



US 20080099013A1

(19) **United States**(12) **Patent Application Publication**  
**Graham**(10) **Pub. No.: US 2008/0099013 A1**(43) **Pub. Date: May 1, 2008**(54) **GAS-TREATMENT DEVICES**(30) **Foreign Application Priority Data**(76) Inventor: **Mark Andrew Graham,**  
Folkestone (GB)Jan. 6, 2005 (GB) ..... 0500133.4  
Jan. 29, 2005 (GB) ..... 0501937.7**Publication Classification**

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**A61M 16/00** (2006.01)(52) **U.S. Cl.** ..... **128/202.13**(57) **ABSTRACT**

An HME has exchange elements (4) at opposite ends of a tubular housing (1, 101) and a central port (2) for connection to a tracheal tube (3). An oxygen port (5, 105, 105') is located centrally with the major part of it being contained within a recess (40, 140, 140') on the exterior of the housing and extending at right angles to the length of the housing. The oxygen port (5, 105, 105') opens into a wider passage (32, 32') extending within the housing, which opens on the external face (30) of the two exchange elements (4). A large suction aperture (60) aligns with the port (2) opening to the tracheal tube (3) and is covered by a hinged flap (61) when not in use.

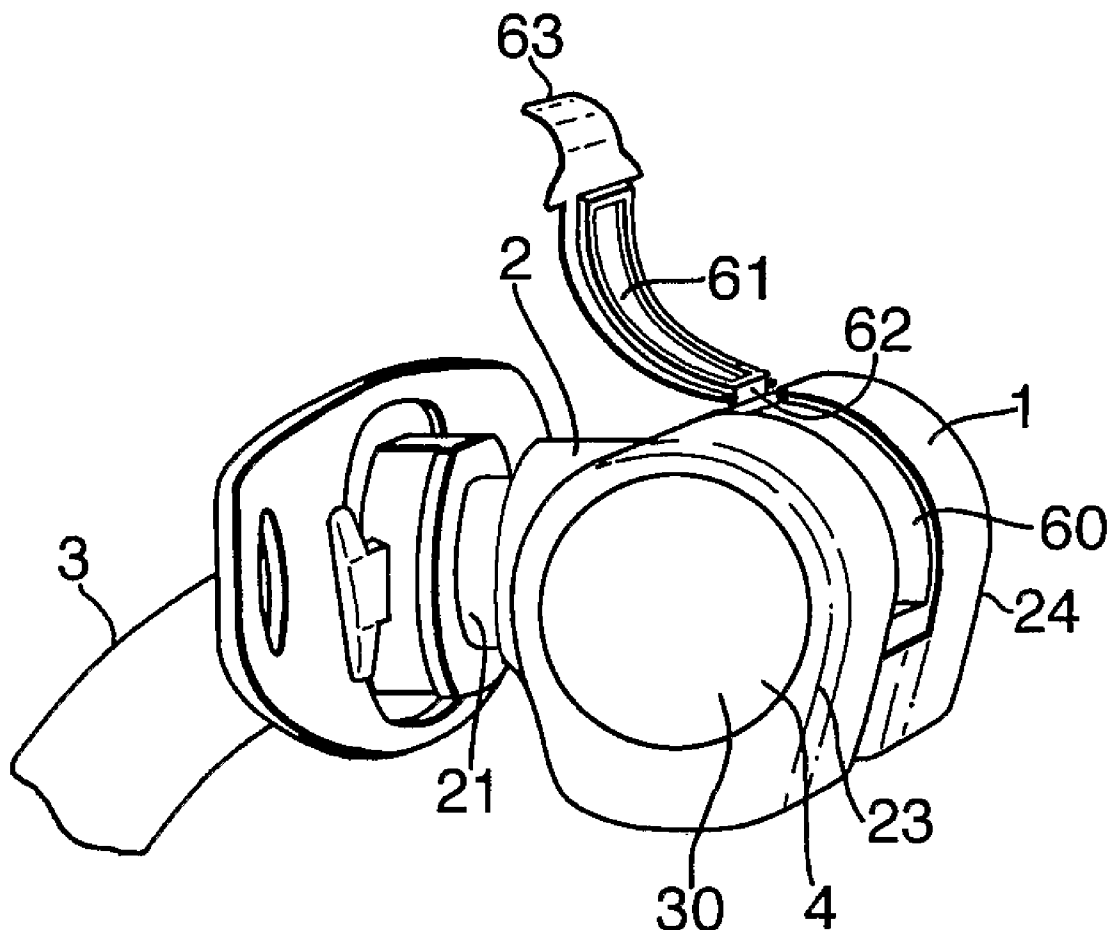
(21) Appl. No.: **11/793,235**(22) PCT Filed: **Dec. 23, 2005**(86) PCT No.: **PCT/GB05/05067**§ 371 (c)(1),  
(2), (4) Date: **Jun. 15, 2007**

Fig.1.

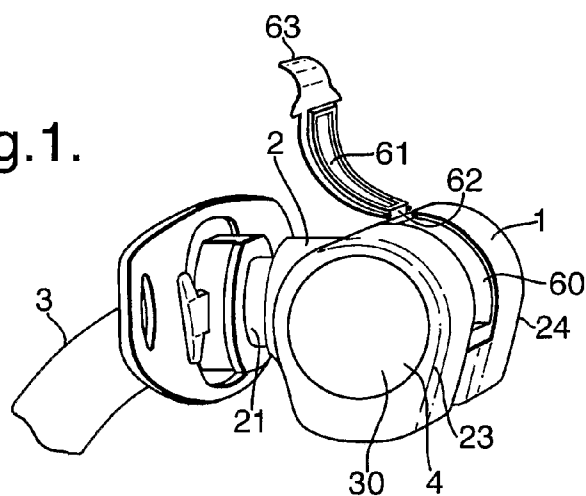


Fig.2.

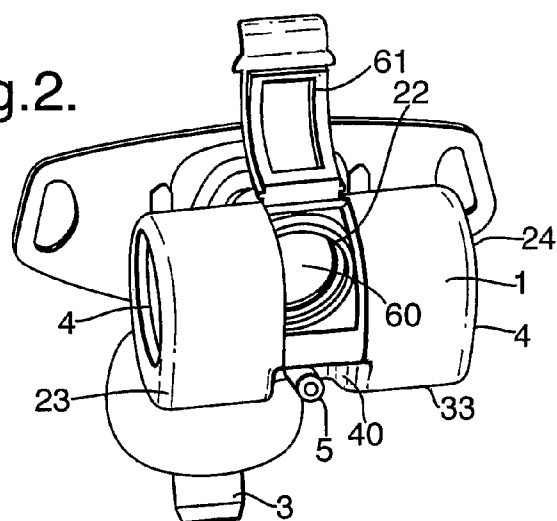
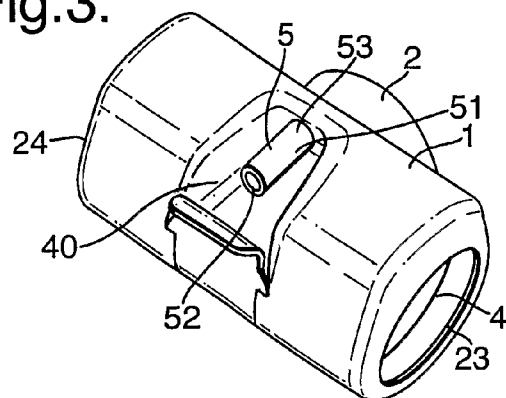


Fig.3.



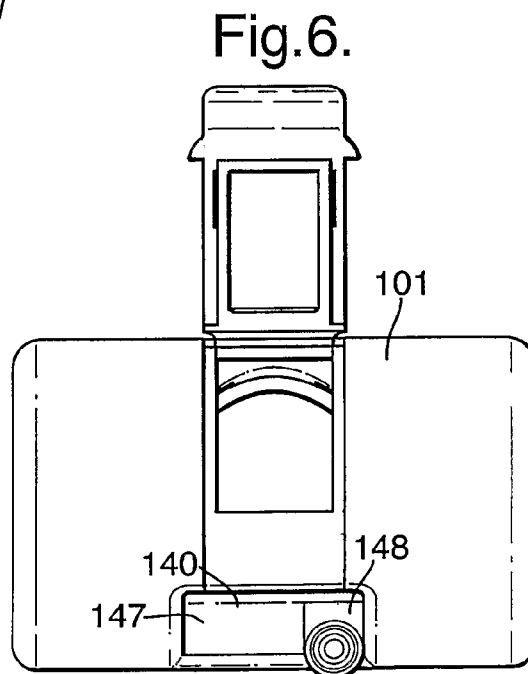
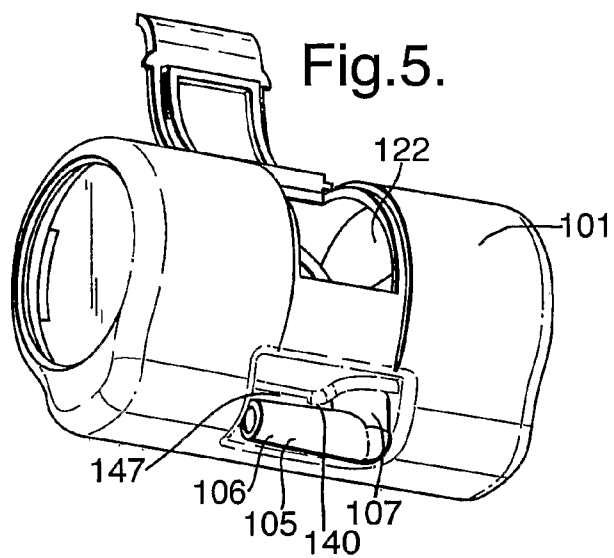
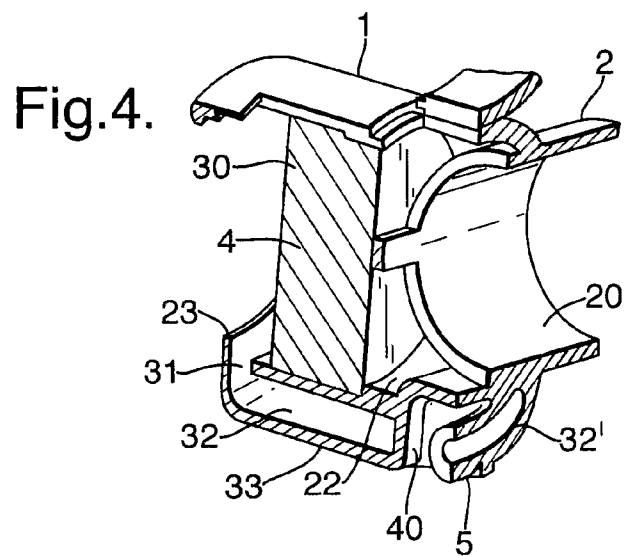


Fig.7.

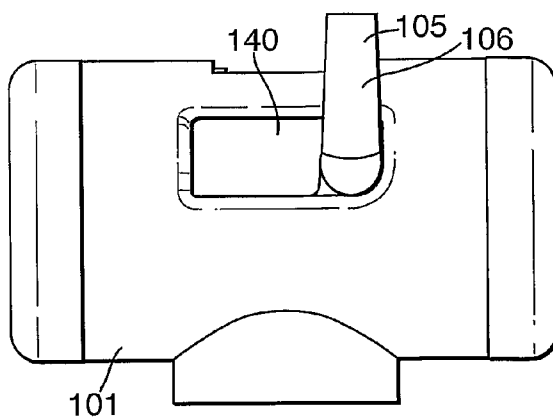


Fig.8.

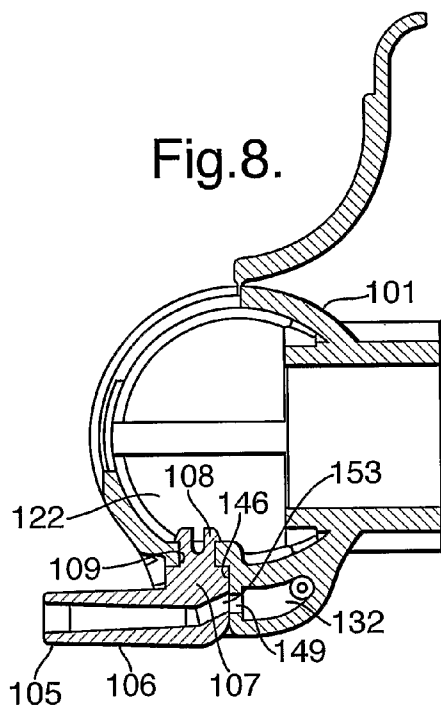
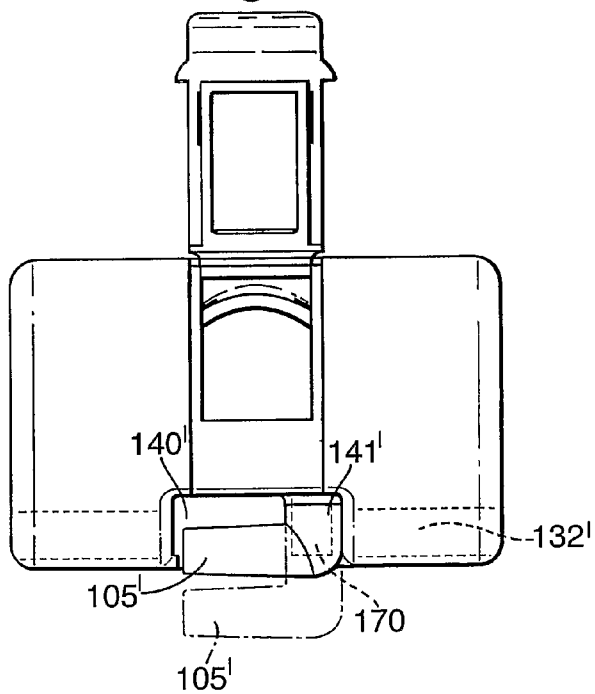
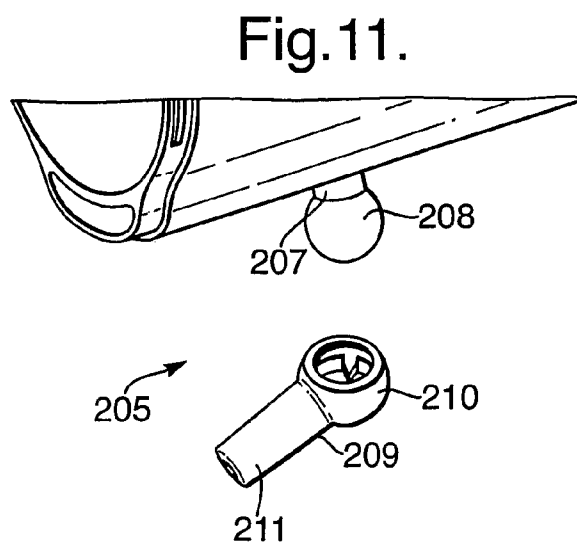
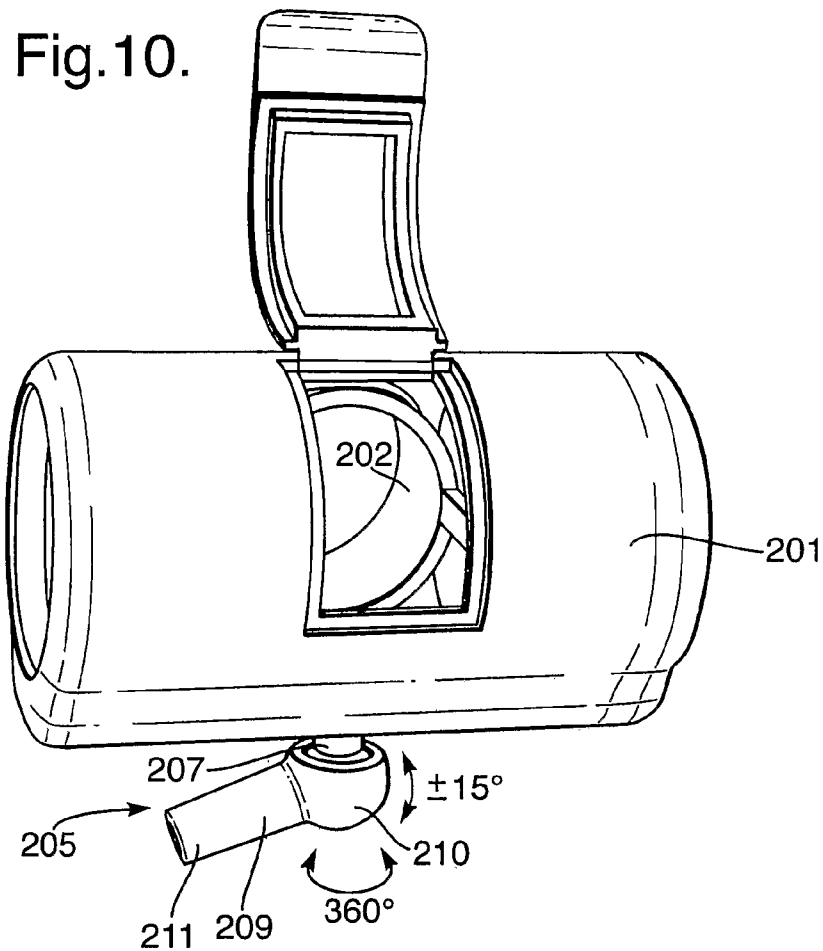


Fig.9.





## GAS-TREATMENT DEVICES

**[0001]** This invention relates to gas-treatment devices of the kind having a housing, a first port adapted for connection to a patient breathing device, a gas-treatment element through which gas can flow in both directions to and from the patient and a second, oxygen supply port by which oxygen can be supplied to the patient via the gas-treatment device, the oxygen supply port being in the form of a tubular stem.

**[0002]** The invention is more particularly, but not exclusively, concerned with heat and moisture exchangers (HMEs) of the kind connected to a patient breathing device.

**[0003]** Where a patient breathes through a tube inserted in the trachea, such as a tracheostomy or endotracheal tube, gas flow to the bronchi is not warmed and moistened by passage through the nose. Unless the gas is warmed and moistened in some way it can cause damage and discomfort in the patient's throat. The gas can be conditioned by a humidifier in the ventilation circuit but, most conveniently, a heat and moisture exchange device (HME) is used. HMEs are small, lightweight devices including one or more exchange elements, such as of a paper or foam treated with a hygroscopic substance. When the patient exhales, gas passes through the exchange element and gives up a major part of its heat and moisture to the element. When the patient inhales, gas passes through the exchange element in the opposite direction and takes up a major part of the heat and moisture in the exchange element so that the gas inhaled by the patient is warmed and moistened. These HMEs are low cost and disposable after a single use so do not require cleaning or present any cross contamination risk. They can be connected in a breathing circuit or simply connected to the machine end of a tracheal tube and left open to atmosphere where the patient is breathing spontaneously.

**[0004]** HMEs are sold by Smiths Medical International Limited of Hythe, Kent, England under the Thermovent name (Thermovent is a registered trade mark of Smiths Medical International Limited), by Hudson RCI AB under the TrachVent name (TrachVent is a registered trade mark of Hudson RCI AB), by DAR, Medisize, Intersurgical and other manufacturers. HMEs often include an oxygen inlet port to which an oxygen supply tube can be connected. This enables supplementary oxygen to be administered to the patient via the HME. Advantageously, the oxygen port opens on the side of the HME element remote from the patient so that the oxygen has to pass through the HME element before reaching the patient. Examples of HMEs with oxygen supply ports are described in GB 2391816, WO 01/72365, U.S. Pat. No. 5,505,768, SE 516666, U.S. Pat. No. 3,881,482, DE 20302580, WO 20114355U, US 97/01366, US 2002/0157667, U.S. Pat. No. 6,422,235, EP 1208866 and U.S. Pat. No. 4,971,054.

**[0005]** Because the HME is often connected to the end of a tracheal tube it is desirable that its construction be as compact as possible.

**[0006]** It is an object of the present invention to provide an alternative gas-treatment device.

**[0007]** According to one aspect of the present invention there is provided a gas-treatment device of the above-specified kind, characterised in that the housing has a recess on its external surface, and that the major part of the oxygen supply port extends within the recess when not in use.

**[0008]** The device preferably has two gas-treatment elements at opposite ends of the housing. The oxygen supply port may be located intermediate the ends of the housing. The or each gas-treatment element may be an HME exchange element. The housing preferably has an elongate shape and the port preferably extends at right angles to the axis of the housing. The oxygen supply port may be displaceable from a first position in which a major part of the port is contained within the recess and a second position in which it projects from the recess for connection of an oxygen supply tube. The port may be displaceable by rotation or by sliding. The housing may have a suction aperture located substantially opposite the first port, the suction aperture being covered by a flap that can be displaced to enable a suction catheter to be extended through the suction aperture into the patient breathing device. An oxygen supply passage preferably extends along the housing and opens onto an external face of the or each gas-treatment element, the oxygen supply port being directed at an angle to the oxygen supply passage such that oxygen flow changes direction where it emerges from the port into the passage, and the cross-sectional area of the oxygen passage being greater than that of the oxygen port so that oxygen pressure drops where it emerges from the port into the passage.

**[0009]** An HME according to the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

**[0010]** FIG. 1 is a perspective side view of the HME connected to the end of a tracheostomy tube;

**[0011]** FIG. 2 is a perspective end view of the HME;

**[0012]** FIG. 3 is view of the lower side of the HME;

**[0013]** FIG. 4 is a cross-sectional view of a part of the HME;

**[0014]** FIG. 5 is a perspective view of an alternative HME with its oxygen port stowed;

**[0015]** FIG. 6 is a side elevation view of the HME of FIG. 5 with the oxygen port extended;

**[0016]** FIG. 7 is a view of the underside of the HME of FIG. 5 with the oxygen port extended;

**[0017]** FIG. 8 is a cross-sectional view of the HME with the oxygen port extended; and

**[0018]** FIG. 9 is a side elevation view of a second alternative, modified HME.

**[0019]** With reference first to FIGS. 1 to 4, the HME has an outer housing 1 with a coupling or port 2 by which it is connected to a tracheal tube 3. The housing 1 supports two heat and moisture exchange elements 4 at opposite ends by which gas supplied to the patient is warmed and moistened. An oxygen supply port 5 is mounted on the housing 1 to enable supplementary oxygen to be supplied to the patient when necessary.

**[0020]** The housing 1 is generally cylindrical and is moulded from a rigid plastics material. The patient coupling 2 projects radially outwardly of the housing midway along its length and has an internal tapered surface 20 adapted to connect to a standard male tapered coupling 21 on the end of the tracheal tube 3. The coupling 2 opens to the interior 22 of the housing 1 in communication with the inner surface of the exchange elements 4.

**[0021]** The exchange elements 4 are each conventional, being in the form of a disc comprising a spiral roll of corrugated paper treated with a hygroscopic salt to promote the retention of moisture. The exchange elements 4 extend transversely of the axis of the housing 1, being retained on the ends

of the housing by annular, inwardly-projecting end flanges **23** and **24**. The external face **30** of each exchange element **4** is located just rearwardly of a curved slot **31** formed between the end of the housing **1** and the respective end flanges **23** and **24**. Each slot **31** communicates with an oxygen conduit **32** extending longitudinally of the HME in a ridge **33** along the lower side of the housing **1**. The space between the external face **30** of the exchange elements **4** and the ends of the housing **1** helps protect the elements from contact and contamination.

**[0022]** Midway along its length, the ridge **33** is interrupted by a recess **40**, of a tapering shape, on the lower side of the exterior of the housing **1**. The depth of the recess **40** is about half the width of the ridge **33**, the oxygen conduit **32** continuing with a reduced width behind the recess, along the entire length of the housing **1** so that the slots **31** at both ends communicate with one another via the conduit. The recess **40** serves to house and protect the oxygen supply port **5**.

**[0023]** The oxygen supply port **5** is formed by a stem **51** of circular external section and with a taper on its external surface such that its outer, free end **52** has a smaller diameter than its inner end **53**. The port **5** extends parallel to the patient coupling **2** in the opposite direction, that is, at right angles to the axis of the housing **1**. The oxygen supply port **5** is located in the recess **40** on the lower side of the housing and its length is such that it is entirely contained within the recess. In modifications of the HME, the oxygen supply port could project slightly from the recess providing that the major part of its length was contained within the recess. The space within the recess **40** around the oxygen supply port **5** is such as to enable a female coupling on the end of an oxygen supply tube (not shown) to be pushed onto and retained on the port.

**[0024]** Oxygen supplied to the port **5** flows through the relatively narrow passage through the port and opens into the section **32'** of the oxygen conduit **32**. This space **32'** has a larger cross-sectional area (typically about 13.4 mm<sup>2</sup>) than that of the passage through the oxygen port (typically about 3.1 mm<sup>2</sup>) thereby resulting in a drop in pressure as the oxygen flows out of the port **5** into the section **32'**. The flow of oxygen is then abruptly diverted through 90° as it flows outwardly in both directions away from the port **5**. This change in direction produces turbulence and a further drop in pressure. The oxygen then flows from the reduced width section **32'** into opposite ends of the main section **32** and, because these have a larger cross-sectional area (typically about 47.9 mm<sup>2</sup>) than the reduced width section, this results in a further reduction in the pressure of the oxygen. Oxygen flow from the port **5** in both directions is substantially equal because of the central location of the port and its symmetrical disposition. Oxygen flows along the conduit **32** and out of the slots **31** over the external surface **30** of the two exchange elements **4**. In this way, the supplementary oxygen has to pass through the exchange elements **4** before passing to the trachea, so that it is warmed and moistened in the same way as the ambient air. The reduced pressure caused by the geometry of the oxygen flow path from the port **5** to the external surfaces of the exchange elements **4** reduces the flow rate out of the slots **31** and ensures that a maximum proportion of the oxygen remains in the region of the exchange elements without flowing past them. This helps ensure the maximum efficiency of oxygen mixing with ambient air in the region of the exchange elements **4** and hence the maximum concentration of oxygen supplied to the patient.

**[0025]** The HME additionally has a suction access aperture **60** located directly opposite the tracheal tube coupling **2**. The aperture **60** is rectangular and is normally covered and closed by a cover or flap **61** formed integrally with the housing **1** and attached with it at one end by a web or living hinge **62**, which is bendable to allow the flap to be raised or lowered over the aperture. The edges of the flap **61** and the aperture **60** are shaped such that the flap can snap into position in the aperture and provide a substantially gas-tight seal. The free end **63** of the flap **61** is curved away from the surface of the housing **1** to form a lip when the flap is closed by which it can be gripped and opened. When the patient's tracheal tube **3** needs suctioning, the clinician lifts the flap **61** and inserts the suction tube down the tracheal tube through the patient coupling **2**. This avoids the need to remove the HME. The fit of the flap **61** in the aperture **60** could be arranged such that the flap can be blown outwardly by increased pressure created by the patient, such as when coughing. This would provide a pressure relief feature. The dimensions of the suction aperture **60** are relatively large so that a suction catheter can be inserted through the aperture with minimal contact with the edge of the aperture so as to minimize wiping the catheter and thereby reduce the risk that secretions on the outside of the catheter will be removed and remain inside the HME. Preferably the width of the aperture **60** is at least substantially the same as the internal diameter of the tracheal tube **3** with which the HME is used, typically the width is about 10 mm and the depth is about 16 mm. Suction catheters should have an external diameter not greater than half the internal diameter of the tracheal tube, the maximum size of the suction catheter usually being 16 F, that is 5.3 mm outside diameter, for use with a 10 mm internal diameter tracheal tube.

**[0026]** By locating the oxygen supply port in a recess where it is contained substantially entirely within the boundaries of the recess, in the manner described above, the HME can present a compact configuration and its surface is less likely to snag on adjacent tubes, dressings, wires or the like when not in use.

**[0027]** The oxygen supply port need not be concealed within the recess when connected to the oxygen supply tube. Instead, the port could be displaceable from a position where it is concealed within a recess, when not in use, to a position where it projects from the recess, when in use.

**[0028]** In the arrangement shown in FIGS. 5 to 8, the oxygen supply port **105** has an outer tapered portion **106** and a shorter, inner stem **107** projecting at right angles to the outer portion. As most clearly shown in FIG. 8, the stem **107** is solid and formed with a bifurcated toothed end **108**, which is a snap fit in a hole **109** through the upper wall **110** of the recess **140** into the interior **122** of the housing **101**. One side of the stem **107** makes close sliding contact in a concave cavity **146** formed in the corner between a rear wall **147** and a side wall **148** of the recess **140** adjacent the hole **109**. The cavity **146** has a small opening **149** located towards the rear wall **147** and opening through the wall into the conduit **132**.

**[0029]** A passage **152** extends axially through the outer portion **106** of the port **105** from the open, forward end **151** to a rear opening **153** formed in the wall of the stem **141**. The oxygen supply port **105** is rotatable through 90° about the axis of the stem **107**, the fit of the toothed end **108** in the hole **109** enabling the stem to rotate in the hole, whilst the friction between the stem and the hole is sufficient to ensure that the port remains in whatever angular position to which it is displaced. In the stowed position shown in FIG. 5, the outer

portion **106** extends parallel to the axis of the housing **101** and parallel to its external surface, alongside the rear wall **147** of the recess **140**. The length of the outer portion **106** locates in the recess **140** with just a small part of its width protruding so that the major part of the port **105** is contained within the boundaries of the recess. In this position, the curved surface of the stem **107** blocks any flow of gas through the opening **149**. When the oxygen supply port **105** is stowed, as shown in FIG. 5, the external surface of the HME is substantially uninterrupted by projections so that it presents a compact, retracted configuration.

**[0030]** When the oxygen supply port **105** is swung clockwise through 90° (as viewed from below and as shown in FIGS. 6, 7 and 8) the outer portion **106** extends outwardly at right angles to the axis of the housing **101** so that the oxygen supply tubing can be connected to it readily. In this position, the rear opening **153** of the oxygen supply port **105** aligns with the opening **149** so that oxygen can flow along conduit **132**.

**[0031]** It is not essential for the oxygen supply port be displaceable between an extended and retracted position by rotation. As shown in FIG. 9, the port **105'** could be movable linearly in a slidable, telescopic fashion. In this arrangement, the port **105'** has an inner stem **141'** slidably mounted in a telescopic fashion on the outside of a short, radially extending tube **170** opening into the conduit **132'**. The outer stem **142'** extends at right angles to the inner stem **141'** in the same manner as in the swivel port **105**. The telescopic movement is such that, in its retracted position, substantially all the port **105'** is contained within the boundaries of the recess **140'** whereas, when pulled out fully to its extended position, the outer stem **142'** extends outside the recess **140'** so that an oxygen supply connector can be fitted easily to the stem. The mounting of the inner stem **141'** on tube **170** could be such as either to prevent or to permit rotation of the port **105'**. Where rotation is prevented, the outer stem **142'** would be confined to extend only parallel to the axis of the HME. Where rotation is permitted, the outer stem **142'** would be free to swivel to any desired orientation once pulled out of the recess **140'**. Because rotation of the port **105'** is not hindered by contact with the sides of the recess **140'**, when it is extended, it can be free to rotate through 360°. The port **105'** could be arranged to restrict flow of gas through it when in the retracted position. This could be achieved by means of a formation inside the port **105'** that obstructs the end of the tube **170** when the port is retracted. Alternatively, the open end of the outer stem **142'** could be arranged to be obstructed by a formation on the inside of the recess **140'** when in its stowed, retracted position. Instead of the inner stem **141'** embracing the outside of the tube **170**, alternative arrangements could have an inner stem extending inside a tube in a telescopic fashion. The port need not be bent at an angle but could simply be straight, aligned with the axis of telescoping movement. In such an arrange-

ment, it might be desirable for the port to be able to be locked in its extended position so as to facilitate coupling to the oxygen tubing. This could be achieved by a pull-and-twist bayonet action. After use, the port would be unlocked and retracted to its stowed position within a recess.

**[0032]** It will be appreciated that the invention is not confined to HMEs but could be used with other devices such as where the gas-treatment elements are filters.

1. A gas-treatment device having a housing, a first port adapted for connection to a patient breathing device, a gas-treatment element through which gas can flow in both directions to and from the patient and a second, oxygen supply port by which oxygen can be supplied to the patient via the gas-treatment device, the oxygen supply port being in the form of a tubular stem, characterized in that the housing has a recess on its external surface, and that the major part of the oxygen supply port extends within the recess when not in use.

2. A device according to claim 1, characterized in that the device has two gas-treatment elements at opposite ends of the housing.

3. A device according to claim 1, characterized in that the oxygen supply port is located intermediate the ends of the housing.

4. A device according to claim 1, characterized in that the gas-treatment is an HME exchange element.

5. A device according to claim 1, characterized in that the housing has an elongate shape and that the oxygen supply port extends substantially at right angles to the axis of the housing.

6. A device according to claim 1, characterized in that the oxygen supply port is displaceable from a first position in which a major part of the port is contained within the recess and a second position in which it projects from the recess for connection of an oxygen supply tube.

7. A device according to claim 6, characterized in that the oxygen supply port is displaceable by rotation.

8. A device according to claim 6, characterized in that the oxygen supply port is displaceable by sliding.

9. A device according to claim 1, characterized in that the housing has a suction aperture located substantially opposite the first port, and that the suction aperture is covered by a flap that can be displaced to enable a suction catheter to be extended through the suction aperture into the patient breathing device.

10. A device according to claim 1, characterized in that an oxygen supply passage extends along the housing and opens onto an external face of the gas-treatment element, that the oxygen supply port is directed at an angle to the oxygen supply passage such that oxygen flow changes direction where it emerges from the port into the passage, and that the cross-sectional area of the oxygen passage is greater than that of the oxygen port so that oxygen pressure drops where it emerges from the port into the passage.

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