(12) UK Patent Application (19) GB (11) 2580835 (13) A

(43) Date of A Publication 29.07.2020

(21) Application No: 2005510.9

(22) Date of Filing: 15.04.2020

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(51) INT CL:
A61M 16/00 (2006.01) ***A61M 16/04*** (2006.01)

(56) Documents Cited:
GB 2338902 A1 **GB 2318518 A**
GB 2137509 A **WO 2008/052364 A1**
US 4493614 A **US 20080196720 A1**

(58) Field of Search:
INT CL **A61M**
Other: **WPI, EPODOC**

(54) Title of the Invention: **Portable micro ventilation lung ventilator**
Abstract Title: **A portable micro ventilation lung ventilator with an air pump**

(57) A portable micro ventilation lung ventilator with an air pump 1 connected via an inspiratory limb 2 to a narrow lumen 3 of a double lumen endotracheal tube 4. An expiratory limb 11 is connected at its proximal end to a wide lumen 5 of the double lumen endotracheal tube 4 by a Cobb's connector 8. The terminal end of the expiratory limb is connected via an air suction valve 12 to an occluder valve 13, which may be an electronic solenoid. The occluder valve 13 is further connected to an expiratory valve 14 and a reservoir bag 15. A face mask for induction ventilation may be connected via an inlet and outlet to the inspiratory limb and expiratory limb, respectively. A pressure sensor and capnograph may be connected to the expiratory limb. A humidified may be between the air pump and inspiratory limb.

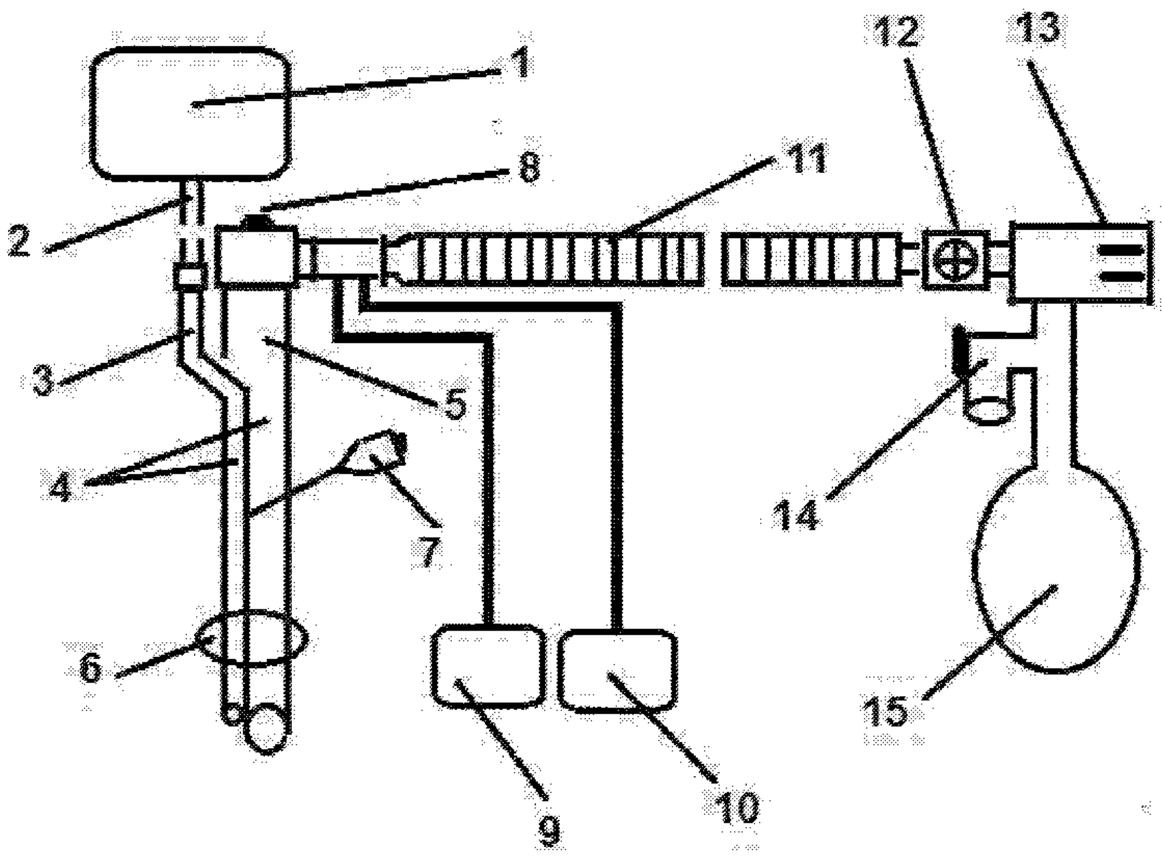

figure 1

GB 2580835 A

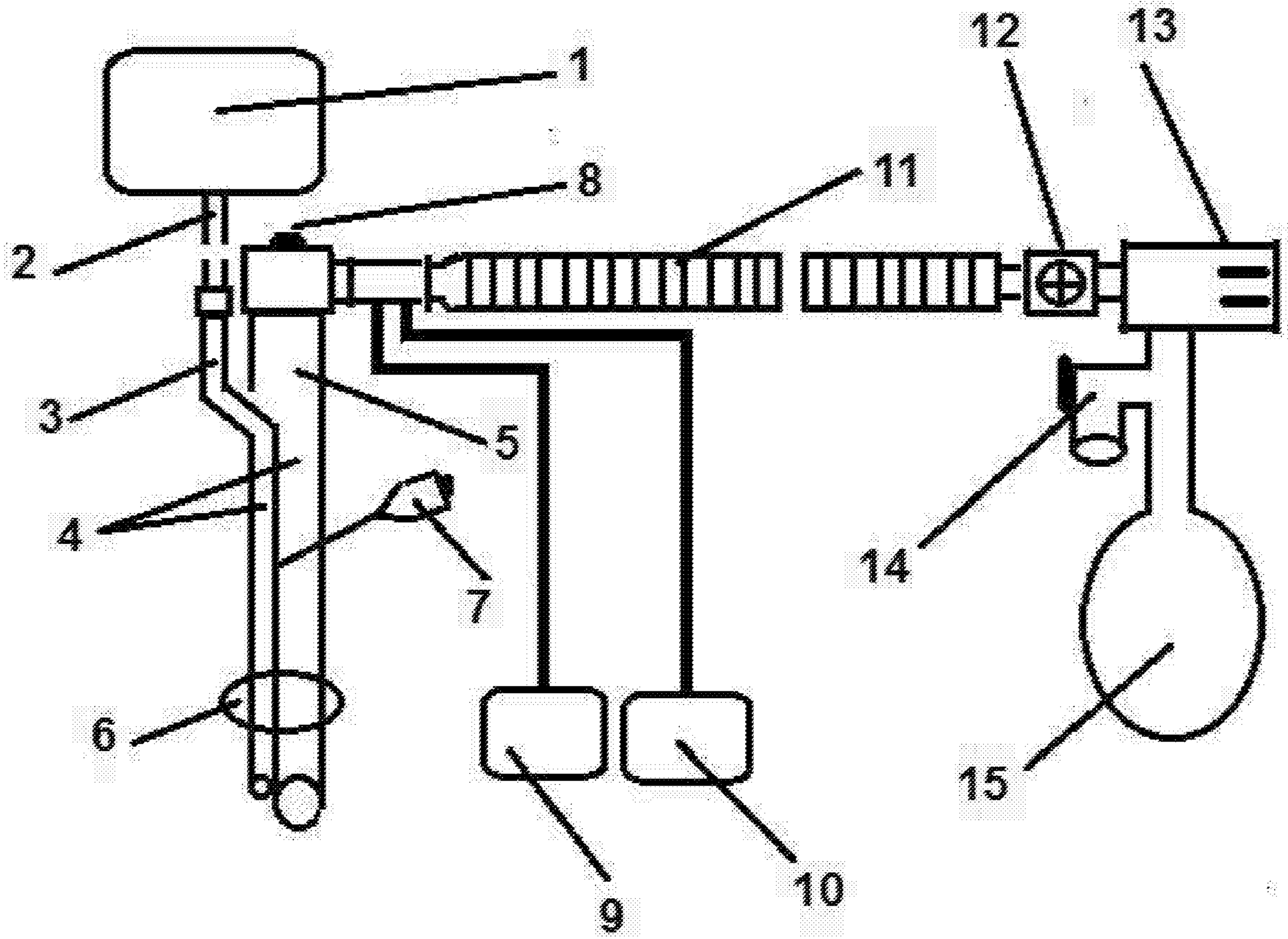

figure 1

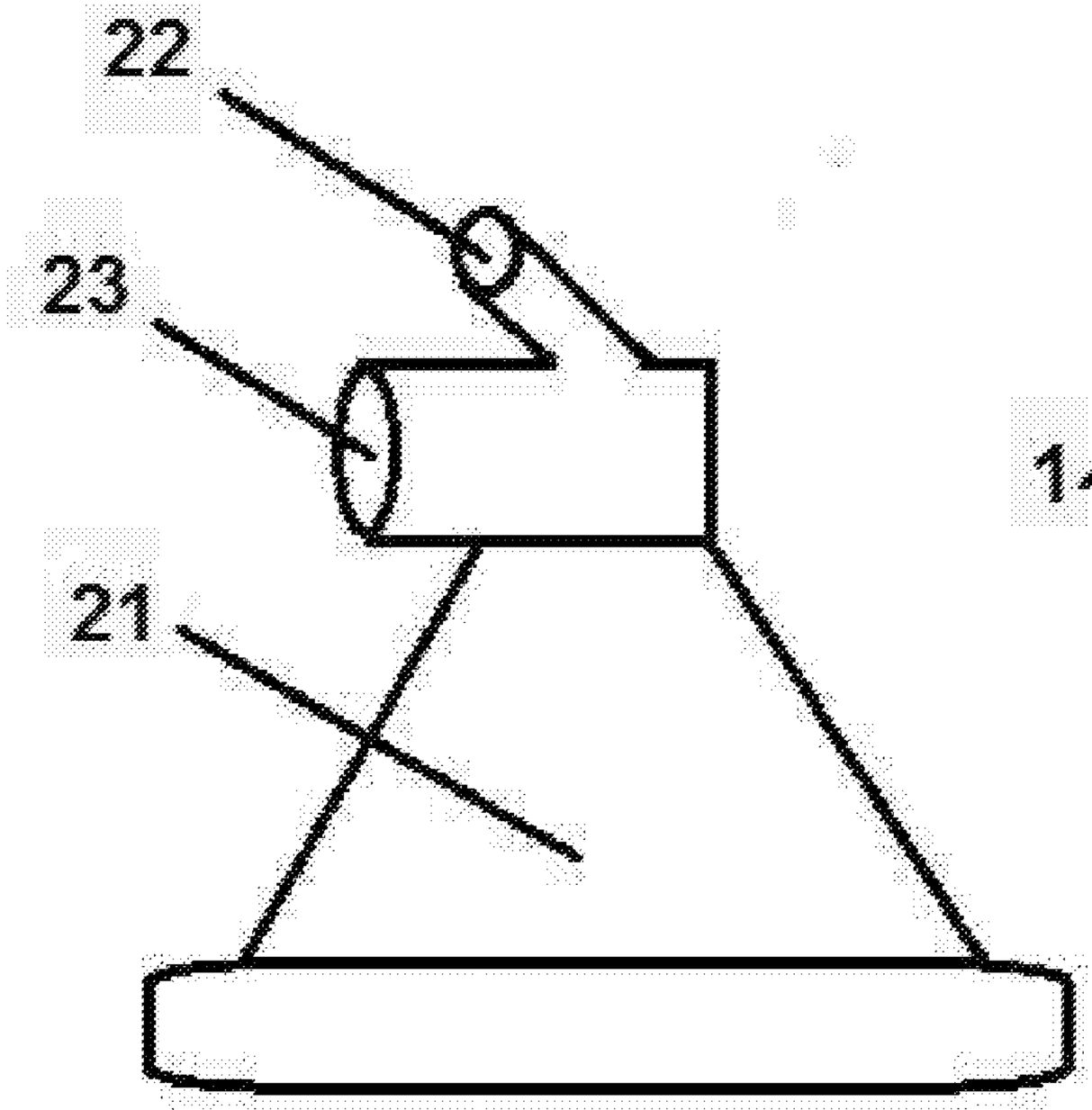

figure 5

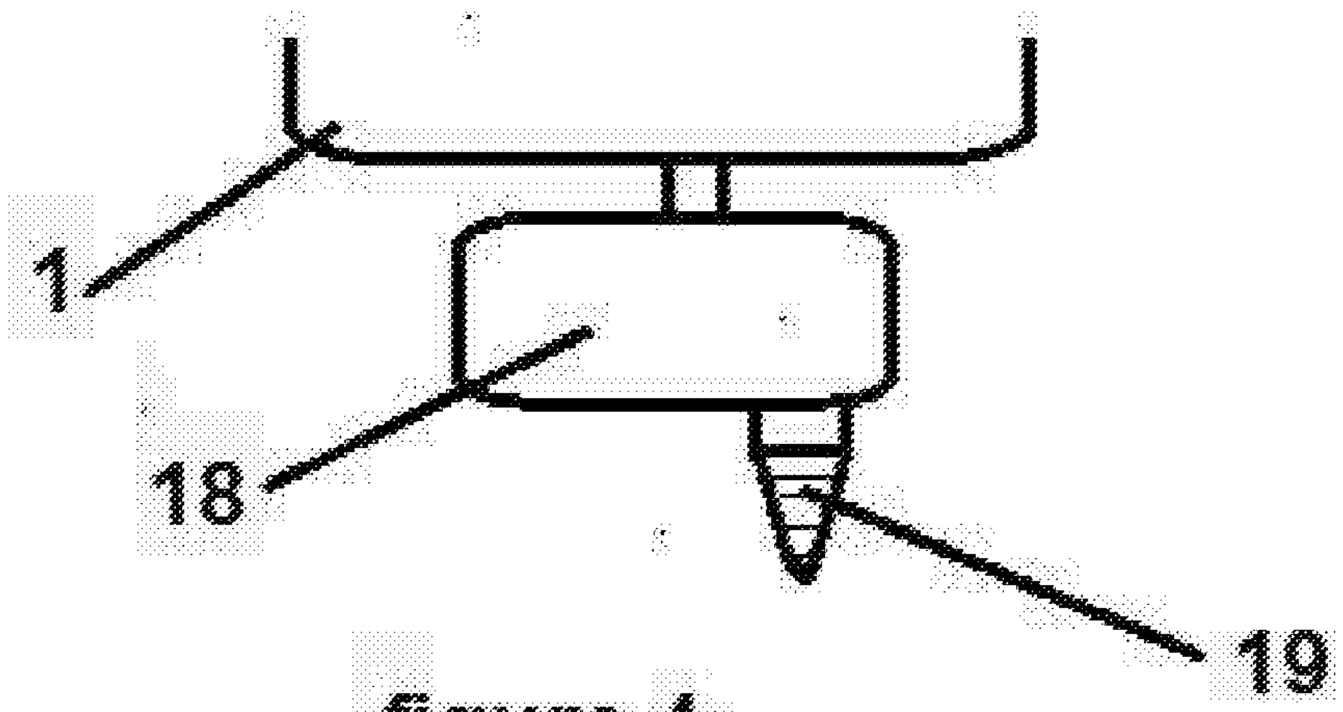

figure 4

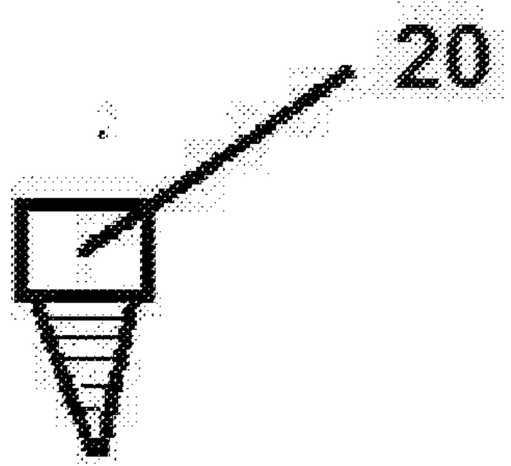

figure 3

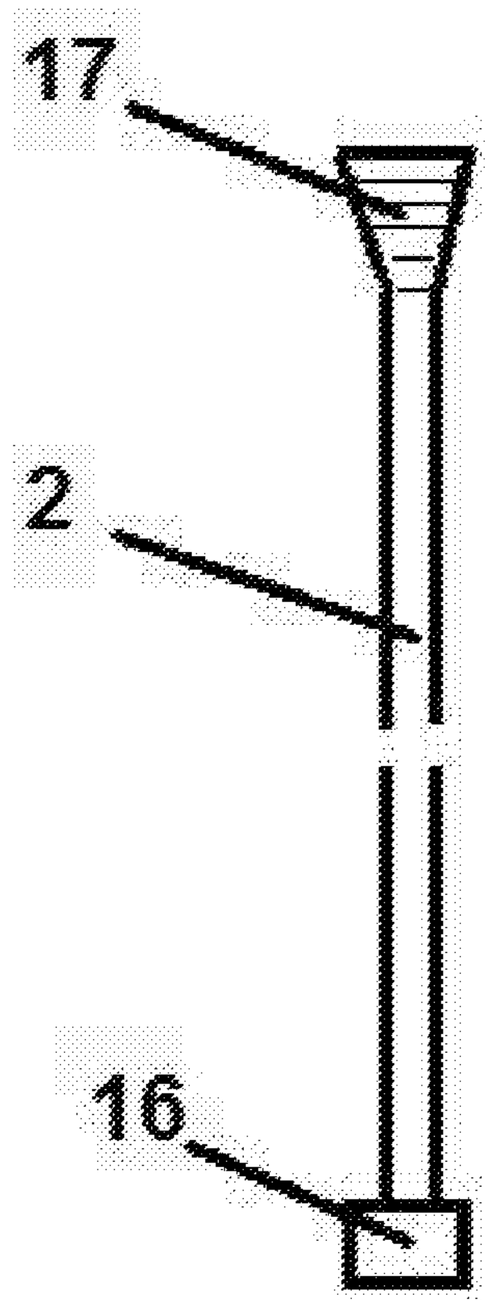

figure 2

Portable micro ventilation lung ventilator

This invention relates to a portable lung ventilator which can be used in emergency cases of mass casualties. It is based on my two previous UK patented circuits , Micro ventilation anesthetic circuit UK patent no. 2318518 dated 10 Dec. 1997 and Modified micro ventilation anesthetic circuit UK patent no. 2338902 dated 21 July 1999.

Both circuits are based on the use of double lumen portex tube (not double lumen tube of thoracic anesthesia) . One lumen is narrow for continuous FGF and the second lumen is wide for expiration in controlled ventilation, and for breathing in spontaneous ventilation.

Both circuits are based on my ' discovery ' of the ' micro loop flow '.

The paper of micro loop flow phenomenon was published together with micro ventilation anesthetic circuit.

Micro ventilation anesthetic circuit main components are double lumen tube , inspiratory limb, solenoid valve , expiratory limb and reservoir bag with expiratory valve.

Modified micro ventilation anesthetic circuit is based on the same principles but on soda lime containing circuit.

I could not be able to find a manufacturer at that time because the space of time to do the patent protection was passed.

Portable micro ventilation lung ventilator is a low pressure circuit based on the same principles of my previous mentioned patents apart from the presence of an air pump to make a portable ventilator so that it can be used in emergency cases of mass casualties.

The main components of the portable ventilator are air pump, inspiratory limb , double lumen tube , expiratory limb, solenoid valve , air suction valve, expiratory valve, reservoir bag and a special face mask.

Air pump :

The air pump has a maximum flow rate of 40 liter / minute. It should be operated by AC current 110 V / 220 V and DC current 12 V (forambulance use). A durable rechargeable battery is incorporated. The air pump has a flow regulator.

The pump is light in wt and small in size. It is a heavy duty air pump.

Inspiratory limb :

A narrow lumen plastic tube 2 meters long is sufficient. This limb can be attached to the flow meter of the O2 cylinder in the ambulance for critically ill patients having pan pneumonia in order to supply the patient with 100% oxygen for example in covid19 patients. The outlet of the air pump and the outlet of the O2 cylinder flow meter are of the same design. In anesthesia the inspiratory limb is connected to the FGF outlet of the anesthetic machine via a special intermediate adapter.

In ICU duties the inspiratory limb is connected to a suitable air oxygen mixer. Therefore we are talking about multi function portable ventilator.

Double lumen tube :

Portex double lumen tube size 7 , 8 and 9 is suitable in this circuit for adult cases. The narrow lumen diameter is around 2 – 2.5 mm .

Expiratory limb :

An expiratory limb of ordinary size and length is required. It is attached to the wide lumen of the endotracheal tube by a Cobb 's connector for suction purposes at its terminal end , and to air suction valve at its proximal end. Suctioning time is longer that in ordinary circuits . This is because of continuous air flow into the lungs during suctioning process. Covid19 patients with severe lung involvement feel as if they are drowning. That is why suctioning is required for many cases.

Cuff of the endotracheal tube :

The circuit is low pressure one . Minimal inflation is required to seal the trachea.

Pressure transducer (monitor) and capnograph can be connected to the circuit before the expiratory limb.

Air suction valve :

This valve is situated at the proximal end of the expiratory limb. It opens when the patient takes a deep breath while the occluder valve is operating . This happens when muscle relaxant effect is finished.

Occluder valve :

Electronic solenoid valve is used in the circuit.

Expiratory valve :

Good quality expiratory valve with gentle adjustment knob is used. In addition to its function as an expiratory valve, PEEP can be established to increase FRC when required. We may achieve an acceptable degree of controlled ventilation at a PEEP of 10 cm for example or less without operating the occluder valve, that is to say without moving the lungs. This property may have a place in thoracic and upper abdominal surgery. Scavenging system can be attached to the expiratory valve.

Face mask :

A suitable face mask with connection adapter having a narrow inlet for the inspiratory limb connection, and a wide outlet for the expiratory limb connection is found.

Filter (HME) can be added at the terminal end of the expiratory limb.

A humidifier can be attached to the air pump. In such a case the outlet adapter of the air pump will be attached to the humidifier.

Disconnection alarm is placed on the expiratory limb. It operates after 30 seconds zero pressure of expiratory limb during controlled ventilation. High pressure alarm is added to the expiratory limb also. It operates at pressure above 30 cm water.

The endotracheal tube, the inspiratory limb and the expiratory limb are disposable. Both limbs can be autoclavable.

Capnograph :

Readings of the capnograph are less than real readings . This is because of end tidal dilution by continuous air flow . Momentarily closure of air flow may give real readings of end tidal CO2. Calibration studies may be required.

An Example : A tidal volume of 100 ml at a frequency of 50 to 100 and at a flow rate of 10 liters is sufficient to produce proper ventilation. In such a case the intra pulmonary pressure will not be more than 5 cm H2O during the closure of the occluder valve.

How to calculate tidal volume (Vt) :

Tidal volume is calculated by the following equation ;

Tidal volume in ml equals to flow rate in ml multiplied by inspiratory expiratory ratio devided by frequency.

Vt = FR X (I/E ratio) / F

If I/E is 0.5 i.e. 50% inspiratory time , flow rate is 10 000 ml and frequency is 50, then tidal volume = 10 000 x 0.5 / 50

= 100 ml. (Distensibility of the new tubing system is negligible).

Comments on IPPV :

It has been noticed in the USA that most of the patients (80%) with severe pneumonia of covid19 that are put on ventilators die.

In severe pan pneumonia many bronchioles are inflamed, closed and full of secretions and the alveoli are surrounded by inflame, swollen capillaries which are full of micro thrombi. Blood flow, therefore, at the level of alveoli is compromised. On top of that stretching and squeezing of fragile lung tissues which are done by IPPV deprive alveoli from blood flow , which they desperately require for recovering, during the periods of inspirations time. All available mechanical ventilators operate on the principle of IPPV. IPPV enforces air to pass through these blocked bronchioles . During expiration they get blocked again. Air trapping and subsequent shunting will happen. The alveolar block behind the closed bronchiole starts to enlarge more and more with subsequent lung inflations. They may suffer ballooning effect. Gas exchange will deteriorate with time. Lungs with severe pneumonic consolidation in cases of for example covid19 infection suffer high airway resistance and low lung compliance requiring higher pressure to inflate the lung. These effects deteriorate the situation more. In such circumstances we are dealing with fragile lungs. IPPV can inflict more damage to these severely damaged lungs. In IPPV intrapulmonary pressure more than 10 cm may produce more damage to these lungs. At the same time a pressure at or less than this figure will fail to ventilate such low compliant lungs. After covid19 catastrophe IPPV is no more suitable for such patients.
Vigorous lung movements in IPPV with largely positive intrapulmonary pressure will increase damage of these lungs. Drawbacks of IPPV is not noticeably seen in normal lung ventilation but it is clearly evident in covid19 patients of severe extensive pneumonia. I can say that IPPV is lethal to covid19 patients with severe lung infection. These lungs should either be ventilated by a low pressure mode ventilator or ventilated in standstill mode i.e. the lung is ventilated in no movement state for complete comfort. We have to put the lungs into complete rest for few

days. Portable micro ventilation lung ventilator is capable of doing these duties. The properties of breathing which is achieved by this ventilator whether it is spontaneous or controlled is even better than normal physiological breathing for short term use of course. This is because in physiological breathing we have a dead space while this dead space is completely canceled when we use this ventilator.

The invention will now be described solely by way of example and with reference to the accompanying drawings in which:

Figure 1 shows an air pump which is connected through an inspiratory limb to a narrow lumen of a double lumen endotracheal tube , and an expiratory limb which is connected to a wide lumen tube of the double lumen endotracheal tube at its proximal end and to an occluder valve (electronic solenoid valve) that is connected to its distal end with an expiratory valve and a reservoir bag ,

Figure 2 shows details of both ends of the inspiratory limb.

Figure 3 shows an intermediate connection adapter which connects the inspiratory limb to the anesthetic machine.

Figure 4 shows a humidifier which is connected to the air pump and having a special connection adapter.

In figure 1, an air pump 1 is connected to an inspiratory limb 2 which is connected to a narrow lumen 3 of an endotracheal tube 4 . A balloon 7 is connected to a tube cuff 6. An expiratory limb 11 is connected at its proximal end to a wide lumen 5 of the endotracheal tube 4 by a Cobb's connector 8 and to an air suction valve.
A capnograph 9 and a pressure monitor (transducer) 10 are connected to the terminal end of the expiratory limb 11. An occluder valve 13 (electronic solenoid) is attached to the air suction valve 12 at its

proximal end and to an expiratory valve 14 at its distal end. A reservoir bag 15 is connected to the distal end of the expiratory valve 14.

Figure 2 shows a terminal end 16 of the inspiratory limb 2 which is used to connect the narrow lumen 3 of the double lumen endotracheal tube 4, and a proximal end 17 which is used to connect the inspiratory limb 2 to the air pump 1.

Figure 3 shows an intermediate connection adapter 20 to connect the inspiratory limb 2 to the FGF of the anesthetic machine.

Figure 4 shows a humidifier 18 connected to the air pump 1 and has a connection adapter 19 to join the inspiratory proximal end 17 of the inspiratory limb 2.

Figure 5 shows a face mask 21 having an inlet 22 to connect the inspiratory limb 2, and an outlet 23 to connect the expiratory limb 11.

Claims

1.A portable micro ventilation lung ventilator comprising an air pump that is connected to a narrow lumen of a double lumen endotracheal tube by an inspiratory limb, and the presence of an expiratory corrugate limb that is connected at its terminal end to a wide lumen of the endotracheal tube by a Cobb's connector and is connected to an air suction valve at its proximal end, and the presence of an occluder valve (electronic solenoid) that is connected at its terminal end to the air suction valve and at its proximal end to an expiratory valve and a reservoir bag.

2.A portable micro ventilation lung ventilator according to claim 1, in which the inspiratory limb has a terminal end connecting the narrow lumen of the endotracheal tube, and a proximal end connecting the air pump or the O2 cylinder flow meter or the air oxygen mixer or the FGF of the anesthetic machine.

3.A portable micro ventilation lung ventilator according to claim 2, in which a humidifier is connected to the air pump having a special connection adapter to join the inspiratory limb.

4.A portable micro ventilation lung ventilator according to claim 3, in which a connection adapter is used to join the inspiratory limb to the FGF of the anesthetic machine.

5.A portable micro ventilation lung ventilator according to claim 4, in which a face mask is used for induction ventilation having an inlet to join the inspiratory limb and an outlet to connect the expiratory limb.

6.A portable micro ventilation lung ventilator according to claim 5, in which a pressure sensor and a capnograph is connected to the terminal end of the expiratory limb.

7.A portable micro ventilation lung ventilator according to claim 6, in which a humidifier is situated between the air pump and the inspiratory limb.

Intellectual Property Office

Application No:	GB2005510.9	**Examiner:**	Mrs Rachel Banks
Claims searched:	1-7	**Date of search:**	12 June 2020

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
Y	1-7	GB2338902 A1 (ALI) See whole document.
Y	1-7	GB2318518 A (ALI) See whole document.
Y	1-7	WO 2008/052364 A1 (FISHER et al.) See figure 1 and pages 21-22 at least.
Y	1-7	US 2008/196720 A1 (KOLLMEYER et al.) See figure 2 and paragraphs 50-51 at least.
Y	1-7	US4493614 A (CHU et al.) See figure 1 and column 2, at least.
Y	1-7	GB2137509 A (FIGGIE INT INC) See figure 3 and description.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

A61M

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC

Intellectual Property Office

International Classification:

Subclass	Subgroup	Valid From
A61M	0016/00	01/01/2006
A61M	0016/04	01/01/2006