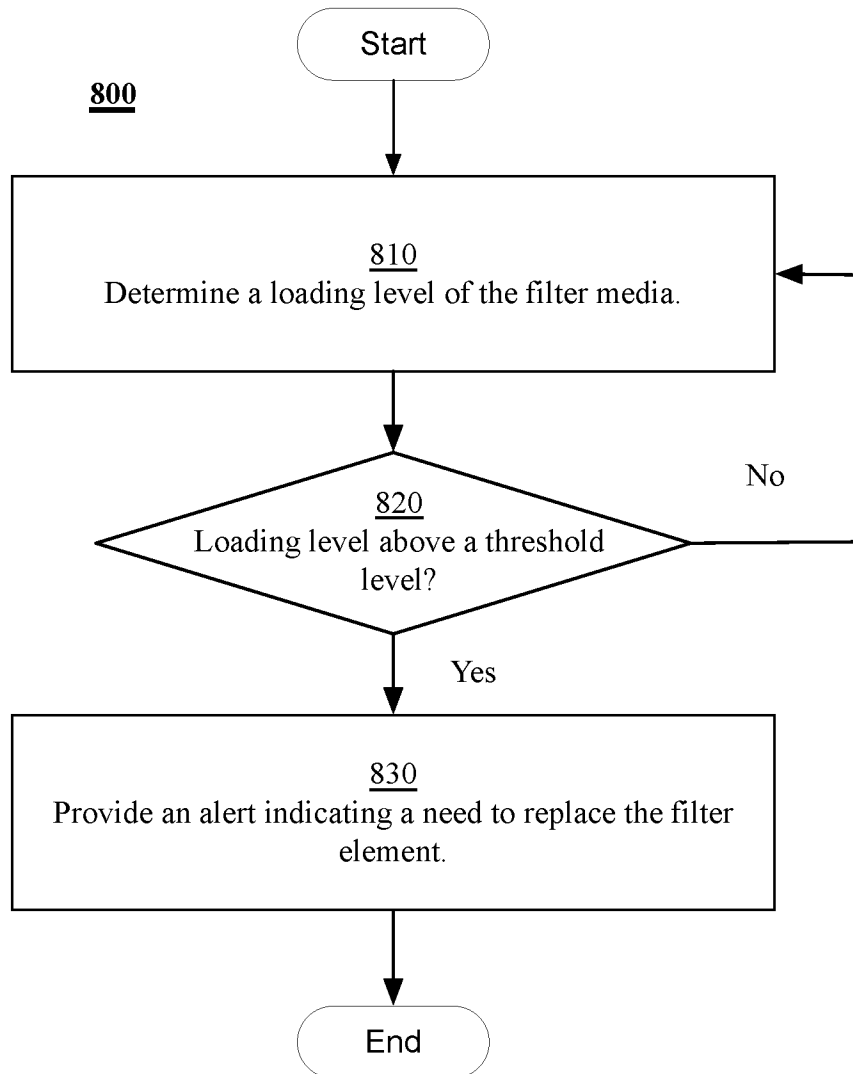
**FIG. 5B**



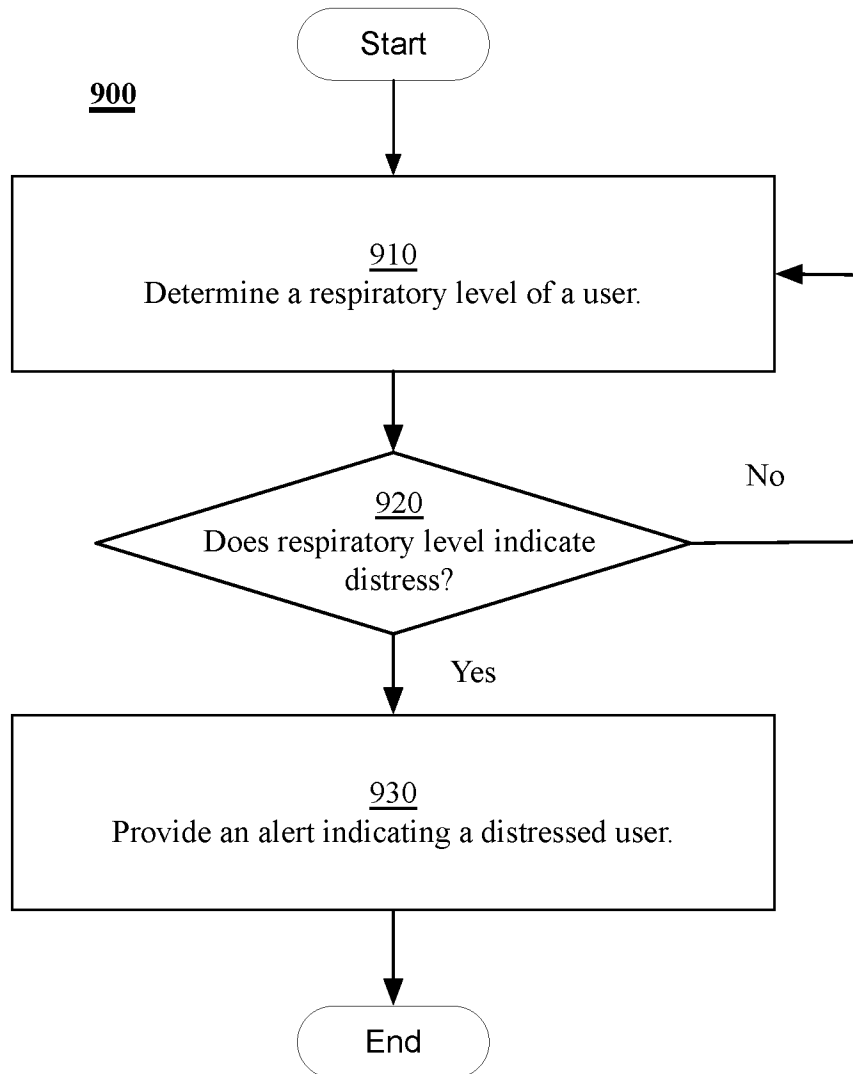
**FIG. 6**



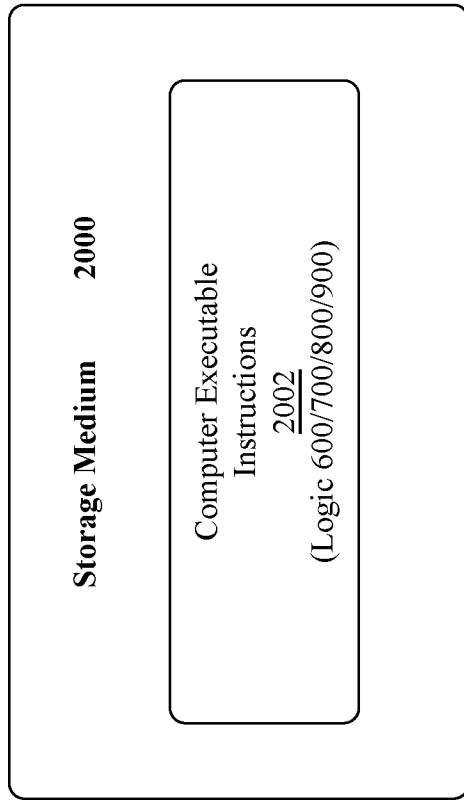
**FIG. 7**



**FIG. 8**

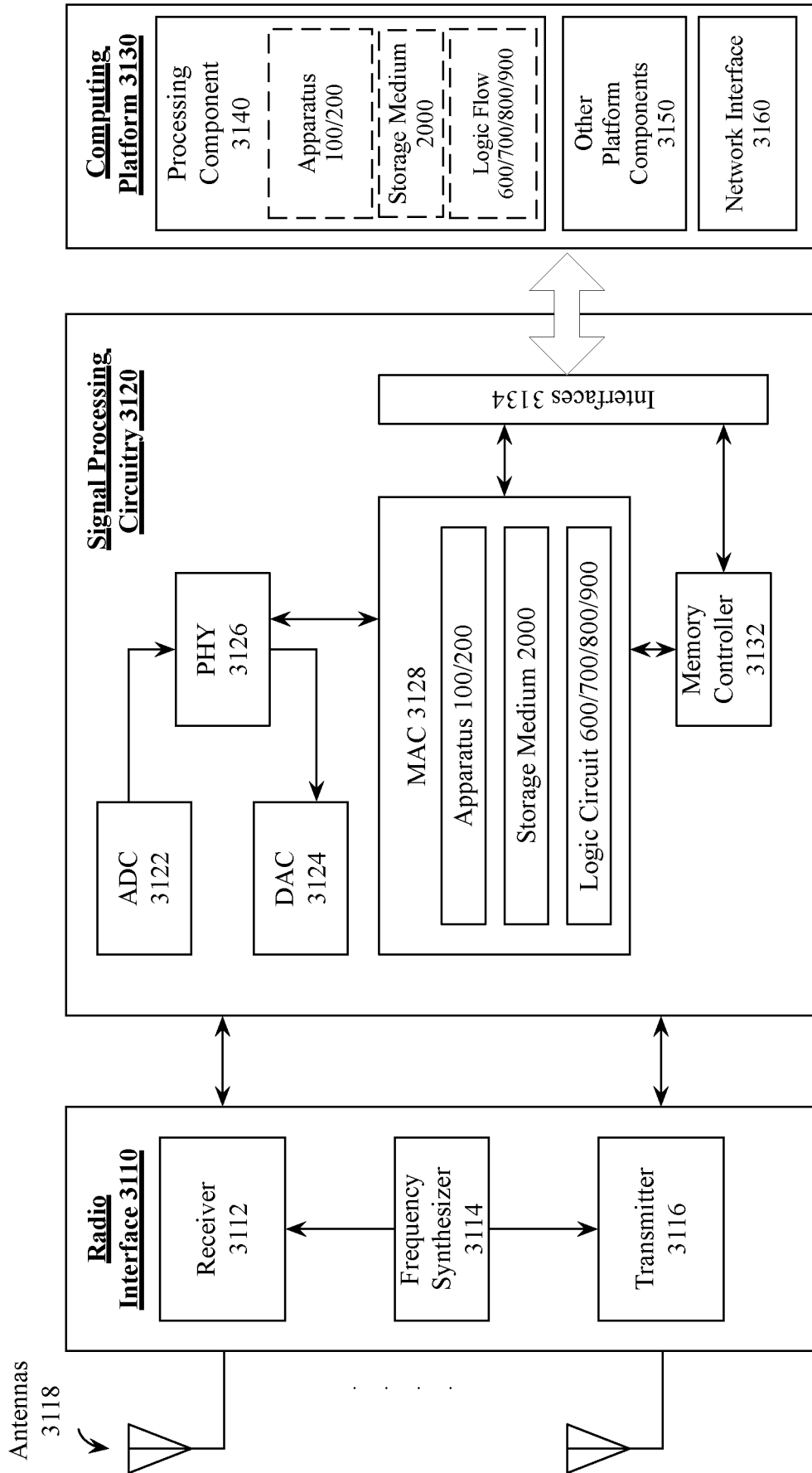


**FIG. 9**

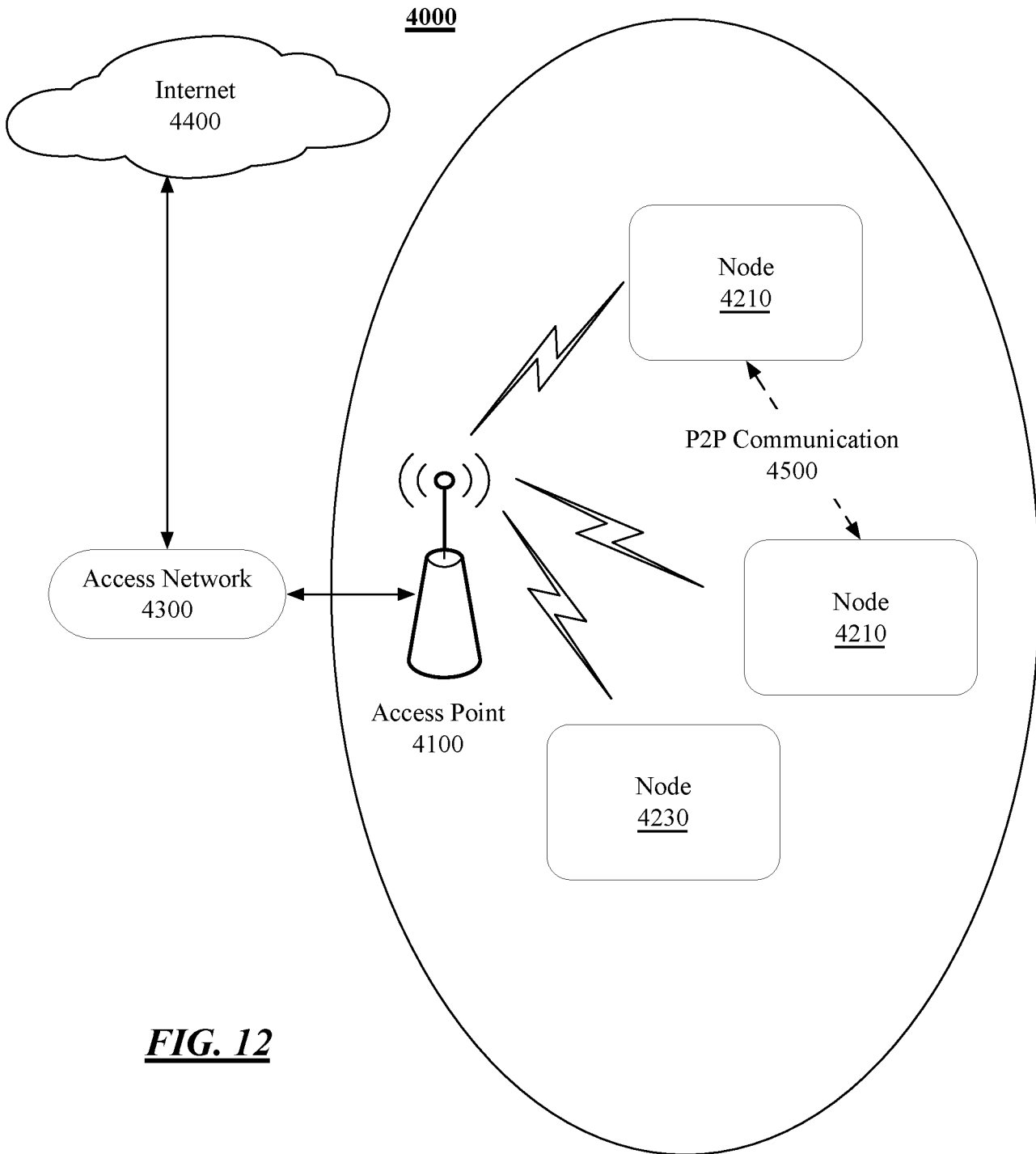


**FIG. 10**

**Device 3000**



**FIG. 11**



**FIG. 12**

## INTERNATIONAL SEARCH REPORT

International application No.  
**PCT/US2016/016451****A. CLASSIFICATION OF SUBJECT MATTER****A62B 18/02(2006.01)i, A62B 18/08(2006.01)i, A62B 23/02(2006.01)i, G08B 5/36(2006.01)i, G08B 3/10(2006.01)i, G08B 21/02(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

A62B 18/02; A62B 7/10; A62B 18/08; A62B 27/00; A62B 18/04; B01D 53/04; A62B 9/00; A62B 23/02; G08B 5/36; G08B 3/10; G08B 21/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models  
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) &amp; Keywords: respirator, filter, sensor, signal, condition, frame, cartridge

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 2365858 B1 (SCOTT TECHNOLOGIES, INC.) 18 February 2015 See paragraphs [0017], [0018], [0023], [0025], [0062], [0063], claims 1, 6 and figures 1, 2, 5.	1-7, 9-10, 12-14, 17-21, 23, 25
A		8, 11, 15-16, 22, 24
A	CN 104922822 A (YANG) 23 September 2015 See paragraph [0005] and figure 2.	1-25
A	US 2014-0283840 A1 (NEXTTEQ, LLC) 25 September 2014 See paragraphs [0140]-[0146] and figures 2, 5, 6.	1-25
A	CN 203154653 U (NANJING ZHENGZE TECHNOLOGY CO., LTD.) 28 August 2013 See paragraphs [0033]-[0049] and figure 7.	1-25
A	EP 2486959 A1 (SHIGEMATSU WORKS CO., LTD.) 15 August 2012 See claim 1 and figures 5, 6.	1-25

 Further documents are listed in the continuation of Box C. See patent family annex.

\* Special categories of cited documents:

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

25 October 2016 (25.10.2016)

Date of mailing of the international search report

**25 October 2016 (25.10.2016)**

Name and mailing address of the ISA/KR

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**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2016/016451**

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