INTEGRATED POSITIVE AIRWAY PRESSURE APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority under 35 U.S.C. § 119(e) of U.S. provisional application nos. 61/288,290, filed on December 19, 2009; 61/253,500, filed on October 20, 2009; and 61/301,151, filed on February 3, 2010. The entire contents of provisional application nos. 61/288,290, 61/253,500 and 61/301,151 are incorporated herein by reference.

BACKGROUND

FIELD OF THE DISCLOSURE

[0002] The present disclosure relates to a gas delivery system. One example of the gas delivery system provides positive airway pressure therapy during a patient's sleep period.

DESCRIPTION OF THE RELATED ART

[0003] The "background" description provided herein is for the purpose of generally presenting the context of the disclosure. Work of the presently named inventors, to the extent it is described in this background section, as well as aspects of the description which may not otherwise qualify as prior art at the time of filing, are neither expressly or impliedly admitted as prior art against the present invention.

[0004] Certain individuals have difficulty breathing during sleeping due to a collapse or obstruction of airways. For example, obstructive sleep apnea (OSA) may occur when the body relaxes during sleep, and the upper airway of the sleeping individual collapses, either partially or completely, to obstruct breathing during sleep. This condition is particularly common in overweight individuals, individuals with large necks, or individuals who abuse alcohol.Another form of apnea is called hypopnea which exhibits shallow and slow breathing during sleep. Still other forms of apnea can be found in individuals with central sleep apnea (CSA). This disease affects the ability to breathe due to the lack of signals transmitted from the brain to the lungs. Collectively, diseases that inhibit normal breathing during sleep are called sleep disordered breathing (SDB).

[0005] One treatment for the above-noted conditions is the application of a continuous positive airway pressure apparatus (CPAP). The CPAP apparatus typically comprises a flow generator in a base unitplaced near the patient's bed connected to a mask unit via a flexible hose. Due to difficulties caused by connection to the flow generator via the flexible hose, compliance with treatment via a CPAP unit is often less than optimal. For example, the patient's movement is restricted by the hose. Additionally, the hose may cause persistentpressure or sensory lag time in response to changes in conditions. Moreover, the flow generatormay require a larger compressorin order to overcome the pressure drop between the flow generatorand the mask unit. The large compressor, in some cases, produces an undesirable level of noise.

[0006] Accordingly, the present disclosure and embodiments recited in the attached claims may ameliorate one or more of the above-noted difficulties and others not highlighted with conventional therapies for SDB.

SUMMARY

[0007] The foregoing paragraphs have been provided by way of general introduction, and are not intended to limit the scope of the following claims. The described embodiments, together with further advantages, will be best understood by reference to the following detailed description taken in conjunction with the accompanying drawings.

[0008] One aspect of the invention includes a gas delivery system that provides positive airway pressure therapy during a patient's sleep period. In this aspect, the system includes a mask that couples to a patient's face to deliver pressurized gas to an airway of the patient. The system further includes a flow generator system that directly detachably couples to the mask and pressurizes the gas.

[0009] Another aspect of the gas delivery system includes a mask that couples to a patient's face to deliver pressurized gas to an airway of the patient. The mask typically includes a flow generator system that pressurizes the gas. The flow generator system includes at least one brushless motor.

[0010] One aspect of the gas delivery system includes a mask that couples to a patient's face to deliver pressurized gas to an airway of the patient. The mask typically includes a flow generator system that pressurizes the gas. The flow generator system includes at least one motor. An acoustic damper unit is disposed upstream of the flow generator system.

[0011] Another aspect of the invention includes a mask that couples to a patient's face to deliver pressurized gas to an airway of the patient. The mask typically includes a flow generator system that pressurizes gas. The flow generator system includes at least one motor. At least one unassisted breathingvent allows fluid communication, separately from the flow generator system, between an exterior of the mask and an interior of the mask. During operation the divertervalve obstructs theat least one breathing vent during operation of the flow generator and allows gas flow from the flow generator to the patient. Alternatively when gas flow from the flow generator is not present, the diverter valve permits free or un-encumbered breathing through the at least one breathing vent.

[0012] One aspect of the invention includes a gas delivery system that provides continuous positive airway pressure therapy. Continuous positive airway pressure or CPAP does not necessarily mean that there is not zero (0) pressures at times during operation. There are several modes of pressure control. A mask couples to a patient's face to deliver pressurized gas to an airway of the patient. The gas delivery systemincludes a flow generator system disposed on the mask and that pressurizes the gas; the flow generator includes at least one motor and gas compressor. A controller controls the at least one motor and compressor according to a power management system.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] A more complete appreciation of the disclosure and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

[0014] FIG. 1 is a process and instrumentation diagram and schematic representation of a background CPAP apparatus;

[0015] FIG. 2 is a perspective view of one embodiment of an integrated continuous positive airway pressure (CPAP) apparatus;

[0016] FIG. 3 is a left side view of the CPAP apparatus depicted in FIG. 2;

[0017] FIG. 4 is an exploded view of the CPAP apparatus depicted in FIG. 2;

[0018] FIG. 5A is a perspective view of astrap with apower unit that may be used to supply power to theCPAP apparatus of FIG. 2;

[0019] FIG. 5B is a detailed side view of the connectors used with the power unit depicted in FIG. 5A;

[0020] FIG. 5C is a detailed top view of the connectors used with the power unit depicted in FIG. 5A;

[0021] FIG. 6A is a front view of a flow generator that may be used with the CPAP unit of FIG. 2;

[0022] FIG. 6B is a section view taken along lines A-A of the flow generator depicted in FIG. 6A;

[0023] FIG. 6C is a section view taken along lines A-A of the flow generator depicted in FIG. 6A, but with the inclusion of a gear system connected to the motor used to drive the flow generator depicted in FIG. 6A;

[0024] FIG. 6D is a front view of an alternative flow generator;

[0025] FIG. 7A is a schematic representation of a gas flow path of theCPAP unit depicted in FIG. 2;

[0026] FIG. 7B is a section view taken along lines A-A in FIG. 7A;

[0027] FIG. 8 is a detailed view of an acoustic damper typically used in conjunction with theCPAP unit depicted in FIG. 2;

[0028] Fig. 9 is a perspective view of an embodiment of a CPAP unit in which a flow generator is detachably couplable to a mask portion (patient interface);

[0029] FIGS. 10A and 10B depict the detachable flow generator coupled to a flow generator, which is in turn connected to a hose for connection to an alternate mask unit;

[0030] FIGS. 11A and 11Barea general system schematic for a CPAP unit as described in FIGS. 2-10, and 12; and

[0031] FIG. 12 is a flow chart depicting one embodiment of power management for the various CPAP unit embodiments described herein.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0032] Referring now to the drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views.

[0033] Fig. 1 depicts a prior artCPAP device in which a flow generator 120 includes a compressor 124 controlled by an electronic controller 122 and which monitors the flow rate and pressure of environmentalair 130 drawn into the compressor 124 via an air inlet 128.

[0034] In the most common embodiments, the flow generator 120 is operated on alternating current (AC) power using an AC to direct current (DC) power supply 112. AC, supplied via a typical household outlet 110, is converted in the power supply 112 to DC power that ultimately drives the flow generator 120. Occasionally, the power supply is incorporated within the flow generator enclosure 120. Also, the DC power used to drive the flow generator 120 may be supplied via another supply, for example, an auxiliaryDC power port 116 on an automobile or via a DC battery pack 114 as shown in FIG. 1.

[0035] The flow generator 120 may also include a humidifier 134 connected to an outlet of the compressor 124, for example, via a connection 132 as shown in FIG. 1. The humidifier is typically connected to a reservoir (not shown) to supply moisture to the pressurized gas ultimately supplied to the patient. In some cases, the amount of moisture supplied to the patient may be in the range of 200 ml to 500 ml per sleep period.

[0036] The conventional CPAP unit shown in FIG. 1 may also include a heater 136. The humidifier 134 in combination with the heater 136 comprises a conditioning unit 133. The CPAP unit has a connector 135 to which a connection such as a hose 138 can be attached. The hose 138connects to a connector 145 on a mask 140. The unit can have a sensor 126 to measure properties of the pressurized gas such as the pressure.

[0037] In some cases, the connector may include an elbow 143, and the connector may itself swivel. The mask 140 typically includes at least one hole233for expiration of the patient, and the hole(s) is commonly referred to as a "washout vent." In FIG. 1, the washout vent 144 allows gas expelled during expiration to leave the mask 140 mixing with pressurizedambientgas from the flow generator. Typically, the washout vent 144 is merely one or more open holes placing the interior of the mask in fluid communication with an exterior of the mask. The washout vent 144 has hole(s) 233 sized so that pressure credit by the flow generator is not decreased below a desired level. (i.e., the flow rate is sufficient and the holes are sized to limit the flow rate of the pressurized gas from the mask 140.)The mask 140 may also include a supplementary gas port 149 which permits gas such as O_2 to be added to environmental gas supplied to the patient.

[0038] The mask typically includes a cushion surface 146 connected to a more rigid shell 142, and the mask is attached to the patient's head via flexible straps 148.

[0039] As discussed previously, certain complications are involved when using a hose such as hose 138. Accordingly, it is beneficial to reduce reliance on a connection such as hose 138 in theCPAP unit disclosed herein.

[0040] FIG. 2 describes an integratedCPAP unit 1122. The integrated CPAP unit 1122 depicted in FIG. 2 includes a flow generator 220 which is either connected to or encased in a rigid mask shell 216 and covered with a flow generator cap 242. The rigid mask shell 216 and/or flow generator cap 242 are typically formed from a plastic or light-weight metal. For example, these components may comprise polystyrene, polycarbonate, polyvinyl carbonate, polypropylene, etc. In one embodiment, one or more of the above-noted components is transparent.

[0041] In the embodiment depicted in FIG. 2, a power supply enclosure 244, which may include batteries, is connected via a strap 212 to the integratedCPAP unit 1122. The strap 212 may be adjustable such that the power supplyenclosure244 may be supported at the back of a patient's neck. While a preferred location is on the back of the neck, other locations, such as the arm, shoulder, hip, or chest etc. may be used. In one embodiment, a cooling supply conduit 248 suppliessomegas from the integrated CPAP unit 1122 to the power supply enclosure 244. One benefit of this arrangement is that, for example, when the power supply enclosure 244 includes batteries or a fuel cell for power, heat generated when the integratedCPAP unit 1122 is in use may be dissipated to preserve the life of the power supply and to increase the comfort of the patient. To increase the effectiveness of supplied cooling, the power supply enclosure 244 may include vents 250 as shown in FIG. 2. An electrical conductor 246 typically follows along the strap 212 and ultimately connects to the integrated CPAP unit 1122 to supply electrical power to the integrated CPAP unit 1122. The strap 212 may be detachable from the integratedCPAP unit 1122, for example, via a strap connector 213 shown in FIG. 2 and in more detailed description of Fig. 5A.

[0042] The integratedCPAP unit 1122 may be supported further by a head rest assembly 214 shown in the upper part of FIG. 2. The head rest assembly214typically includes a head rest adjustor 215 that may be pivotable and/or threadable so as to increase or decrease the pressure on the patient's head so that the integratedCPAP unit 1122 firmly fits across the patient's nasal area, mouth area, or both. The headrest provides adjustment of the mask interface cushion to the

patient for a comfortable and gas-tight fit. The adjustment permits inward and outward tilting of the mask interface from the patient's face allowing minute adjustments of the gas-tight seal. The advantage of this arrangement permits adjustment of the pressure applied to face to be the minimal pressure on the face necessary to accomplish a seal. The head rest assembly214may be secured to the patient's head via an upper strap 210. Typically, the upper strap 210 is adjustable and/or elastic to adjust to the circumference of the patient's head. Furthermore, the head rest assembly 214 may include a head rest cushion 217 as shown in FIG. 2 to increase the comfort of the patient. In another embodiment, the head rest may also include certain sensors which contact the forehead intheheadrest cushion 217 such as those sensors employed in polysomnogramfor measuring brain activity and/or sensors for motion, acceleration, skin perspiration, skin temperature, pulse oximetry deriving blood O_2 levels and pulse rate, acoustics vibrations, humidity, nerve electrical activity, which sensor activity is then communicatedto controller 1168 of flow generator 220. Polysomnogram is the recording of various functions during sleep such as a person's sleep pattern, breathing, heart activity, and limb movements.

[0043] The area of the integratedCPAP unit 1122 below the head rest assembly 214 is configured to couple to the patient's face. In this regard, a patient interface cushion 218 typically comprises a bio-compatible compliant material. In one example, the compliant material includes silicone, gel, foam, or another such compliant material and is configured to form a relatively gas-tight interface between the remainder of the integratedCPAP unit 1122 and the patient's face. In still another embodiment, this cushion may also includesensorssuch as those sensors employed in polysomnogram for measuring brain activity and/or sensors for motion, acceleration, skin perspiration, skin temperature, pulse oximetry deriving blood O_2 levels and pulse rate, acoustics vibrations, humidity, nerve electrical activity, which sensor activity is then communicatedto controller 1168, as best seen in FIG. 11A of flow generator 220.

[0044] The integrated CPAP unit 1122 shown in FIG. 2 typically includes auxiliary gas ports 219 for supplementary gas introduction to the integrated CPAP unit 1122 of auxiliary gases such as O_2, medicinal substances, and/or moisture. Additionally, or alternatively, the auxiliary gas ports 219 may be used to receive a sensor module 330as seen in FIG. 3 to collect data regarding the gas within the integrated CPAP unit 1122. The sensor module may also collect data regarding gas flowing to port 219.For example, the data may include one or more of an oxygen level, CO_2 level, pressure, acoustic vibrations, nitrogen levels, methyl nitrate levels, gas flow

velocity, gas volume displacement, temperature, relative position of the integrated CPAP unit 1122, motion, acceleration, humidity, wired and wireless data communications, infrared signals sent to or from the integrated CPAP unit 1122, and/or to and from external data collection module 1018, as best seen in FIG. 11B, and other such information. Although the auxiliary gas ports 219 shown in FIG. 2 are disposed at the bottom of the integrated CPAP unit 1122, other locations on the integrated CPAP unit 1122 may be used, for example, a side position. Adjacent to the auxiliary gas ports 219 in FIG. 2 is a power/data connection receptacle 252, which may be used to receive a cable from a remote control 1014, as best seen in FIG. 11A, and/or a computer and/or alternate power supplysuch as AC to DC wall adapter 324, as seen in FIG. 3, or apower source 326, which is shown in phantom in FIG. 3which can include batteries or a fuel cell for power. The aforementioned sensor module 330 or data module 1018 can also be attached via that power/data connection receptacle 252. For example, during or after use of the integratedCPAP unit 1122, data logged by a controller disposed on the integrated CPAP unit 1122 may be used to control treatment and/or downloaded for analysis by a physician. This data related to the above-noted parameters can also be measured via sensors connected tothe auxiliary gas ports 219 or sensors disposed in another area of the integrated CPAP unit 1122. Thus, parameter levels with respect to time may be recorded in the integrated CPAP unit 1122 and plotted or otherwise analyzed outside the integrated CPAP unit 1122. In one embodiment, the air flow and/or pressure relationship may be plotted against time, and it may be determined whether the integrated CPAP unit has remedied the sleeping difficulties of the patient.

[0045] The previously mentioned data module 1018 in one embodiment can provide power and data reception and transmission. Data transport can be performed though wired means connected to the data/power port 252 of the integrated CPAP unit 1122, and/or through wireless means such as IR, BlueTooth™, ZigBee™, and others. This module receives power from an AC power supply,which may further provide DC power to the integrated CPAP unit. Communications from the integrated CPAP unit 1122 and the sensor module 330are handled in one group, and concurrent or delayed communications, either wired or wireless, may be transmitted through a second group to non-related external devices/links such as WiFi access routers, cellular, and/ora POTS phone line.

[0046] As the integratedCPAP unit depicted in FIG. 2 may include a controller, it is often beneficial to provide a control button 222 for easy access by the patient wearing the integrated

CPAP unit 1122. In one embodiment, the control button 222 is disposed on the upper area, typically aligned with the nasal area of the patient. However, other areas may be convenient, depending on theuser'spreferences, and the location of the control button 222 is not limited to the upper part of the integrated CPAP unit 1122.

[0047] As further shown in FIG. 2, the integrated CPAP unit 1122 may include a wireless means of communicating such as a radio and/orIR (infrared) transmit/receive device. This device may be used to transmit the above-noted data. Additionally, or alternatively, the IR device 224 may be used to control the operation of the integrated CPAP unit 1122, for example, via a remote control 1014, as seen in FIG. 11A,similar to a remote control used for operation of a television. This remote may also connect with other forms of wireless devices such as radio, for example; BlueTooth™ and ZigBee™ can be used to communicate with smart phones or medical information data collection devices. The remote may also communicate through wired means to a power/data connection receptacle 252. One benefit of this arrangement is that the patient may conveniently control the integrated CPAP unit 1122, even while the integrated CPAP unit 1122 is worn on the patient's face and also potentially when the patient is in a prone position. There are still other methods of transmitting and receiving the above-noted data which include wireless radio 1156, as best seen in FIG. 11A, such as BlueTooth™ and ZigBee™,may also be used to program the integrated CPAP with a wireless radio remote control cable of accepting this communications type.

[0048] Still referring to FIG.2, ambient air or gas will travel through a flow generator intake flow path 232 past orifices such as flow generator intake holes 228. The flow generator intake holes 228 may be, in turn, disposed on a flow generator intake door such as flow generator door 226. One benefit of this arrangement is that the flow generator intake holes may be changed in size by replacement of the flow generator intake door 226. Another benefit of this arrangement is that the flow generator intake door can be opened to replace the intake filter 316, as seen in FIG. 3, occasionally. In one example, the flow generator intake door 226 is connected to the remainder of the integratedCPAP unit 1122 via a flow generator intake door latch 230.

[0049] The integratedCPAP unit 1122 has an unassisted breathing vent 238 which allows the user to breathe freely. The unassisted breathing vent 238 is opened and closed by a gas flow diverter 234 as explained in detail with respect to FIG. 3. Additionally, the integratedCPAP unit 1122 typically includes washout vents 233 which are continually operable. In other words, the

CO_2washout vents 233 remain open during normal operation of the integratedCPAP unit 1122 and even when not in operation. The washout vents 233 are sized so that the pressurized gas created by the flow generator 220 is maintained at a sufficient level in the interior of the mask as the washout vents 233 allow gas to exit the interior or mask chamber 706 as seen in FIG. 7B of the mask 1122 as represented by arrow 236.

[0050] It is recognized that the unit 1122 can provide a variety of CPAP treatment modes which provide variability of pressurized gas delivery which are widely known to those skilled in the art, that of, continuous single pressure (Continuous), two pressure levels responding alternately to certain respiratory inputs of the patient (Bi-level), auto-adjusting pressure also based on certain respiratory inputs of the patient (Auto-set), and servo-ventilation mode which varies pressure to match certain characteristics of the breathing rhythm (Auto-servo). The abbreviation CPAP stands for continuous positive air pressure which in generic terms is a method of noninvasive or invasive ventilation assisted by a flow of air delivered at a positive pressure throughout the respiratory cycle. It is performed for patients who can initiate their own respirations but who are not able to maintain adequate arterial oxygen levels without assistance. Sometimes the word "continuous" is replaced with the "constant." For the purpose of this patent, constant positive airway pressure is referred to as mono-level CPAP. The pressure can also be varied in each pressure mode mentioned to range from 0 pressures to 50 cm H2O pressure.

[0051] Referring to FIG. 3, a side view of the integrated CPAP unit 1122 of FIG. 2 is shown. The unassisted breathing vents 238 are regulated via a diverter flap 310 of the gas flow diverter 234. The diverter flap 310covers the unassisted breathing vents238during pressurization and flow by the compressor312.Gas pressure generated by the flow generator causes the diverterflap 310 to remain closed against the unassisted breathing vents 238. When the compressor 312 is off, the diverter flap 310 returns to a closed position covering an outlet416 of the flow generator.One advantage to this is the prevention of expired gases contaminating upstream components and permitting the patient to breathe freely when flow from the compressor 312 is not present. Hence, when the flow generator is in operation, the pressure generated by the flow generator pushes the diverter flap 310 of the gas flow diverter 234 against the unassisted breathing vents 238, thus closing the vents and allowing the patient to inhale (also refer to as inspire)gas passing primarily through the flow generator without also drawing a sizable volume of air from outside of the integratedCPAP unit 1122. Next, when the patient exhales (also refer

to as expires) and the flow generator is producing pressure, fresh environmental gas from the flow generator and expired gases mix which allows expired gases to escape through the washout vents to outside of the integratedCPAP unit 1122 before the next inspiration event. At all times while pressure is created by the flow generator, the divertervalveflap is force open covering unassisted breathing vents 238. Therefore, expired gas is less likely or is substantially prevented from passing backwards through the flow generator. When the flow generator does not provides sufficient pressure to force the divertervalveflap open, unassisted breathing vents 238 are uncovered and the patient can freely breath through these same ports. As discussed previously, the integrated CPAP unit 1122 may include a diverter valve controlling flow between an interior and exterior of the unit via the unassisted breathing vents 238. In one embodiment, the diverter valve includes a diverter flap 310 that travels along a path 311 to open and close the outlet of a compressor 416. In the upper position along the path 311, the diverter flap 310 closes the unassisted breathing vents 238.

[0052] The unassisted breathing vent 238 allows direct communication between the interior of the integratedCPAP unit 1122 and the exterior of the integratedCPAP unit 1122 when flap is in close to flow generator. The unassisted breathing vent 238 is sized so that a user can breathe freely when the compressor is off and the unassisted breathing vent 238 is open.

[0053] The power and data connector receptacle 252 may be connected to an AC adaptor 324 orthe power source 326which can include batteries, automobile circuit adaptor, or a fuel cell for power to provide power in place of the power supply enclosure 244 shown in FIG. 2. One benefit of this arrangement is that a practically unlimited supply of power may be available by replacing the power supply, and even though the user is somewhat tethered to the AC adaptor 324 or alternative power source 326, the connection between these components and the power and data connector receptacle 252 is relatively thin in comparison to the hose used in typical CPAP apparatuses. Therefore, the patient typically has a greater sense of freedom when using the integratedCPAP unit 1122 even though tethered by a small wire in comparison to conventional CPAP units which is attached and tethered with a large cumbersome hose.

[0054] As shown by the hidden lines in Fig. 3, the integratedCPAP unit 1122 typically includes a compressor 312, which generates the increase in pressure between the ambient air and the gas supplied to the patient. In one embodiment, the compressor 312 is driven by a brushless motor. In another embodiment, the compressor 312 is driven by a motor including a commutator. In

certain embodiments, the motor and/or controller driving the compressor 312 are enclosed with a Faraday cage or other such electromagnetic emission limiting device.

[0055] In the embodiment depicted in FIG. 3, the compressor 312 draws ambient air through an intake filter 316 disposed inside of the flow generator intake door 226. The air then typically travels through some form of sound-abatement device such as an acoustic damper 314 as best seen in FIG. 8. The compressor 312 increases the pressure of the air, which may or may not be combined with an additional gas, and discharges the pressurized gas at an outlet 416 for inspiration by the patient.

[0056] Still referring to FIG. 3, a sensor board 322 is disposed downstream of the compressor 312 and may be used to monitor any one of the parameters noted above, i.e., pressure, flow, temperature, O_2 level, CO_2 level, etc. While the sensor board 322 is shown partially above the diverter flap 310 and in the inhale and exhale breathing pathway, it is recognized that the same or additional sensors can be located in the compressor 312 expansion chamber, prior to the outlet 416 and the diverter flap 310.

[0057] An infrared transceiver 224may communicate with external devices, such as a remote control by sending a signal through anIR transmit/receive lens 320. In another embodiment, a radio transceiver communicates to such as a remote control. Data transmitted can include data collected from treatments, parameters for treatment, and other data used to control or facilitate operation of various features and functions.

[0058] Referring to FIG. 4,an exploded view of the integratedCPAP unit 1122 depicted in FIGS. 2 and 3 is shown. The integrated CPAP unit 1122 has a gas flow diverter gasket 410 which mates with a moisture retention membrane420and/or heat exchanger. In one embodiment, the membrane 420 may comprise a polyamide, polypropylene, or other gas-permeable membrane capable of inhibiting the passage of water vapor or liquid water. This membrane 420 may also be of a loose woven type, very similar to the heat and humidity exchange type used in conjunction conventional medical ventilators for many years. One benefit of the above-noted arrangement is that, as gas is expired by the patient, water vapor within the expired gas is obstructed by the membrane 420. In this regard, the moisture may be collected on the membrane 420 and used to further humidify the air discharged from the compressor 312. In this way, it is possible to reduce or eliminate the need for an external humidifier such as the one depicted in FIG. 1 for a conventional CPAP apparatus. As noted previously, a patient may require

approximately 200-500ml of water vapor to properly humidify the gas stream supplied to the mask with a conventional CPAP unit. In contrast, with the above-noted membrane 420, water vapor is actually recycled, at least to some extent, and the introduction of humidity via an external humidifier may be unnecessary.

[0059] The diverter flap 310, which is typically a flexible, substantially planar component, may be attached to a diverter flap retainer 412. The diverter flap 310 may include a wide portion connected to a remainder of the diverter flap 310 via a thinner portion or neck. In this manner, the diverter flap 310 may be detachably connected to the diverter flap retainer 412 and easily removed when worn, or when a different type of performance is desired.

[0060] An optional particulate screen 414 is shown in FIG. 4 as a discharge portion of the compressor 312. In some embodiments, the particulate screen 414 is connected to the outlet portion of the compressor 312 via the outlet 416 sometimes referred to as a transition coupling.

[0061] As described with reference to FIG. 3, the integratedCPAP unit 1122 may include a sensor board 322 for sensing variouspreviously notedparameters in the gas discharged from the compressor 312. In order to allow electronic communication between the sensor board 322 and the data connector receptacle 252, the integratedCPAP unit 1122 typically includes an interface 418 connectable to the sensor board 322. In this manner, should the sensor board 322 be damaged or expire due to chemical consumption, the sensor board 322 may be easily replaced.In another embodiment, the integrated CPAP unit 1122 may also include additional or either a sensor board containing the previously mentioned sensors which is located downstream of the diverter flap 310 and upstream of the compressor collection chamber. Additionally, there may also be sensors which are located downstream of the compressor inlet.

[0062] As noted above, the membrane 420 may act as an obstruction to moisture expired by the user, the patient. Additionally, the membrane 420 may be replaced or supplemented with a heat exchanger that absorbs heat from the gas expired by the patient. When the patient then inspires, the heat absorbed by the heat exchanger will be released into the gas stream as the patient inspires. Thus, in contrast to the conventional CPAP unit described in Fig. 1, some embodiments of the integratedCPAP unit 1122 may not need an external heaterwhich is commonly part of the humidification system.

[0063] The integrated CPAP unit 1122 can have one or more printed circuit board (PCB) for carrying sensors and circuitry. In addition to the sensor board 332 and the controller 1168, as

seen in FIG. 11, the integrated CPAP unit 1122 has a printed circuit board 318 that contains the IR device 224 and the control button 222.

[0064] Referring to FIG.5A, a perspective view of a strap with a power unit that may be used to supply power to the CPAP apparatus of FIG. 2 is shown. The power supply 244 may be part of a battery and strap assembly 510 that uses a strap 212to rest the power supply enclosure 244 at the back of a patient's neck. Alternatively, the power supplyenclosure244 may be disposed on other areas of a patient's body, for example, near the waist, chest, or hip. Additionally, locations on the shoulder or arms are also available. However, in the embodiment depicted in FIG. 5A, the strap 212 is arranged for placement of the power supplyenclosure244 at the rear of the patient's neck. In order to facilitate connection and disconnection of the power supply enclosure 244 from the integratedCPAP unit 1122, quick-connects or other readily removable connectors may be used, for example, connector 512 may include prongs that allow quick coupling of electrical connects 520 and 522. As discussed previously, pressurized gas from the integratedCPAP unit 1122 may be used to cool the power supply enclosure 244. In the example shown in Fig. 5A, a male fitting 518 connects a cooling supply conduit 248 to the power supply enclosure 244. The male fitting 518 is configured to removably connect to the integratedCPAP unit 1122. Air supplied to the power supplyenclosure244 via the cooling supply conduit 248 may escape from the power supply 244 via the cooling vents 250 along the vented cooling air path 524. Typically, in order to preserve the comfort of the patient, the air path 524 will be directed away from the patient's body, e.g., away from the neck, as shown in FIG. 5A by the arrows extending from the cooling vents 250. These cooling vents may also be directed in other directions..

[0065] As further shown in FIG. 5A, theelectrical conductor 246 couples to theelectrical connector 520 to distribute power from the power supply 244 to the integratedCPAP unit 1122. The electrical connector 520 is disposed on a battery strap cooling and electrical male connector 516, which may combine both a mechanical connection between the strap 212 and the integratedCPAP unit 1122 as well as fluid communication and electrical conductance to/from the power supply enclosure 244. Thus, relatively little stress is placed on the fluid and electrical connections.

[0066] In one embodiment, the fluid and electrical connections are omitted, and the strap 212is provided by itself, i.e., as a purely mechanical connection.

[0067] Referring to FIGS.5B and 5C,detailed views of a mechanical connection for the battery strap cooling and electrical male connector 516. A male nipple 530 may be used to place the power supply enclosure 244 in fluid communication with the integratedCPAP unit 1122. Pressurized air from the integratedCPAP unit 1122 passes through a conduit 532 disposed in a pressurized gas path 534. In one embodiment, the pressurized gas path534 is formed of somewhat resilient material in order to generate a sealing effect between the pressurized gas path523 and the integratedCPAP unit 1122. In order to latch or lock the mechanical connector in place, the battery strap cooling and electrical male connector 516 may include a connector latch 536, which locks in place as shown in FIG. 5C. Pressure on the pointed portions of the battery strap cooling and electrical male connector 516 will allow release of this connector. There are numerous other methods of mechanical connection found in art which may be used as well.

[0068] Referring to FIG. 6A, a front view of a flow generator 602 that can be used with the CPAP unit 1122 of FIG. 2 is shown. The flow generator 602 hasa rotary compressor 610 and an associated motor 640, as seen in FIG. 6B. The motor 640 rotates an impeller 612. The impeller 612 has at least 6 veins 618. Depending on the type of flow intended, different impellers 612 may be used. For example, in some applications, the veins of the impeller 612 may be swept. In other applications, the veins of the impeller 612 may be straight, i.e., directly radial. In another embodiment, any of the combinations cited may be more than 6 veins.The arrows 616 demonstrate the direction of rotation of the impellor 612, and the arrows 614 indicate a flow path of the gas compressed by the impellor 612. In the embodiment shown in FIG. 6A, the veins 618 are straight. However, as noted previously, these veins may be swept depending on the application. In any case, the compressed gas exits the rotary compressor 610 via the exhaust port 619 as pressurized exhaust gas 620. The gas collection duct or chamber 642 has a constant cross section area.

[0069] Referring to FIG. 6B, a section view taken along lines A-A of the flow generator 602depicted in FIG. 6A is shown. A gas intake path 630, which is at relatively low pressure, is disposed toward a central area of the rotary compressor 610. Various levels of efficiency of the rotary compressor 610 will be achieved depending on the exhaust impeller blade depth638, the intake width 632, shroud/impeller clearance 644, and the size and shape of the gas collection duct 642. As further shown in FIG. 6B, a generally trumpet-shaped compressor shroud 636 houses the impeller612 and includes exhaust collection duct 642, which permits the expansion

and collection ofthe pressurized gas and also directs it's air path fordischarge via the compression exhaust port 619. In one embodiment, the shape of the impeller may be parallel from top to bottom rather than trumpet shaped. Correspondingly, the shroud closely follows the shape of the impeller and also provides space in a gas collection duct to accumulate and discharge the compressed gas. A shaft 646 extends from the motor 640 to the impeller 612.

[0070] Referring to FIG. 6C, a section view taken along lines A-A of the flow generator 602 depicted in FIG. 6A, but with the inclusion of a gear system650 connected to the motor 640 used to drive the impeller 612in FIG. 6A is shown.;

[0071] The gear box 650 may "step up" the rotary speed of the impeller 612in relation to the rotary speed of the output shaft 646 on the motor 640. In other words, the impeller 612 will rotate at a greater rotary speed than the output shaft of the motor 640.

[0072] A gear box 650may be used with a motor 640 when the motor 640 is a type which includes a commutator. However, a gear box 650 may be used with a motor 640, even if the motor 640 is a brushless type.Likewise both the commutator or brushless type motor can be used without a gear box as shown in FIG. 6B.

[0073] Referring to FIG. 6D, a front view of an alternative flow generator 602 is shown. The gas collection duct 642 is non-uniform in size in relationship to the circumference of the impeller 612. This gas collection duct is narrower at the start of air collection and departs or is larger distance from the impeller circumference closer to and connecting to the compressor exhaust port 619. The gas collection duct or chamber 642 has an increasing cross sectional area as it approaches the exhaust port 619.

[0074] Referring to FIG. 7A, a schematic representation depictingthe gas paths for inspiration (inhaling) and expiration (exhaling)of a user. As shown in Fig. 7A, an "unassisted" breathing flow path is shown by arrows 712. This flow path is used when no pressurization is provided by the integratedCPAP unit 1122.

[0075] Also shown in Fig. 7A is a compressor exhaust path 716. As shown by this arrow, gas is discharged through the membrane/heat exchanger 420 toward the patient's face, i.e., the nasal area or mouth. As noted previously, some embodiments of the integratedCPAP unit 1122 may couple only with the nasal area. Other embodiments couple with the nasal area and mouth area. Further embodiments cover the eyes, nasal area, and mouth area.

[0076] The arrows 718 depict the inspiration and expiration flow path during normal use, i.e., when the integratedCPAP unit 1122 is operating, and the compressor pressurizes the gas directed to the patient. In that arrows 718 show the flow path between the users, the patient's, nose and / or mouth and a chamber 706 within the mask, this portion of the flow path is used in both "unassisted" breathing and with pressurized air from the compressor 312. The arrow 236 representing gas flow out of the washout holes 233 occurs at all times; however when the diverter flap 310 is in the closed position, as seen in FIG. 7B, opening the unassisted breathing vent 238 the majority of gas flow during exhaling (expiration) will follow arrow 712.

[0077] Referring to Fig. 7B,a section view of the mask showing the chamber 706 with washout vent 233 and unassisted breathing vent 238 section. The compressor exhaust flap seat 720 abuts the diverter valve flap 310 in order to close the outlet of the compressor. This state of the diverter valve flap 310 is typical when the pressure generated by the compressor cannot overcome the elastic resistance of diverter valve flap 310, for example, when the compressor is turned off. This diverter valve may also be deployed with a spring, spring tension clip, a diaphragm or other such method known to those skilled in the art.

[0078] Still referring toFig. 7B, the diverter valve flap 310 is shown in phantom in an "up" position when the pressure is supplied by the compressor 312, which provides an abutment contact between the unassisted breathing vent valve seat 722 and the diverter valve flap 310. In this state of the diverter valve flap 310, the patient expires through the CO_2 wash-out vents. Arrow 311 shows the movement of the diverter flap 310.

[0079] Referring to FIG. 8, a cross-section view of the acoustic damper 314 is shown. A circuitous flow path 810 winds back and forth to provide various overlapping portions. One benefit of this arrangement is that high frequency, which typically travels in generally straight lines, bounces around within the circuitous internal flow path 810 as shown by the vectors 816 which disperses energy. In this manner, noise generated by the edges of the veinsand air flowof the compressor on the intake side may be suppressed. In other words, the acoustic emissions 814 will bound around within the convoluted path 820 and be greatly diminished before exiting the integratedCPAP unit 1122, for example, via the intake filter 316. In one embodiment, the internal air gas path 810 is bounded by an acoustically absorbent material 818, for example, a polymer, polyether urethane foam or other type of foam material, or rubber or silicone or any combination thereof.

[0080] Referring to FIG. 9 a detailed view of an integratedCPAP unit 1122 in which a separable flow generator 912 is couplable to a mask structure 918. In other words, the flow generator may attach and detach from the mask structure 918 via dedicated clasping devices. For example, a latch 916 may be used to secure the separable flow generator 912 to the mask structure 918. Furthermore, a hinge, preferably a separable hinge 910 may be used to further couple the separable flow generator from the mask structure 918. One benefit of the above-noted arrangement is that different flow generators 912 with different properties such as compressors optimized for a specific treatment pressure range which may be more efficient and or quieter, may be used with a given mask structure. This would also permit the mask be changed or separated for cleaning. Additionally, the separable flow generator 912 may be sent to a service center for service while the mask structure is retained by the patient. Additionally, the separable flow generator 912, in some embodiments, may be removed from the mask structure 918 and connected to a stationary base unit 1010, as seen in FIG. 10A. For example, the separable flow generator 912 may be tilted through a predetermined angle line 914 to unhinge the separable flow generator 912 from the mask structure 918.

[0081] Referring to FIGS. 10A and 10B, a base unit 1010 with the separable flow generator 912is shown. The separable flow generator can be coupled into the stationary base unit 1011 in order to supply gas to a mask unit 140 as shown in Fig. 10B. In this way, the stationary base unit may be a relatively simple device, and all of the components included in the separable flow generator 912 may be used in conjunction either in direct contact with the mask structure or indirectly via the hose 1016 and second mask 140.

[0082] The stationary base unit may include a battery 1011 that is dedicated or rechargeable. Additionally, the stationary base unit 1010 will typically include a connection on a base 1012 for coupling to an AC adaptor 324 ora power source 326, which is shown in phantom in FIG. 10A which can include batteries, a fuel cell for power, or anautomobile DC circuit adaptor .

[0083] A docking receptacle 1013 typically receives the separable flow generator 912 and/or a remote control 1014, which may be charged in the docking receptacle 1013. Typically, the remote control 1014, which may be used to control the separable flow generator 912 or, in general, integratedCPAP unit 1122, will be insertable and removable from the docking receptacle 1013 as shown by the arrows 1030. In one embodiment, the remote control may be charged and or docked in a separate dedicated docking station.

[0084] The hose 1016 may include an adapter to attach to the detachable mask, thus permitting the reuse of the detached mask when the flow generator is remotely docked.

[0085] Referring to FIGS. 11A and 11B, a system schematic of one example of the present invention of the integrated CPAP unit 1122 is shown. In this example, a human 1110 interacts with the integratedCPAP unit 1122 when the integratedCPAP unit 1122 is affixed to the human through human mask interface junction 1112.The lungs of the human 1110 are represented by block 1114. The upper airway is represented by block 1118 that can be constricted by oropharyngeal occlusions as represented block 1116.

[0086] Expiration gases and inspiration gases 1120 are transmitted through device 1122 for the purposes of assisting breathing in the treatment of sleep disorders. Thebreathinggases 1120 are first transmitted bidirectionally through membrane 420 and further transmitted bythesensors 322 and through flow path 1124 and 712 if diverter flap 310 of the gas flow diverter 234 is in closed position since there isno air flow from compressor 312.

[0087] When the compressor is in operation,air, and optionally, other gases, are pressurized by the compressor when the intake of compressor 312 ingests ambient air 232. The ambient air 232 experiences low pressure at the intake of the integrated CPAP unit 1122, and the low pressure air passes through cap 242 and penetrates the optional filter 316 whereby the air is further ingested by acoustic damper 314 and finally communicated into intake of compressor 312. Sensors can be upstream or downstream of the compressor and diverter valve, that is, between the compressor and the diverter valve and or between after the diverter valve. The compressor312 draws this same air (and optionally other gases, medicines, or chemicals) into its impeller where centrifugal forces act on the air from rotational energy, and compress the air which then exits the compressor into the mask chamber 706, as seen in FIG. 7B. The pressurized air passes through the outlet 416 that is open with the diverter flap 310 of the gas flow diverter 234 in the open position and further through air path 1124 which can be actedupon by the optional sensor(s) 322. Thepressurized air is further transmitted through optional membrane 420 and into airway of human 1110.

[0088] The exhaust gas from the user exits the system through the washout vents 233 as represented by arrow 236.Prior to exiting through the washout vents 233 the exhaust gas passes through the through optional membrane/heat exchanger 420 if installed, and further transmitted adjacent the sensors 322

[0089] Electrical signals are generated when optional sensors 322 are acted upon by gases 1120 and 232 whereby the electrical signals are communicated to the controller 1168. The controller typically includes memory, for example optical or magnetic memory such as RAM, ROM, or other tangible, non-transitory media, and executable software code is typically stored on the memory. Signals from sensors 322 are computed by the controller using the software, which results in controlling the output of the compressor 312.

[0090] The integratedCPAP unit 1122 operates when powered by a power supply 244 (which may be one or more batteries) or an AC adapter 1038. Battery sources include the internal battery source 1176, which is typically enclosed within the flow generator, batteries disposed in the power supply 244, an external battery source 1210, and/or automobile DC current through an automobile adapter 1020, and/or any or all previously noted power sources such as batteries and fuel cells. Batteries used in any of the above-noted components may beof therechargeable or non-rechargeable type. If rechargeable, the batteries can be optionally charged through the electrical circuit of device 1112. As discussed previously,thepower supply 244 may include a pressurized gas cooling source 532.

[0091] AC adapter 1038 receives AC power 1152 and acts upon the power with the AC to DC rectifier1154resulting in converted DC power whereby DC power is then conditioned by DC power conditioning 1155. The DC power is transmitted by line 1160.

[0092] It is sometimes preferable to incorporate power conditioning with the controller. To achieve lightweight miniaturization of the controller in the flow generator 912, power conditioning may belocated within the AC adapter 1038. In still another embodiment of the AC adapter 1038, a POTS modem 1148 is incorporated within the adapter which maythenbepowered with power conditioning 1155. Further, wireless network WiFi module 1150 also powered by power conditioning 1155 can be incorporated withthe AC adapter 1038 or, together with POTS modem 1148 and AC adapter 1038. In still another embodiment, the control and power conditioning may be included in the power adapter. In this case, electrical leads between the integrated device 1112 and power adapter may be included to control the motor. In still another embodiment, the above-mentioned power conditioning and control circuit included in the power adapter may work in connection with a second sensor processing control which may be included in the integrated device 1112.

[0093] The POTS modem 1148 and WiFi network module 1150 communicate with device 1122 and further with the controller 1168 of the device with any one of, or combination of, communication methods including an infrared link 1156, wireless BlueTooth™ communications 1158, other wireless frequency communications, orwired electrical communications 1162. Similarly, the remote control 1014 communicates with the device 1122 and further with the controller 1168 of the device with any one of or combination of communication methods including an infrared link 1156, wireless BlueTooth™ communications 1158, other wireless frequency communications, orwired electrical communications 1162.

[0094] Data that is logged bythecontroller 1168 resulting from operational information and events that are recorded during treatment is typically communicated to one or more ofafirst removable flash memory card 1170 of flow generator 120, a second removable flash memory card 1170 of remote control 1014, a third removable flash memory card 1170 of adapter 1038, POTS modem 1148, and WiFi module 1150, for example. Also, data can be stored on the removable flash memory.

[0095] The removable flash memory card may log treatment data and can also be programmed by a second device, namely a personal computer, to change the settings and operating parameters. Once programmed, the removable flash memory is re-attached to the integrated device 1112 and the controller is updated to reflect the changes to the settings and operating parameters.

[0096] A POTS modem 1148 may communicate externally through a telephone line 1146 which telephone line is further connected to a telephone system. A WiFi network module 1150 communicates within the corresponding Wireless Network througharadio signal 1144 which is then received by a wireless access point and a wireless modem 1142 which is further capable of communicating through one or more ofatelephone line 1146, cellular phone network 1172, and media network cable 1174. Further communication may be achieved via the cellular data module 1138 of the AC adapter 1038 overthecellular network 1172.

[0097] It is recognized that the communications such as IR and Radio can communicate with other devices directly such as smart phones andWiFi access points, which can be used to transmit data.

[0098] Analysisof logged data is typically performed externally to the integratedCPAP unit 1122 on data that is transmitted externally over one or more communication routes of the

telephone line 1146 and then tothetelephone system, WiFi network signal to Internet modem and then internet network, cellular phone network 1172, and media network cable 1174. Transmitted data may also permit programming of settings and operational parameters of device 1112.

[0099] The integratedCPAP unit 1122 typically includes audio capability of one or more of an internal microphone 1136, internal speaker 1134, external microphone 1130, external speaker 1132, microphone jack 1126, and speaker jack 1128, all of which communicate with the controller1168 and whereby the microphone jack 1126, andthespeaker jack 1128 further communicate with common inputs and outputs of external audio capable devices. One or more of a microphone jack 1126 and speaker jack 1128 can also be combined into one commonly known combination jack.

[00100] Referring to FIG. 12, a flow chart depicting one example of a power management arrangement usable with the integratedCPAP unit 1122 is shown. As shown in Fig. 12, when power is supplied in step 1210, a controller will determine, in step 1220, whether the power supplied is AC power or DC power. In a further embodiment, a determination is made whether, when the power is ACpower,if a battery is connectedto the system as represented by decision diamond 1230.If a battery is determined to be attached tothe systemthen the battery is charged in step 1240. Additionally, a determination may be made as to whether the battery contains sufficient charge to last for a predetermined amount of time. For example, if a battery has sufficient charge for 12 hours of operation, and a patient is expected to sleep for eight hours, then the integratedCPAP unit 1122 can successfully complete a sleep period for this patient. However, if the battery contains sufficient charge only for a four hour operation, and the patient intends to sleep for eight hours, it is preferable that a controller disposed within the integratedCPAP unit 1122 provide a warning signal indicating that theCPAP unit does not have sufficient battery power for completion of the sleep cycle. To ameliorate the above-noted problem, or, in general, when batterypower is applied alone, the integratedCPAP unit 1122 may run in a power conservation mode. For example, data logging, radio transmission, or other optional operations may be suspended or reduced while the integratedCPAP unit 1122 is in the conservationmode depicted in step 1260. In this way, power within the battery may be conserved and the operational period available to the patient may be extended. Alternatively, when the AC adaptor is determined to supply power to the integratedCPAP unit 1122, the unit may be run in a non-power conservation mode as shown in step 1250.

[00101] Thus, the foregoing discussion discloses and describes merely exemplary embodiments of the present invention. As will be understood by those skilled in the art, the present invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. Accordingly, the disclosure of the present invention is intended to be illustrative, but not limiting of the scope of the invention, as well as other claims. The disclosure, including any readily discernible variants of the teachings herein, define, in part, the scope of the foregoing claim terminology such that no inventive subject matter is dedicated to the public.

CLAIMS:

1. A gas delivery system that provides positive airway pressure therapy for a user, the system comprising:

a mask that couples to a user's face to deliver pressurized gas to an airway of the patient;

a flow generator system that pressurizes gas, the flow generator system i including

at least one motor,

a flow generator having an impeller, a housing defining a collection chamber for collection of the air from the impeller, and an outlet from the flow generator; and

a diverter valve movable between an open and closed position and blocking the outlet from the flow generator in the closed position,

wherein the flow generator system is integrated with the mask, the mask having a shell defining a mask chamber and a plurality of washout vents for venting exhaust gas and further comprising an acoustic damper unit integrated with the mask and disposed upstream of the flow generator system.

2. A gas delivery system of claim 1 wherein the flow generator is detachable from the mask.

3. A gas delivery system of claim 2 further comprising a hose interposed from the mask and the flow generator.

4. A gas delivery system of claim 2 further comprising a base unit configured to couple via a hose to the mask, wherein the flow generator system detachably directly couples to the base unit.

5. A gas delivery system of claim 1 further comprising a moisture retention membrane within the mask chamber for the exchange of moisture into an air flow path of the mask chamber.

6. A gas delivery system of claim 1 further comprising at least one sensor in the mask chamber for monitoring of the airflow in the air flow path of the mask chamber.

7. A gas delivery system of claim 1 wherein the acoustic damper unit includes an internal pathway that repeatedly folds over upon itself to create a convoluted pathway that overlaps itself a plurality of times.

8. A gas delivery system of claim 1 further comprising:

at least one unassisted breathing orifice that allows fluid communication, separately from the flow generator system, between an exterior of the mask and an interior of the mask, the at least one unassisted breathing orifice sized to allow unencumbered / free breathing; and

the diverter valve movable from the open position that obstructs the at least one unassisted breathing orifice and allows pressurized gases from the flow generator into the interior of the mask orifice during inspiration by the patient and allows gas flow through the at least one unassisted breathing orifice during expiration by the patient and the closed position blocking the outlet from the flow generator and allowing unencumbered breathing through the at least one unassisted breathing orifice.

9. A gas delivery system of claim 1 wherein the collection chamber has a constant cross sectional area.

10. A gas delivery system of claim 1 wherein the collection chamber has an increasing cross sectional area.

11. A gas delivery system of claim 1 further comprising a controller configured to control pressure of the gas supplied by the flow generator to within a pressure range of from 0 cm/H20 to 30 cm/H_20.

12. A gas delivery system of claim 1, further comprising a power supply attached to the mask.

13. A gas delivery system of claim 12, wherein the power supply includes at least one battery and is connected to a strap and configured to attach to the body of the patient.

14. A gas delivery system of claim 12, wherein the power supply includes at least one battery and is connected to a strap and configured to rest against the back of the neck of the patient.

15. A gas delivery system that provides positive airway pressure therapy for a user, the system comprising:

a mask that couples to a user's face to deliver pressurized gas to an airway of the patient;

a flow generator system that pressurizes gas integrated with the mask, the flow generator system includes at least one motor, the flow generator having an

impeller and a housing defining a collection chamber for collection of the air from the impeller, an outlet from the flow generator;

the mask includes at least one washout vent that places an interior of the mask in fluid communication, separately from the flow generator system, with an exterior of the mask; and

an acoustic damper unit integrated with the mask and disposed upstream of the flow generator system.

16. A gas delivery system of claim 15 further comprising:

at least one unassisted breathing orifice that allows fluid communication, separately from the flow generator system, between an exterior of the mask and an interior of the mask, the at least one unassisted breathing orifice sized to allow unencumbered / free breathing; and

a diverter valve movable from an open position that obstructs the at least one unassisted breathing orifice and allows pressurized gases from the flow generator into the interior of the mask orifice during inspiration by the patient and allows gas flow through the at least one unassisted breathing orifice during expiration by the patient and a closed position blocking the outlet from the flow generator and allowing unencumbered breathing through the at least one unassisted breathing orifice.

17. A gas delivery system of claim 16 further comprising a moisture retention membrane within the mask chamber for the exchange of moisture into an air flow of the mask.

18. A gas delivery system of claim 16 further comprising at least one sensor in the mask chamber for monitoring of the airflow in the air flow path of the mask chamber.

19. A gas delivery system of claim 16 wherein the acoustic damper unit includes an internal pathway that repeatedly folds over upon itself to create a convoluted pathway that overlaps itself a plurality of times.

20. A gas delivery system of claim 19, wherein the acoustic damper unit comprises a resonance noise cancellation unit.

21. A gas delivery system that provides positive airway pressure therapy for a user, the system comprising:

a mask that couples to a user's face to deliver pressurized gas to an airway of the user, the mask including

a flow generator system that pressurizes gas integrated with the mask, the flow generator system including at least one motor, the flow generator having an impeller and a housing defining a collection chamber for collection of the air from the impeller, an outlet from the flow generator;

at least one washout vent that allows constant fluid communication, separately from the flow generator system, between an exterior of the mask and an interior of the mask, the at least one washout vent sized to allow pressure to be maintained in the interior of the mask;

at least one unassisted breathing orifice that allows fluid communication, separately from the flow generator system, between an exterior of the mask and an interior of the mask, the at least one unassisted breathing orifice sized to allow unencumbered / free breathing;

a diverter valve movable from an open position that obstructs the at least one unassisted breathing orifice and allows pressurized gases from the flow generator into the interior of the mask orifice during inspiration by the patient and allows gas flow through the at least one unassisted breathing orifice during expiration by the patient and a closed position blocking the outlet from the flow generator and allowing unencumbered breathing through the at least one unassisted breathing orifice; and

an acoustic damper unit integrated with the mask and disposed upstream of the flow generator system.