(54) Title: PORTABLE HANDHELD PRESSURE SUPPORT SYSTEM AND METHOD

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(57) Abstract: The present disclosure pertains to a portable handheld pressure support system configured to deliver a pressurized flow of breathable gas to the airway of a subject. The pressure support system is configured to treat COPD and/or other patients suffering from dyspnea and/or other conditions. The pressure support system is configured to be small and lightweight so that a subject may carry the system and use the system as needed without requiring a device to be worn on the face. The present disclosure contemplates that the portable handheld pressure support system may be used to treat symptoms and/or conditions related to dyspnea, and/or for other uses. In one embodiment, the system comprises one or more of a pressure generator, a subject interface, one or more sensors, one or more processors, a user interface, electronic storage, a portable power source, a housing, a handle, and/or other components.

FIG. 1
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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PORTABLE HANDHELD PRESSURE SUPPORT SYSTEM AND METHOD
CROSS REFERENCE TO RELATED APPLICATIONS

[01] This patent application claims the priority benefit under 35 U.S.C. § 119(e) of U.S. Provisional Application No. 61/637,586 filed on April 24, 2012, the contents of which are herein incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[02] The present disclosure pertains to a portable handheld pressure support system configured to deliver a pressurized flow of breathable gas to the airway of a subject.

2. Description of the Related Art

[03] It is well known to apply a positive air pressure (PAP) to a patient's airway to keep the airway open and avoid collapse during breathing. This positive pressure effectively "splints" the airway, thereby maintaining an open passage to the lungs. Dyspnea, or shortness of breath, is a primary symptom of COPD. COPD patients suffer occurrences of dyspnea when exerting themselves. The forms of exertion may include performing household chores, walking to the local store, or climbing a set of stairs. An onset of dyspnea limits a patient's ability to perform activities and can trigger apprehension or panic, further reducing the patient's ability to function. COPD patients carry short acting bronchodilators to alleviate their symptoms of dyspnea. Bronchodilators have drawbacks including that they are steroid based, they are slow acting (4-20 minutes), they are effective for only asthmatic-based symptoms, and they rely on expensive pharmaceuticals.

SUMMARY OF THE INVENTION

[04] Accordingly, one or more aspects of the present disclosure relate to a portable handheld pressure support system configured to deliver a pressurized flow of breathable gas to the airway of a subject. The pressure support system comprises a
pressure generator, a subject interface, one or more sensors, one or more processors, a portable power source, a housing, and a handle. The pressure generator is configured to generate the pressurized flow of breathable gas. The subject interface is configured to communicate the pressurized flow of breathable gas to the airway of the subject. The one or more sensors are configured to generate output signals conveying information related to one or more gas parameters of the pressurized flow of breathable gas. The one or more processors are configured to control operation of the pressure generator to generate the pressurized flow of breathable gas based on the output signals from the one or more sensors, according to a positive pressure support therapy regime. The portable power source is configured to power the pressure generator, the one or more sensors, and the one or more processors. The housing is configured to contain the pressure generator, the subject interface, the one or more sensors, the one or more processors, and the power source. The handle is attached to and/or formed by the housing and is configured to be grasped by the subject to hold the housing in position with respect to the airway of the subject as the pressurized flow of breathable gas is delivered to the airway of the subject.

Yet another aspect of the present disclosure relates to a method of delivering a pressurized flow of breathable gas to the airway of a subject with a handheld pressure support system that includes a housing. The housing contains a pressure generator, a subject interface, one or more sensors, one or more processors, and a power source. The housing forms and/or is attached to a handle. The method comprises generating the pressurized flow of breathable gas with the pressure generator; communicating the pressurized flow of breathable gas to the airway of the subject with the subject interface; generating output signals conveying information related to one or more gas parameters of the pressurized flow of breathable gas with the one or more sensors; controlling generation of the pressurized flow of breathable gas with the one or more processors, based on the output signals, according to a positive pressure support therapy regime; portably powering the pressure generator, the one or more sensors, and the one or more processors with the power source; and grasping the handle to hold the housing in...
position with respect to the airway of the subject as the pressurized flow of breathable gas is delivered to the airway of the subject.

Still another aspect of the present disclosure relates to a portable handheld pressure support system configured to deliver a pressurized flow of breathable gas to the airway of a subject. The pressure support system comprises means for generating the pressurized flow of breathable gas; means for communicating the pressurized flow of breathable gas to the airway of the subject; means for generating output signals conveying information related to one or more gas parameters of the pressurized flow of breathable gas; means for controlling the means to generate the pressurized flow of breathable gas based on the output signals, according to a positive pressure support therapy regime; means for portably powering the means to generate the pressurized flow of breathable gas, the means for generating output signals, and the means for controlling; means for containing the means to generate the pressurized flow of breathable gas, the means for communicating, the means for generating output signals, the means for controlling, and the means for portably powering; and means for engaging the hand of the subject to be grasped by the subject, the means for engaging being connected to and/or formed by the means for containing, the means for engaging being configured to be grasped by the subject to hold the means for containing in position with respect to the airway of the subject as the pressurized flow of breathable gas is delivered to the airway of the subject.

These and other objects, features, and characteristics of the present disclosure, as well as the methods of operation and functions of the related elements of structure and the combination of parts and economies of manufacture, will become more apparent upon consideration of the following description and the appended claims with reference to the accompanying drawings, all of which form a part of this specification, wherein like reference numerals designate corresponding parts in the various figures. It is to be expressly understood, however, that the drawings are for the purpose of illustration and description only and are not intended as a definition of the limits of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS
FIG. 1 is a schematic of a portable handheld pressure support system configured to deliver a pressurized flow of breathable gas to the airway of a subject;

FIG. 2 is an example embodiment of the portable handheld pressure support system; and

FIG. 3 is a method of delivering a pressurized flow of breathable gas to the airway of a subject.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

As used herein, the singular form of "a", "an", and "the" include plural references unless the context clearly dictates otherwise. As used herein, the statement that two or more parts or components are "coupled" shall mean that the parts are joined or operate together either directly or indirectly, i.e., through one or more intermediate parts or components, so long as a link occurs. As used herein, "directly coupled" means that two elements are directly in contact with each other. As used herein, "fixedly coupled" or "fixed" means that two components are coupled so as to move as one while maintaining a constant orientation relative to each other.

As used herein, the word "unitary" means a component is created as a single piece or unit. That is, a component that includes pieces that are created separately and then coupled together as a unit is not a "unitary" component or body. As employed herein, the statement that two or more parts or components "engage" one another shall mean that the parts exert a force against one another either directly or through one or more intermediate parts or components. As employed herein, the term "number" shall mean one or an integer greater than one (i.e., a plurality).

Directional phrases used herein, such as, for example and without limitation, top, bottom, left, right, upper, lower, front, back, and derivatives thereof, relate to the orientation of the elements shown in the drawings and are not limiting upon the claims unless expressly recited therein.

FIG. 1 schematically illustrates a portable handheld pressure support system 10 configured to provide pressure support therapy to a subject 12. Pressure support system 10 is configured to provide the pressure support therapy in the form of a
pressurized flow of breathable gas that is delivered to the airway of the subject. Pressure support system 10 is configured to treat COPD and/or other patients suffering from dyspnea and/or other conditions. The pressure support therapy provided to dyspnea patients is configured to be used as needed by subject 12 to rapidly alleviate shortness of breath. Pressure support system 10 is configured to be small and lightweight so that subject 12 may carry system 10 and use system 10 as needed without requiring a device to be worn on the face. The present disclosure contemplates that portable handheld pressure support system 10 may be used to treat symptoms and/or conditions related to dyspnea due to COPD, and/or for other uses. The other uses may include, for example, treating dyspnea related to pulmonary cancer, treating emphysema, treating pneumonia, treating Cheyne-Stokes respiration and/or other disordered breathing, improving the exercise capacity of any patient limited by dyspnea, and/or other uses.

[15] In some embodiments, system 10 comprises one or more of a pressure generator 14, a subject interface 16, one or more sensors 18, one or more processors 20, a user interface 22, electronic storage 24, a portable power source 26, a housing 28, a handle 30, and/or other components.

[16] Pressure generator 14 is configured to generate a flow of gas for delivery to the airway of a subject 12. Pressure generator 14 may control one or more parameters of the flow of gas (e.g., flow rate, pressure, volume, temperature, gas composition, etc.) for therapeutic purposes, and/or for other purposes. By way of a non-limiting example, pressure generator 14 may be configured to control the flow rate and/or pressure of the flow of gas to provide pressure support to the airway of subject 12.

[17] Pressure generator 14 receives a flow of gas from a gas source, such as the ambient atmosphere, and elevates the pressure of that gas for delivery to the airway of a patient. In some embodiments, pressure generator 14 receives a flow of gas from a gas source through inlet port 15. Pressure generator 14 is any device, such as, for example, a pump, blower, piston, or bellows, that is capable of elevating the pressure of the received gas for delivery to a patient. Pressure generator 14 may comprise one or more valves for controlling the pressure/flow of gas. The present disclosure also contemplates controlling
the operating speed of the blower, either alone or in combination with such valves, to control the pressure/flow of gas provided to the patient.

In some embodiments, pressure generator 14 may be configured to supply a pressurized flow of breathable gas at pressures up to about 40cm of water. In some embodiments, pressure generator 14 may be configured to supply a pressurized flow of breathable gas at pressures up to about 30cm of water. In some embodiments, pressure generator 14 may be configured to supply a pressurized flow of breathable gas at pressures up to about 20cm of water.

Subject interface 16 is configured to communicate the pressurized flow of breathable gas to the airway of subject 12. As such, subject interface 16 comprises conduit 40, interface appliance 42, filter 43, and/or other components. In some embodiments, filter 43 is configured to filter bacteria and/or other materials. Conduit 40 is configured to convey the pressurized flow of gas to interface appliance 42. Interface appliance 42 is configured to deliver the flow of gas to the airway of subject 12. In some embodiments, interface appliance 42 is configured to be non-invasively engaged by the mouth of subject 12. Non-invasive engagement comprises removably engaging one or more external orifices of the airway of subject 12 (e.g., nostrils and/or mouth) to communicate gas between the airway of subject 12 and interface appliance 42.

In some embodiments, interface appliance 42 is removably coupled to conduit 40. Interface appliance 42 may be removed for cleaning and/or for other purposes. In some embodiments, conduit 40 is configured as a mouthpiece to be engaged by the mouth of subject 12.

In some embodiments, other non-invasive interface appliances may be configured as interface appliance 42. Some examples of non-invasive interface appliance 42 may comprise, for example, a nasal cannula, a nasal mask, a nasal/oral mask, a full face mask, a total face mask, or other interface appliances that communicate a flow of gas with an airway of a subject. The present disclosure is not limited to these examples, and contemplates delivery of the flow of gas to the subject using any interface appliance. In
some embodiments, system 10 may be connected to a classical respiratory circuit (e.g., a six foot hose) such that the classical respiratory circuit functions as subject interface 16.

One or more sensors 18 are configured to generate output signals conveying information related to one or more parameters of the gas within system 10. The one or more parameters of the gas within system 10 may comprise gas parameters related to the pressurized flow of breathable gas, breathing parameters related to respiration of subject 12, and/or other parameters. Sensors 18 may comprise one or more sensors that measure such parameters directly (e.g., through fluid communication with the flow of gas in interface appliance 42). Sensors 18 may comprise one or more sensors that generate surrogate output signals related to the one or more parameters indirectly. For example, sensors 18 may comprise one or more sensors configured to generate an output based on an operating parameter of pressure generator 14 (e.g., patient flow and/or pressure estimations from motor current, voltage, rotational velocity, and/or other operating parameters), and/or other sensors.

The one or more gas parameters of the pressurized flow of breathable gas may comprise, for example, one or more of a flow rate, a volume, a pressure, humidity, temperature, acceleration, velocity, and/or other gas parameters. Breathing parameters related to the respiration of subject 12 may comprise a tidal volume, a timing (e.g., beginning and/or end of inhalation, beginning and/or end of exhalation, etc.), a respiration rate, a duration (e.g., of inhalation, of exhalation, of a single breathing cycle, etc.), respiration frequency, and/or other breathing parameters.

Although sensors 18 are illustrated in FIG. 1 at a single location in system 10, this is not intended to be limiting. Sensors 18 may comprise sensors disposed in a plurality of locations, such as for example, at various locations within (or in communication with) conduit 40, within pressure generator 14, within (or in communication with) interface appliance 42, and/or other locations.

Processor 20 is configured to provide information processing capabilities in system 10. As such, processor 20 may comprise one or more of a digital processor, an analog processor, a digital circuit designed to process information, an analog circuit
designed to process information, a state machine, and/or other mechanisms for
electronically processing information. Although processor 20 is shown in FIG. 1 as a
single entity, this is for illustrative purposes only. In some implementations, processor 20
may comprise a plurality of processing units. These processing units may be physically
located within the same device (e.g., pressure generator 14), or processor 20 may
represent processing functionality of a plurality of devices operating in coordination.

[26] As shown in FIG. 1, processor 20 is configured to execute one or more
computer program modules. The one or more computer program modules may comprise
one or more of a parameter module 50, a transition module 52, a control module 54,
and/or other modules. Processor 20 may be configured to execute modules 50, 52, and/or
54 by software; hardware; firmware; some combination of software, hardware, and/or
firmware; and/or other mechanisms for configuring processing capabilities on processor
20.

[27] It should be appreciated that although modules 50, 52, and 54 are
illustrated in FIG. 1 as being co-located within a single processing unit, in implementations
in which processor 20 comprises multiple processing units, one or more of modules 50,
52, and/or 54 may be located remotely from the other modules. The description of the
functionality provided by the different modules 50, 52, and/or 54 described below is for
illustrative purposes, and is not intended to be limiting, as any of modules 50, 52, and/or
54 may provide more or less functionality than is described. For example, one or more of
modules 50, 52, and/or 54 may be eliminated, and some or all of its functionality may be
provided by other modules 50, 52, and/or 54. As another example, processor 20 may be
configured to execute one or more additional modules that may perform some or all of the
functionality attributed below to one of modules 50, 52, and/or 54.

[28] Parameter module 50 is configured to determine one or more parameters
within system 10. The one or more parameters within system 10 may comprise gas
parameters related to the pressurized flow of breathable gas, and/or other parameters.
Parameter module 50 is configured to determine the one or more parameters based on the
output signals of sensors 18. The information determined by parameter module 50 may be
used for controlling pressure generator 14, stored in electronic storage 24, and/or used for other uses.

The one or more gas parameters of the pressurized flow of breathable gas may comprise, for example, one or more of a flow rate, a volume, a pressure, humidity, temperature, acceleration, velocity, and/or other gas parameters.

Transition module 52 is configured to determine the respiratory phase (e.g., inhalation, exhalation) during breathing of subject 12. The respiratory phase determinations made by module 52 are based on the output signals from sensors 18, information determined by parameter module 50, and/or other information. Transition module 52 may be configured to determine additional breathing parameters related to the respiration of subject 12. Additional breathing parameters related to the respiration of subject 12 may comprise a tidal volume, a timing (e.g., beginning and/or end of inhalation, beginning and/or end of exhalation, etc.), a respiration rate, a duration (e.g., of inhalation, of exhalation, of a single breathing cycle, etc.), respiration frequency, and/or other breathing parameters. The determinations made by transition module 52 may be used by control module 54 to control pressure generator 14 to control the pressurized flow of breathable gas delivered to subject 12, may be stored in electronic storage 24, and/or used for other uses. In some embodiments, transition module 52 is configured to determine the respiratory phase (e.g., inhalation, exhalation) based on changes in pressure, flow rate, and/or other parameters determined by parameter module 50.

Control module 54 is configured to control pressure generator 14 to generate the flow of gas in accordance with a positive pressure support therapy regime. In positive airway pressure support therapy the pressurized flow of gas generated by the pressure generator is controlled to replace and/or compliment a patient's regular breathing. Positive airway pressure support therapy may be used to maintain an open airway in a patient so that oxygen and carbon dioxide may be exchanged more easily, requiring little and/or no effort from the patient. By way of non-limiting example, control module 54 may control pressure generator 14 such that the pressure support provided to the subject via the flow of gas comprises continuous positive airway pressure support.
(CPAP), bi-level positive airway pressure support (BPAP), proportional positive airway pressure support (PPAP), forced oscillation technique, and/or other types of pressure support therapy.

CPAP supplies a fixed positive pressure to maintain a continuous level of positive airway pressure in a patient. BPAP provides a first inspiratory pressure (IPAP) and a second, typically lower, expiratory pressure (EPAP) for easier exhalation during ventilation. In some therapy modes (e.g., PPAP), control module 54 may control pressure generator 14 to apply variable pressure support in which the amount of pressure delivered to the patient during inhalation and/or during exhalation is determined and delivered on a breath by breath basis. In some embodiments, control module 54 may be configured to control pressure generator 14 to temporarily drop the supplied pressure during exhalation (C-Flex) to reduce exhalation effort required by the patent.

In some embodiments, control module 54 is configured to control pressure generator 14 to deliver staged pressure support. In staged pressure support therapy, the pressure delivered by pressure generator 14 gradually increases over time. In some embodiments, control module 54 may control pressure generator 14 to switch therapy modes based on information related to the respiration of subject 12 and/or other information. For example, control module 54 may control pressure generator 54 to change from BPAP to CPAP after a certain number of breaths by subject 12.

Control module 54 is configured to control pressure generator 14 based on information related to the output signals from sensors 18, information determined by parameter module 50, information determined by transition module 52, information entered by a user to user interface 22, and/or other information.

User interface 22 is configured to provide an interface between system 10 and subject 12 and/or other users through which subject 12 and/or other users may provide information and receive information from system 10. Other users may comprise, for example, a caregiver, a doctor, and/or other users. This enables data, cues, results, and/or instructions and any other communicable items, collectively referred to as "information," to be communicated between a user (e.g., subject 12) and one or more of
pressure generator 14, processor 20, and/or other components of system 10. For example, a user may specify one or more therapy regimes that are to be delivered to subject 12 using user interface 22. Control module 54 may then customize the therapy regime delivered to the subject based on the one or more inputs made by the user to the user interface. As another example, therapy pressures, the breath rate of subject 12, the portable power source energy level, and/or other information may be displayed to a user (e.g., subject 12) via user interface 22.

Examples of interface devices suitable for inclusion in user interface 22 comprise a keypad, buttons, switches, a keyboard, knobs, levers, a display screen, a touch screen, speakers, a microphone, an indicator light, an audible alarm, a printer, a tactile feedback device, and/or other interface devices. In one embodiment, user interface 22 comprises a plurality of separate interfaces. In one embodiment, user interface 22 comprises at least one interface that is provided integrally with housing 28.

It is to be understood that other communication techniques, either hard-wired or wireless, are also contemplated by the present disclosure as user interface 22. For example, the present disclosure contemplates that user interface 22 may be integrated with a removable storage interface provided by electronic storage 24. In this example, information may be loaded into system 10 from removable storage (e.g., a smart card, a flash drive, a removable disk, etc.) that enables the user(s) to customize the implementation of system 10. Other exemplary input devices and techniques adapted for use with system 10 as user interface 22 comprise, but are not limited to, an RS-232 port, RF link, an IR link, modem (telephone, cable or other). In short, any technique for communicating information with system 10 is contemplated by the present disclosure as user interface 22.

In some embodiments, electronic storage 24 comprises electronic storage media that electronically stores information. The electronic storage media of electronic storage 24 may comprise one or both of system storage that is provided integrally (i.e., substantially non-removable) with system 10 and/or removable storage that is removably connectable to system 10 via, for example, a port (e.g., a USB port, a firewire port, etc.)
or a drive (e.g., a disk drive, etc.). Electronic storage 24 may comprise one or more of optically readable storage media (e.g., optical disks, etc.), magnetically readable storage media (e.g., magnetic tape, magnetic hard drive, floppy drive, etc.), electrical charge-based storage media (e.g., EEPROM, RAM, etc.), solid-state storage media (e.g., flash drive, etc.), and/or other electronically readable storage media. Electronic storage 24 may store software algorithms, information determined by processor 20, information received via user interface 22, and/or other information that enables system 10 to function properly.

Electronic storage 24 may be (in whole or in part) a separate component within system 10, or electronic storage 24 may be provided (in whole or in part) integrally with one or more other components of system 10 (e.g., user interface 22, processor 20, etc.).

Information determined by processor 20 and/or stored by electronic storage 24 may comprise information related to respiration of subject 12, compliance, use frequency, and/or other information. The information stored by electronic storage 24 may be viewed via user interface 22, by connecting (wired and/or wireless) to a separate computer, and/or other via other methods. The information stored by electronic storage 24 may be used, for example, to adjust settings, to make adjustments to power source 26, used by a doctor to make medical decisions, and/or for other uses. In some embodiments, system 10 may include a wireless transmitter (not shown) and the information determined by processor 20, the information stored by electronic storage 24, and/or other information may be communicated to a care giver, for example, over a wireless network. By way of a non-limiting example, the care giver may receive use information, patient status, and/or other information, allowing the care giver to remotely track the therapy delivered by system 10. By way of a second non-limiting example, system 10 may be configured to signal for emergency assistance when information determined by processor 20 related to the respiration of subject 12 breaches a threshold level.

Portable power source 26 is configured to power pressure generator 14, one or more sensors 18, one or more processors 20, user interface 22, electronic storage 24, and/or other components of system 10 in a portable manner. Power source 26 may comprise one or more power sources connected in series and/or in parallel. In some
embodiments, power source 26 is rechargeable. Power source 26 may be recharged via a home AC power source, a car battery outlet, an airplane power outlet, a USB port, a non-contact charging circuit, and/or other recharging methods. In some embodiments, portable power source 26 may supply up to 10V. In some embodiments, portable power source 26 may supply up to 15V. In some embodiments, portable power source 26 may supply up to 20V. Examples of portable power sources that may be included as portable power source 26 include one or more DC batteries, Lithium Ion and/or Lithium Polymer Cells, Nickel Metal Hydride, and/or other portable power sources. In some embodiments, portable power source 26 is configured to power system 10 for 10 or more hours of use. In some embodiments, portable power source 26 is configured to power system 10 for up to 10 hours of use. In some embodiments, portable power source 26 is configured to power system 10 for up to 8 hours of use. In some embodiments, portable power source 26 is configured to power system 10 for up to 6 hours of use.

Housing 28 is configured to contain pressure generator 14, subject interface 16, one or more sensors 18, one or more processors 20, user interface 22, electronic storage 24, power source 26, flow path 60, exhaust port 62, handle 30, and/or other components of system 10. Housing 28 is configured to contain the components of system 10 in a space small enough to be handheld and portable so pressure support therapy may be delivered at any time during the normal daily activities of subject 12. In some embodiments, the weight of system 10 is up to three pounds. In some embodiments, the weight of system 10 is up to two pounds. In some embodiments, the weight of system 10 is up to one pound. In some embodiments, the volume of housing 28 is up to 135 cubic inches. In some embodiments, the volume of housing 28 is up to 100 cubic inches. In some embodiments, the volume of housing 28 is up to 60 cubic inches.

Flow path 60 is configured to place subject interface 16 in fluid communication with pressure generator 14 and/or exhaust port 62. Exhaust port 62 is configured to direct exhaled gas from flow path 60 and/or pressure generator 14 to the ambient atmosphere. In some embodiments, flow through exhaust port 62 may be controlled by a valve 63. Valve 63 may be controlled by processor 20 to close during
inhalation of subject 12 and open during exhalation. By way of a non-limiting example, control module 54 may control valve 63 to open and/or close based on one or more parameters determined by parameter module 50, information determined by transition module 52, and/or other information. In some embodiments, housing 28 may contain one or more additional ports (e.g., USB) configured to provide one or more connection points such that portable power source 26 may be recharged, electronic storage 24 may be accessed, and/or for other purposes.

Handle 30 is configured to be attached to and/or formed by housing 28. Handle 30 is configured to be grasped by subject 12 to hold the housing in position with respect to the airway of subject 12 as the pressurized flow of breathable gas is delivered to the airway of subject 12. Handle 30 may be attached to housing 28 by coupling handle 30 to housing 28 at one or more locations with screws and/or another method of fixing handle 30 to housing 28. Handle 30 may be formed in housing 28 by way of a ridged, knurled, and/or other textured surface. Handle 30 formed in housing 28 may comprise finger shaped surface depressions in housing 28 such that a user's fingers may fit into the finger depressions for gripping system 10. The method for mounting, and/or the form factor for handle 30 formed by housing 28 described in the present disclosure are not intended to be limiting. Handle 30 may be attached to and/or formed in housing 28 by any method, in any shape, and/or in any location(s) that allows it to function as described herein.

By way of a non-limiting example FIG. 2 shows a perspective view of a possible embodiment of system 10. In this embodiment, housing 28 has a length 200 running along a first axis 201 from a first side 202 to a second side 204 of less than about 7 inches. Length 200 may be between about 5 inches and about 7 inches. Length 200 may be about 6 inches. In some embodiments, housing 28 may have a width 206 running along a second axis 208 from a third side 210 to a fourth side 212 of greater than about 3 inches. Width 206 may be between about 2 inches and about 3 inches. Width 206 may be about 2.5 inches. Housing 28 has a thickness 214 running along a third axis 216 from a fifth side 218 toward a sixth side 220 of less than about 5 inches. Thickness 214 may be
between about 4 inches and about 5 inches. Thickness 214 may be about 4.5 inches. The
generally rectangular shape and approximate dimensions of housing 28 shown in FIG. 2 are not intended to be limiting. Housing 28 may take any shape that allows it to function as described in the present disclosure.

User interface 22 is also shown in FIG. 2. In example FIG. 2, user interface 22 is located on fifth side 218 and includes a power button 222, adjustment buttons 224, and a display 226. In this embodiment, display 226 has a width 230 running along second axis 208 from third side 210 to fourth side 212 of greater than about 2 inches. Width 230 may be between about 1 inch and about 2 inches. Width 230 may be about 1.8 inches. Display 226 has a height 234 running along first axis 201 from first side 202 toward second side 204 of greater than about 0.5 inches. Height 234 may be between about 0.5 inches and about 1 inch. Height 234 may be about 0.6 inches.

Examples of subject interface 16 and handle 30 are also shown in FIG. 2. In FIG. 2, handle 30 is formed in housing 28 on sixth side 220 toward second side 204, opposite user interface 22. In FIG. 2, subject interface 16 is located on fifth side 218 (the same side as user interface 22) toward first side 202. Subject interface 16 is located in an area where thickness 214 increases along third axis toward fifth side 218 near first side 202.

FIG. 3 illustrates a method 300 of delivering a pressurized flow of breathable gas to the airway of a subject with a handheld pressure support system that includes a housing. The housing contains a pressure generator, a subject interface, one or more sensors, one or more processors, and a power source. The housing forms and/or is attached to a handle. The operations of method 300 presented below are intended to be illustrative. In some embodiments, method 300 may be accomplished with one or more additional operations not described, and/or without one or more of the operations discussed. Additionally, the order in which the operations of method 300 are illustrated in FIG. 3 and described below is not intended to be limiting.

In some embodiments, method 300 may be implemented in one or more processing devices (e.g., a digital processor, an analog processor, a digital circuit designed
to process information, an analog circuit designed to process information, a state machine, and/or other mechanisms for electronically processing information. The one or more processing devices may include one or more devices executing some or all of the operations of method 300 in response to instructions stored electronically on an electronic storage medium. The one or more processing devices may include one or more devices configured through hardware, firmware, and/or software to be specifically designed for execution of one or more of the operations of method 300.

At an operation 302, the pressurized flow of breathable gas is generated with the pressure generator. In some embodiments, operation 302 is performed by a pressure generator the same as or similar to pressure generator 14 (shown in FIG. 1 and described herein).

At an operation 304, the pressurized flow of breathable gas is communicated to the airway of the subject with the subject interface. In some embodiments, operation 304 is performed by a subject interface the same as or similar to subject interface 16 (shown in FIG. 1 and described herein).

At an operation 306, one or more output signals conveying information related to one or more gas parameters of the pressurized flow of breathable gas are generated with the one or more sensors. In some embodiments, operation 306 is performed by sensors the same as or similar to sensors 18 (shown in FIG.1 and described herein.)

At an operation 308, the generation of the pressurized flow of breathable gas is controlled with the one or more processors. The generation of the pressurized flow of breathable gas is controlled based on the output signals, according to a positive pressure support therapy regime. In some embodiments, operation 308 is performed by a processor the same as or similar to processor 20 (shown in FIG.1 and described herein.)

At an operation 310, the pressure generator, the one or more sensors, and the one or more processors are powered with the portable power source. In some embodiments, operation 310 is performed by a portable power source the same as or similar to power source 26 (shown in FIG.1 and described herein.)
At an operation 312, the handle is grasped to hold the housing in position with respect to the airway of the subject as the pressurized flow of breathable gas is delivered to the airway of the subject. In some embodiments, operation 312 is performed by a handle the same as or similar to handle 30 (shown in FIG. 1 and described herein.)

In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. The word "comprising" or "including" does not exclude the presence of elements or steps other than those listed in a claim. In a device claim enumerating several means, several of these means may be embodied by one and the same item of hardware. The word "a" or "an" preceding an element does not exclude the presence of a plurality of such elements. In any device claim enumerating several means, several of these means may be embodied by one and the same item of hardware. The mere fact that certain elements are recited in mutually different dependent claims does not indicate that these elements cannot be used in combination.

Although the description provided above provides detail for the purpose of illustration based on what is currently considered to be the most practical and preferred embodiments, it is to be understood that such detail is solely for that purpose and that the disclosure is not limited to the expressly disclosed embodiments, but, on the contrary, is intended to cover modifications and equivalent arrangements that are within the spirit and scope of the appended claims. For example, it is to be understood that the present disclosure contemplates that, to the extent possible, one or more features of any embodiment can be combined with one or more features of any other embodiment.
What is claimed is:

1. A portable handheld pressure support system (10) configured to deliver a pressurized flow of breathable gas to the airway of a subject (12), the pressure support system comprising:
   - a pressure generator (14) configured to generate the pressurized flow of breathable gas;
   - a subject interface (16) configured to communicate the pressurized flow of breathable gas to the airway of the subject;
   - one or more sensors (18) configured to generate output signals conveying information related to one or more gas parameters of the pressurized flow of breathable gas;
   - one or more processors (20) configured to control operation of the pressure generator to generate the pressurized flow of breathable gas based on the output signals from the one or more sensors, according to a positive pressure support therapy regime;
   - a portable power source (26) configured to power the pressure generator, the one or more sensors, and the one or more processors;
   - a housing (28) configured to contain the pressure generator, the subject interface, the one or more sensors, the one or more processors, and the power source; and
   - a handle (30) attached to and/or formed by the housing configured to be grasped by the subject to hold the housing in position with respect to the airway of the subject as the pressurized flow of breathable gas is delivered to the airway of the subject.

2. The system of claim 1, wherein the maximum volume of the housing is 135 cubic inches.

3. The system of claim 1, wherein the therapy regime comprises one or more of non-invasive ventilation, positive airway pressure support, continuous positive
airway pressure support, proportional positive airway pressure support, or bi-level positive airway pressure support.

4. The system of claim 1, wherein the power source is rechargeable.

5. The system of claim 1, further comprising:
   a user interface (22) configured to provide an interface between the system and a user through which the user provides information to and receives information from the system, wherein the one or more processors customize the therapy regime delivered to the subject based on one or more inputs made by the user to the user interface, and wherein the user interface is powered by the power source and contained in the housing.

6. A method (300) of delivering a pressurized flow of breathable gas to the airway of a subject (12) with a handheld pressure support system (10) that includes a housing (28), the housing containing a pressure generator (14), a subject interface (16), one or more sensors (18), one or more processors (20), and a power source (26), the housing forming and/or being attached to a handle (30), the method comprising:
   generating the pressurized flow of breathable gas with the pressure generator;
   communicating the pressurized flow of breathable gas to the airway of the subject with the subject interface;
   generating output signals conveying information related to one or more gas parameters of the pressurized flow of breathable gas with the one or more sensors;
   controlling generation of the pressurized flow of breathable gas with the one or more processors, based on the output signals, according to a positive pressure support therapy regime;
   portably powering the pressure generator, the one or more sensors, and the one or more processors with the power source; and
grasping the handle to hold the housing in position with respect to the airway of the subject as the pressurized flow of breathable gas is delivered to the airway of the subject.

7. The method of claim 6, wherein the maximum volume of the housing is 135 cubic inches.

8. The method of claim 6, wherein the therapy regime comprises one or more of non-invasive ventilation, positive airway pressure support, continuous positive airway pressure support, proportional positive airway pressure support, or bi-level positive airway pressure support.

9. The method of claim 6, wherein the power source is rechargeable.

10. The method of claim 6, further comprising:
interfacing between the pressure generator, the one or more sensors, the one or more processors, and/or the power source and a user with a user interface (22), through which the user provides information to and receives information from the pressure generator, the one or more sensors, the one or more processors, and/or the power source;
customizing the therapy regime delivered to the subject based on one or more inputs made by the user to the user interface,
powering the user interface with the power source; and
containing the user interface in the housing.

11. A portable handheld pressure support system (10) configured to deliver a pressurized flow of breathable gas to the airway of a subject (12), the pressure support system comprising:
means (14) for generating the pressurized flow of breathable gas;
means (16) for communicating the pressurized flow of breathable gas to the
airway of the subject;
means (18) for generating output signals conveying information related to
one or more gas parameters of the pressurized flow of breathable gas;
means (20) for controlling the means to generate the pressurized flow of
breathable gas based on the output signals, according to a positive pressure support
therapy regime;
means (26) for portably powering the means to generate the pressurized
flow of breathable gas, the means for generating output signals, and the means for
controlling;
means (28) for containing the means to generate the pressurized flow of
breathable gas, the means for communicating, the means for generating output signals, the
means for controlling, and the means for portably powering; and
means (30) for engaging the hand of the subject to be grasped by the
subject, the means for engaging being connected to and/or formed by the means for
containing, the means for engaging being configured to be grasped by the subject to hold
the means for containing in position with respect to the airway of the subject as the
pressurized flow of breathable gas is delivered to the airway of the subject.

12. The system of claim 11, wherein the maximum volume of the means
for containing is 135 cubic inches.

13. The system of claim 11, wherein the therapy regime comprises one or
more of non-invasive ventilation, positive airway pressure support, continuous positive
airway pressure support, proportional positive airway pressure support, or bi-level
positive airway pressure support.

14. The system of claim 11, wherein the means for portably powering is
rechargeable.
15. The system of claim 11, further comprising means (22) for interfacing between the system and a user through which the user provides information to and receives information from the system, wherein the means for controlling customizes the therapy regime delivered to the subject based on one or more inputs made by the user to the means for interfacing, and wherein the means for interfacing is powered by the means for portably powering and contained in the means for containing.
Method 300

Generate a pressurized flow of breathable gas.

Communicate the pressurized flow of breathable gas to the airway of the subject.

Generate one or more output signals.

Control generation of the pressurized flow of breathable gas based on the output signals.

Portably power the system.

Grasp and hold the system in position with respect to the airway of the subject as the pressurized flow of breathable gas is delivered to the airway of the subject.

FIG. 3
**INTERNATIONAL SEARCH REPORT**

**International application No**
PCT/IB2013/053187

**A. CLASSIFICATION OF SUBJECT MATTER**

INV. A61M16/00

ADD.

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)

A61M

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

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

EPO-Internal , WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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

* Special categories of cited documents:
  * "A" document defining the general state of the art which is not considered
    to be of particular relevance
  * "E" earlier application or patent but published on or after the international
    filing date
  * "L" document which may throw doubts on priority claim(s) or which
    is cited to establish the publication date of another citation or other
    special reason (as specified)
  * "O" document referring to an oral disclosure, use, exhibition or other
    means
  * "P" document published prior to the international filing date but later than
    the priority date claimed

Date of the actual completion of the international search

6 August 2013

Date of mailing of the international search report

21/08/2013

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016

Authorized officer

Bottcher, Stephanie
### INTERNATIONAL SEARCH REPORT

**Box No. II  Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. **Claims Nos.: 6-10**  
   Because they relate to subject matter not required to be searched by this Authority, namely:
   
   **Rule 39.1(iv)**  
   PCT - Method for treatment of the human or animal body by therapy

2. □ Claims Nos.:  
   Because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. □ Claims Nos.:  
   Because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 64(a).

**Box No. III  Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

1. □ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. □ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of additional fees.

3. □ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. □ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**  
- □ The additional search fees were accompanied by the applicant’s protest and, where applicable, the payment of a protest fee.
- □ The additional search fees were accompanied by the applicant’s protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- □ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (April 2005)
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