a housing defining a gasflow passage,

a motor with an impeller to deliver gas through the gasflow passage,

a flexible printed circuit electrically connected to the motor for electrically connecting the motor to the controller.

[0059] In some configurations, the apparatus further comprises a sensor system, wherein the flexible printed circuit also electrically connects the sensor system to the controller.

[0060] Optionally in some configurations, the flexible printed circuit has signal traces electrically connects the sensor system to the controller and motor traces electrically connecting the motor to the controller, wherein the signal traces are positioned over the top of the motor traces with a substrate between the signal traces and motor traces.

[0061] In some configurations, the flexible printed circuit has signal traces electrically connecting the sensor system to the controller and motor traces electrically connecting the motor to the controller, wherein the signal traces are positioned towards one side of the flexible printed circuit and the motor traces are positioned towards another side of the flexible printed circuit with a substrate between the signal traces and motor traces. Optionally a portion of substrate may be provided or may be present between the motor traces and the signal traces. A portion of substrate may be located between the adjacent motor traces. Adjacent motor traces may be disposed on separate layers of the flexible printed circuit. Alternatively an air gap may be located between motor traces and/or the signal traces that are disposed on the same layer of the printed circuit board.

[0062] In some configurations, the apparatus further comprises a seal that provides a seal around the flexible printed circuit where it exits the housing.

[0063] In some configurations, an end of the flexible printed circuit is receivable by an edge connector of the controller.

[0064] In some configurations, the flexible printed circuit has one or more stiffened regions to assist with attaching the flexible printed circuit to other components.

[00130] Figure 38 is a perspective view of the flow generator of figure 25 with the rotor hidden.

[00131] Figure 39 is a cross-sectional view of the flow generator of figure 25 with the stator assembly hidden.

[00132] Figure 40 is a detailed cross-sectional view of the flow generator of figure 25 with the stator assembly hidden.

[00133] Figure 41 is a view similar to figure 40 showing an extrapolation of bearing mount flex.

[00134] Figure 42 is a perspective view of a bearing mount.

[00135] Figure 43 is a top view of the bearing mount of figure 42.

[00136] Figure 44 is a top view of the bearing mount of figure 42 with dimensions.

[00137] Figure 45 is a side view of the bearing mount of figure 42.

[00138] Figure 46 is a side view of the bearing mount of figure 42 with dimensions.

[00139] Figure 47 is a cross sectional view of the bearing mount of figure 42.

[00140] Figure 48 shows a bearing.

[00141] Figure 49 is a side view of the bearing of figure 48.

[00142] Figure 50 is another embodiment of a bearing mount.

[00143] Figure 51 is a top view of the bearing mount of figure 50.

[00144] Figure 52 is a top view of the bearing mount of figure 50 with dimensions.

[00145] Figure 53 is a side view of the bearing mount of figure 50.

[00146] Figure 54 is a side view of the bearing mount of figure 50 with dimensions.

[00147] Figure 55 shows a bearing mount bottom surface.

[00148] Figure 56 shows a bearing mount section plane.

breathing conduit 16 through the cannula 17. The patient breathing conduit 16 can have a heater wire 16a to heat gasflow passing through to the patient. The heater wire 16a is under the control of the controller 13. The patient breathing conduit 16 and/or patient interface 17 can be considered part of the flow therapy apparatus 10, or alternatively peripheral to it. The flow therapy apparatus 10, breathing conduit 16, and patient interface 17 together form a flow therapy system.

[00177] General operation of a flow therapy breathing apparatus 10 will be known to those skilled in the art, and need not be described in detail here. However, in general terms the controller 13 controls the flow generator 11 to generate a gasflow of the desired flow rate, controls one or more valves to control the mix of air and oxygen or other alternative gas, and controls the humidifier 12 if present to humidify the gasflow and/or heat the gasflow to an appropriate level. The gasflow is directed out through the patient breathing conduit 16 and cannula 17 to the patient. The controller 13 can also control a heating element in the humidifier 12 and/or the heating element 16a in the patient breathing conduit 16 to heat the gas to a desired temperature that achieves a desired level of therapy and/or comfort for the patient. The controller 13 can be programmed with or can determine a suitable target temperature of the gasflow.

[00178] Operation sensors 3a, 3b, 3c, 20, 25 such as flow, temperature, humidity, and/or pressure sensors can be placed in various locations in the flow therapy apparatus 10 and/or the patient breathing conduit 16 and/or cannula 17. Output from the sensors can be received by the controller 13, to assist it to operate the flow therapy apparatus 10 in a manner that provides optimal therapy. In some configurations, providing optimal therapy includes meeting a patient's inspiratory demand. The apparatus 10 may have a transmitter and/or receiver 15 to enable the controller 13 to receive eight signals from the sensors and/or to control the various components of the flow therapy apparatus 10, including but not limited to the flow generator 11, humidifier 12, and heater wire 16a, or accessories or peripherals associated with the flow therapy apparatus 10. Additionally, or alternatively, the transmitter and/or receiver 15 may deliver data to a remote server or enable remote control of the apparatus 10.

[00179] The flow therapy apparatus 10 may comprise a high flow therapy apparatus. As used herein, "high flow" therapy refers to administration of gas to the airways of a patient at a relatively high flow rate that meets or exceeds the peak inspiratory demand of the patient. The flow rates used to achieve "high flow" may be any of the flow rates listed below. For example, in some configurations, for an adult patient 'high flow

[00188] The configuration is such that if there is any leaking of gas from the motor or gasflow path following the motor via any seals, the gas will vent to atmosphere rather than ingressing into the interior of the main housing that contains the control boards and other electrical components as described below. The electrical components and electronics boards in the housing are pneumatically isolated from the gasflow path. The only way for gas to leak into the portion of the main housing 100 that contains the electronics boards and other electrical components will be if there is a physical crack in the housing 100 or another physical component.

[00189] In the motor and/or sensor module 400, the pressure is lower before/upstream of the motor impeller, and the pressure is higher after/downstream of the motor impeller. An electrical connection will be provided for the motor upstream of the motor impeller, in the lower pressure region. If there is a failure in the housing in the portion near the electrical connection, air will be sucked into the low pressure side.

[00190] In an alternative configuration, the motor recess comprising items 252, 254, 256, 258, 260, 264 may be separately formed from the lower chassis 202. The motor assembly including the recess may be insertable into the recess opening 251 and attachable to the lower chassis 202. Upon insertion of the motor and/or sensor module 400and recess into the lower chassis 202, the gasflow passage tube 264 will extend through the downward extension tube 133 and be sealed by the soft seal.

[00191] In the form shown, the recess 250 comprises a recess opening in a bottom wall of the housing. Alternatively, the recess opening could be in a different part of the housing, such as a side, front, or top of the housing.

[00192] The described configuration provides a chamber shaped to receive a motor and/or sensor module 400 as described below with reference to figures 9 and 10. The motor may be a removable motor or a non-removable or fixed motor. The interior wall of the recess 250 (including but not limited to portions of the peripheral wall 252) may be provided with guides and/or mounting features to assist with locating and/or attaching the module 400 in the recess 250. The motor and/or sensor module 400 comprises a flow generator 11 with an impeller 72001 that operates as a blower to deliver gases to the patient interface 17 via the liquid chamber 300. It will be appreciated that the shape of the chamber can vary depending on the shape of the motor and/or sensor module 400. However, the chamber will be provided with continuous, gas impermeable, and unbroken walls and a ceiling to isolate the gasflow from electrical and electronic components in the main housing 100.

example, via a flexible printed circuit (FPC) 10001, which is described in more detail below. The control can be tuned to suit a low inertia impeller. The central hub 20032 of the impeller 20031 is engaged with a shaft 20060 that extends from the motor 402. Mounted to the shaft is a plurality of, preferably small, magnetic segments to form a rotor 20062. In one embodiment the magnet is 20mm in diameter, but more generally the diameter could be less than 20mm and preferably between 10mm to 15mm. The magnet volume is less than 1600mm^3 and can be between 500mm^3 and 1600mm^3. Surrounding the rotor 20062 is a laminated stator having a plurality of poles 20063 and windings 20068. The windings 20068 are selectively energised by the controller 13 via the FPC 10001 to facilitate rotation of the rotor, and therefore the shaft 20060 and impeller 20031, about the central axis defined by the centreline of the shaft 20060. In an alternate configuration, rather than an FPC, one or more rigid-flexible circuit/s or one or more flexible flat cable/s could be used.

[00208] A gases outlet 406 is in fluid communication with a gases inlet of the outlet gasflow path and sensing layer 420, which is stacked on top of the motor 402. This layer 420 comprises a body 422 which comprises a plurality of mounting legs 425 that can be inserted into a plurality of mounting slots (not shown) of the base 403 to secure the body 422 to the base 403. In other configurations, other structures or arrangements may be used to secure the body 422 to the base 403, including but not limited to fasteners, clips, or quick release arrangements. In one configuration, the body 422 defines a gasflow path that couples the gases outlet 406 with the gases inlet of the gasflow path and sensing layer 420. An alternative configuration such as but not limited to a coupling tube could be used to couple the gases outlet 406 with that gases inlet.

[00209] The body 422 defines a lower portion 426 of a sensing and gasflow path. The cover layer 440 has a body 442 that defines the upper portion 446 of the sensing and gasflow path, with the shape of the lower and upper portions 426, 446 corresponding substantially to each other.

[00210] As shown in figures 10 and 11, the gasflow path comprises a linear elongate gasflow portion 428, 448. The inlet is in fluid communication with an entrance portion 430, 450 of the gasflow path, which is located at or adjacent an entrance end of the linear elongate portion 428, 448 of the gasflow path. Recesses 433, 453 and 434, 454 may be provided at opposite ends of the linear elongate portion of the gasflow path.

[00211] A gasflow outlet port 452 extends vertically through the body 442 of the cover layer 440, and is located at or adjacent an opposite exit end of the linear elongate

portion 428, 448 of the gasflow path. The gas outlet port 452 is in fluid communication with an upper portion of the motor recess 250, which in turn is in fluid communication with the gasflow passage. Again, due to the wall 252 and ceiling 262 configuration of the recess 250, if there is gas leakage from the motor/sensor module 400, that will be vented to atmosphere rather than entering the portion of the main housing 100 that contains the bulk of the electronics and control equipment. The recess 250 may comprise spacer(s), such as lugs that protrude downwardly from ceiling 262 as shown in figure 7, to maintain a suitable spacing for gasflow from the gas outlet port 452 and the ceiling of the recess 262.

[00212] It can be seen from figure 10 that at least part of the gasflow path through and out of the motor and/or sensing module 400 has a tortuous or sinuous configuration.

[00213] As shown in figure 11, the cover layer 440 comprises a sensing printed circuit board (PCB) 456. The cover layer 440 may also comprise one or more temperature sensors such as thermistors that sit in the elongate portion 428, 448 of the gasflow path. One sensor will measure gas temperature and the other can act as a redundant temperature sensor. Alternatively, one of the thermistors could be used as a reference flow sensor (e.g. via use as a constant-temperature thermistor), and the measured temperatures could be used to determine the gasflow rate through the portion 428, 448 of the gasflow path. The one or more temperature sensors may be located on a portion of the sensing PCB 456 that faces the gasflow. The sensing PCB 456 may additionally comprise other sensors including but not limited to pressure sensors, humidity sensors and dew point sensors.

[00214] Figure 12 shows an alternative embodiment of sensing printed circuit board (PCB) 2200. The sensing PCB can comprise ultrasonic transducers 2204, and one or more of separate gas temperature sensors 2205, heated temperature sensing elements 2206, humidity sensors including humidity only sensors to be used with a separate temperature sensor and combined humidity and temperature sensors, sensors for measuring barometric pressure, sensors for measuring differential pressure, and/or sensors for measuring gauge pressure. The sensing PCB can comprise drivers, microcontrollers, and/or other circuitry 2207. A heated temperature sensing element can comprise a heated temperature sensing element, hot wire anemometer, such as a platinum wire or heated thermistor, and/or a negative temperature coefficient (NTC) thermistor. Other non-limiting examples of the heated temperature sensing element

[00267] The partition 33001 is generally circular and substantially divides the top casing 25002 from the bottom casing 25003 thereby defining the upper and lower gases flow (interior) regions of the blower. To allow gases to flow from the upper region to the lower region an opening is located at, or close to the outer edge of the partition. The opening is most preferably formed by a cut-away in the partition 33001, or some other configuration/shape of the casing such that the combination/arrangement of the partition 33001 and the casing creates an opening or gap between the two. In the embodiment shown, the opening partition 33001 is circular and is located concentrically within the casing. As a result, the opening is an annular opening that is the same width around the perimeter of the partition 33001.

[00268] In an alternative embodiment, the curvature/centre of radius of the circumferential aperture may be offset from the centre of radius of the partition 33001 or otherwise has a curvature that differs from that of the circumference of the partition 33001 resulting in an eccentric or otherwise offset circumferential aperture around the circumference of the partition 33001. This produces an aperture with a crescent ("smile") shaped opening that spans a leading edge to a trailing edge., the aperture may be of any shape with a gradual opening and closing relative to the plane of impeller rotation.

[00269] The width and length of the aperture controls the velocity in the lower (volute) section of the housing. A wider and longer aperture increases velocity in the volute, for example.

[00270] By dividing the flow generator internal space into two separate regions a number of advantages can be realised. In a conventional blower, high velocity gases leaving the impeller are incident to the edge, or tongue, that defines a physical boundary where gases are split from the volute to enter the outlet passage. High velocity gas flow incident the tongue is turbulent and results in inefficiency, reducing flow generator performance. The turbulence caused by the tongue also introduces a source of noise. In contrast, dividing the casing of the preferred blower into the upper and lower regions reduces the impact caused by the tongue. The upper region allows the gases to circulate at a high speed. The gradual radial opening and closing of the preferred partition 33001 provides a fluid path to the lower region that is free from (or has reduced) aerodynamically turbulent edges. When circulating gases have entered the lower region, the enlarged volume of the volute encourages the gases to slow and increase pressure. The reduced gases velocity reduces the impact of turbulence normally

$\beta = 7.8\,mm$. The bearing mount collar 42005 has an outer diameter $\gamma = 11.9\,mm$. The bearing mount ledge 42011 defines an aperture with a diameter $\alpha = 6\,mm$.

[00292] In this configuration, $\delta > \gamma$ and $\beta > \alpha$, while $\beta < \gamma$. More specifically:

$$\delta{:}\,\alpha = 2.6{:}\,1\,, \delta{:}\,\beta = 2{:}\,1 \;\; and \;\; \delta{:}\,\gamma = 1.3{:}\,1$$

[00293] Providing a bearing mount 42001 having an annular body external diameter greater than the collar outer diameter ($\delta > \gamma$), results in a bearing mount having a lateral distance between the top of the bearing mount 42001 collar and the outer edge of the bearing mount 42001. This distance provides the recess 42015 around the edge of the bearing mount 42001. The recess allows the bearing mount 42001 to flex and behave as described around Figure 41.

[00294] Providing a bearing mount 42001 having a bearing mount 42001 aperture greater than the bearing mount ledge aperture ($\beta > \alpha$), provides the bearing mount ledge 42011. As described earlier, this ledge 42011 supports the bearing 48001 in the axial direction.

[00295] Figure 45 shows a side view of the bearing mount 42001. The bearing mount 42001 includes a tapered surface 42017. With reference to the orientation of figure 45, the surface tapers downwardly and inwardly towards the rotational axis. The tapered surface 42017 acts as an alignment feature, making it easier to place the bearing mount 42001 in the bearing mount 42001 recess of the bottom casing cap/partition.

[00296] Figure 46 shows a side view of the bearing mount 42001 with dimensions shown. The bearing mount 42001 includes a total height ε, a collar height ζ, a ridge height η and a tapered surface height κ. In this configuration, $\varepsilon = 5.4\,mm, \zeta = 2.2\,mm, \kappa = 2\,mm \; and \; \eta = 1.2\,mm$. The recess has a radius $r = 2\,mm$.

[00297] In this configuration, the collar height is greater than the ridge height ($\zeta > \eta$) and the tapered surface height is greater than the ridge height ($\kappa > \eta$).

[00298] Figure 47 shows the section plane identified in Figure 43. The bearing mount 42001 has a bearing mount ledge thickness μ and a bearing mount 42001 aperture thickness λ. In this case, $\mu = 1.2\,mm \; and \; \lambda = 4.2\,mm$. As a result, the ratio of $\lambda{:}\,\mu$ is 3.5:1.

[00299] It is preferred that the bearing mount ledge thickness μ is relatively small to reduce the profile of the bearing mount 42001, while also having sufficient thickness to retain and secure the bearing.

[00300] Figure 48 shows a perspective view of a bearing 48001 that can fit into the bearing mount 42001 and figure 49 shows a side view of the bearing 48001. The bearing includes an inner race 48005 and an outer race 48003 that can rotate with respect to the inner race 48005. The bearing has an outer diameter dimension $\tau = 4\,mm$. The ratio $\tau : \epsilon$ is therefore 4:5.4 or about 1:1.35, the ratio $\tau : \mu$ is 4:1.2 or about 3.3:1, and the ratio $\tau : \lambda$ is 4:4.2 or about 1:1.05.

[00301] The $\tau : \mu$ ratio of 4:1.2 results in a relatively thin ledge thickness μ minimising the profile of the bearing mount 42001, whilst being thick enough to provide enough support for the bearing.

[00302] It will be appreciated that one or more of the dimensions discussed above may be altered depending on different factors, such as the amount of vibration dampening required, or the size and shape of other components. However, the bearing mount will meet the conditions set out above, including:

[00303] $\delta > \gamma$

[00304] $\beta > \alpha$

[00305] $\beta < \gamma$

[00306] For example the annular body external diameter could be about 12.5 mm, about 13 mm, about 13.5 mm, about 14 mm, about 14.5 mm, about 15 mm, about 15.5 mm, about 16 mm, about 16.5 mm, about 17 mm, about 17.5 mm, about 18 mm, or about 15.5 mm.

[00307] The collar diameter could be about 9 mm, about 9.5 mm, about 10 mm, about 10.5 mm, about 11 mm, about 11.5 mm, about 12 mm, about 12.5 mm, about 13 mm, about 13.5 mm, about 14 mm, about 14.5 mm, or about 15 mm.

[00308] The central bore diameter could be about 5 mm, about 5.5 mm, about 6 mm, about 6.5 mm, about 7 mm, about 7.5 mm, about 8 mm, about 8.5 mm, about 9 mm, about 9.5 mm, about 10 mm, about 10.5 mm, or about 11 mm.

biasing component biases or urges the components together to remove the play. In particular, the biasing component biases the components together in a direction that is parallel to the direction of the shaft.

[00370] Figure 70 shows one example of a biasing component in the form of a stator preload cap. The stator preload cap 70001 is located between the stator bottom of the stator and the inner surface of the bottom casing cap 25008. The stator preload cap 70001 supports the stator and acts to damp any vibration of the stator 35003. The illustrated embodiment of the stator preload cap is compressible. The stator preload cap 70001 is or comprises an elastomeric material. In particular, the elastomeric material is silicone.

[00371] The stator preload cap 70001 can be an elastomeric material (e.g. silicone). The stator preload cap 70001 can span an entire perimeter of the adjacent surface of the stator, or can be broken into segments only spaning partial perimeters of the adjacent surface of the stator 35003. The illustrated stator preload cap 70001 is annular with a central opening. Alternately, the stator preload cap can be cylindrical or another shape. The stator preload cap 70001 can include additional stator preload cap openings configured to permit airflow through the stator preload cap. These additional openings can correspond with the openings in the bottom casing cap. This allows air to flow through the motor assembly more easily or effectively, assisting in dissipating heat from the motor assembly.

[00372] Figure 83 shows a biasing component in the form of a modified bottom casing cap 83000. The bottom casing cap 83000 has the same features and functions as the bottom casing cap described above, except that it includes resilient fingers 83003. The resilient fingers are integrally formed with the bottom casing cap 83000. The resilient fingers 83003 are shaped and formed form a resilient material to provide a biasing force towards the stator 35003 to damp any vibration of the stator 35003.

[00373] The preferred form of the impeller is shown in Figures 72 to 76. The impeller 72001 has a plurality of blades 72005 extending outward from a central hub 72003. The impeller is a centrifugal impeller. The hub 72003 defines the axis about which the impeller rotates. Preferably the hub 72003 has an aperture or recess on the underside to allow engagement with a motor shaft 33003 which facilitates impeller rotation. However, other engagement mechanisms, such as over moulding of the shaft 33003 with a hub, could be used. Each impeller blade 72005 includes a concave surface 72005a and a convex surface 72005b. Each of the concave and convex surfaces are oriented parallel to

6. A bearing mount according to any one of claims 1 to 5, wherein the annular body comprises a rim at or near the outer periphery of the annular body.

7. A bearing mount according to any one of claims 1 to 6, wherein the ledge is substantially perpendicular to the bearing rotational axis.

8. A bearing mount according to any one of claims 1 to 7, wherein at least the annular body comprises a silicone material.

9. A blower for an apparatus for delivering a flow of gas, the blower comprising:

a casing,

an impeller,

a motor for driving the impeller, the motor including:

a rotatable shaft,

a rotor connected to the rotatable shaft, and

a stator,

a bearing arranged to allow rotation of the rotatable shaft relative to the casing, and

a bearing mount according to any of claims 1 to 8, wherein the bearing mount is arranged to support the bearing.