**Claims**

1. An apparatus for providing an apparatus gas flow and determining a parameter of gas present in an exhaled patient gas flow, comprising:

a flow source,

a sensor for sensing a composite gas outflow, and

a controller,

wherein the apparatus is configured to:

provide an apparatus gas flow with a time-varying flow rate,

determine a parameter of a gas present in a composite gas outflow from the patient, the composite gas outflow comprising:

leak gas flow from apparatus gas flow, and

exhaled gas flow from a patient with the gas,

and

determine the parameter of the gas present in the exhaled gas flow using the determined parameter of gas present in the composite gas outflow and the time-varying flow rate.

2. An apparatus according to claim 1 further comprising a humidifier for humidifying the apparatus gas flow.

3. An apparatus according to any preceding claim further comprising a non-sealing patient interface, and preferably a non-sealing nasal cannula to provide the apparatus gas flow to a patient.

4. An apparatus according to any preceding claim wherein the apparatus gas flow is a high flow gas flow.

5. An apparatus according to any preceding claim wherein the parameter comprises a fraction of the gas component in the exhaled gas flow.

6. An apparatus according to any preceding claim wherein the gas is:

$CO_2$,

$O_2$,

Nitrogen,

Helium, and/or

Anaesthetic agent such as sevoflurane

and/or

the sensor is configured to sense one or more of the following in the composite gas outflow:

$CO_2$,

$O_2$,

Nitrogen,

Helium, and/or

anaesthetic agent such as sevoflurane.

7. An apparatus according to any preceding claim wherein the parameter of gas present in an exhaled gas flow is gas fraction and determining the fraction of the gas ($F_E$) present in an exhaled gas flow using the determined parameter of gas present in the composite gas outflow and the time-varying flow rate comprises determining the gas fraction as a function of:

$$Q_o(t), Q_o(t+\Delta t),\ F_m(t+\Delta t), F_m(t)$$

where

$F_E(t)$ is the gas component concentration in the exhaled patient gas flow (volume fraction of expired gas)

$F_m(t)$, fraction of the gas component measured in the patient composite gas outflow at time t

$Q_o(t)$, flow rate of the apparatus gas flow provided to the patient (apparatus gas flow rate), at time t

$F_m(t+\Delta t)$, fraction of the gas component measured in the patient composite gas outflow (this is the measured $CO_2/O_2$ fraction parameter of the composite gas outflow) at time t + Δt

$Q_o(t+\Delta t)$, flow rate of the apparatus gas flow provided to the patient (apparatus gas flow flow rate) at time t + Δt.

8. An apparatus according to any preceding claim wherein the parameter of the gas present in the exhaled gas flow is gas fraction and the gas is preferably $CO_2$ and determining the gas fraction ($F_E$) in the exhaled gas flow using the determined parameter of gas present in the composite gas outflow and the time-varying flow rate comprises using:

$$F_E(t) \sim F_m(t+\Delta t)F_m(t) \cdot \frac{Q_o(t+\Delta t) - Q_o(t)}{Q_o(t+\Delta t)F_m(t+\Delta t) - Q_o(t)F_m(t)}$$

Where

$F_E(t)$ is the $CO_2$ or $O_2$ or other gas in the exhaled patient gas flow (volume fraction of expired gas) at time t

$F_m(t)$, fraction of $CO_2$ measured in the composite gas outflow at time t

$Q_o(t)$, flow rate of the apparatus gas flow provided to the patient (apparatus gas flow flow rate) at time t

$F_m(t+\Delta t)$, fraction of $CO_2$ measured in the composite gas outflow at time t + Δt

$Q_o(t+\Delta t)$, flow rate of the apparatus gas flow provided to the patient (apparatus gas flow flow rate) at time t + Δt.

9. An apparatus according to any preceding claim wherein the sensor is positioned to measure the parameter of the gas present in the composite gas outflow from the patient at or near the mouth and/or nose of the patient.

10. An apparatus according to any preceding claim wherein the parameter of the gas present in the composite gas outflow is determined during an inspiration and/or expiration phase of the patient breathing.

11. An apparatus according to any preceding claim wherein the time varying flow rate is an oscillation with a varying flow rate of greater than or equal to about 0 L per minute, and preferably about or greater than about 20 L per minute, and more preferably between about 20 L per minute to about 90 L per minute.

12. An apparatus according to any preceding claim wherein the apparatus is further configured to provide the apparatus gas flow during an anaesthetic procedure.

13. An apparatus according to any preceding claim wherein the apparatus gas flow with the time-varying flow rate comprises at least a first flow rate at a first time and a second flow rate at a second time, and

determining the parameter of the gas present in the exhaled gas flow using the determined parameter of the gas present in the composite gas outflow and the time-varying flow rate comprises:

using the determined parameter of the gas present in the composite outflow determined at the first flow rate and determined at the second flow rate.

14. An apparatus according to claim 13 wherein the first and second flow rates are different flow rates.

15. An apparatus according to claim 13 or 14 wherein the first and second flow rates are high flow rates.

16. An apparatus according to any of claims 13 to 15 wherein the first and second flow rates are greater than or equal to about 0 L per minute, and preferably about or greater than about 20 L per minute, and more preferably between about 20 L per minute to about 90 L per minute.