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(54) **BREATHING APPARATUS**

BEATMUNGSGERÄT

RESPIRATEUR

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(73) Proprietor: **Safety Equipment Sweden AB**
Warriewood, NSW 2102 (AU)

(72) Inventors:
- **KLOCKSETH, Martinus, Oliver**
Belrose, NSW 2085 (AU)
- **JERVMO, Bengt, Yngve, Roland**
Greenpoint, NSW 2251 (AU)
- **BERNDTSSON, Goran, Bertil, Claes**
Elanora Heights, NSW 2101 (AU)

(74) Representative: **Hale, Peter**
Kilburn & Strode
20 Red Lion Street
London WC1R 4PJ (GB)

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Description

Field of the Invention

[0001] The present invention relates to a fan forced positive pressure breathing apparatus of the kind in which filtered air is pumped to a face piece or mask covering at least the nose or mouth of the wearer, the air being pumped by means of a fan driven by an electric motor which is usually battery powered.

Background Art

[0002] Breathing apparatus of the kind of which the present invention is concerned is well known and a variety of different constructions have been proposed and the advantages and disadvantages of such apparatus is discussed in many patent specifications. Among the requirements of a satisfactory apparatus are that it supplies adequate quantities of air when the user takes a deep breath which, testing shows, necessitates the supply of a substantially higher flow rate than normally anticipated. It is desirable to minimise power consumption by the motor driving the fan consistent with the requirements set out above to increase battery life.

[0003] It is also highly desirable that the air pressure within the face piece or mask is never allowed to fall below the ambient atmospheric pressure. If this happened air may be drawn into the space within the piece or mask drawing environmental contaminants into that space.

[0004] DE 4,205,412 describes a gas mask and breathing equipment arrangement with a storage tank for liquefied respiration gas and an air circulation duct intended for transmitting heat of evaporation from the ambient air to the liquefied respiration gas. According to the disclosure of DE 4,205,412, a sufficient flow rate of ambient air will be achieved under all conditions of use by providing a fan for delivering ambient air through the air circulation duct.

Disclosure of the Invention

[0005] The present invention consists in a forced air breathing apparatus comprising a face piece or mask covering at least the nose or mouth of a wearer, a pump unit arranged to supply air to a space within the face piece or mask, an electric motor within the pump unit arranged to drive a fan forming part of the pump unit, a filter to filter air entering the face piece or mask and a valve means controlling the flow of air from the pump unit to the face piece or mask during inhalation and from the face piece or mask during exhalation, the valve means including an air inlet valve and an air outlet valve, the air outlet valve being maintained in a closed position during inhalation through the air inlet valve by air pressure from the pump unit and being opened by exhaled air which also acts on the inlet valve to prevent the entry of exhaled air to the pump unit;

wherein the apparatus further includes means for maintaining and controlling the speed of the motor so that the fan rotates at a substantially constant speed irrespective of whether air is being inhaled or exhaled by the user.

[0006] It is desirable to control the speed of the motor driving the fan so that it runs at a substantially constant speed. This is in contrast to previous proposals which have required the speed of the fan to be accelerated when more air flow is required. It has been found that operating at constant speed results in a saving of power consumed as compared with letting the fan slow down and then speeding it up again.

[0007] It has also been found that the functioning of such apparatus can be improved by the provision of a valve controlling the inlet of air to the pump unit, the valve being arranged upstream or downstream of the fan and being arranged to close when a defined air pressure is present within the pump unit. With such apparatus it is easier to ensure that there shall always be a positive pressure within the face piece or mask at all times thus avoiding the existence of the negative pressure which could give rise to the entry of contaminated air.

[0008] The term face piece or mask is taken to include any device covering the nose or mouth of a wearer and adapted to engage with the wearer's body or clothing around its edges. It may cover only the mouth or the nose or both of them. If desired, it may comprise a helmet covering the whole of the wearer's head.

[0009] As used in this specification, the term filter is taken to include any device for the removal of particulate and/or gaseous contaminants from the inhaled air. The particulates may be solid, as in smoke, or liquid as in insecticide sprays. The filter may be adapted to remove gaseous contaminants, in which case the filter may be in the form of activated carbon or another gaseous absorbent.

[0010] The apparatus according to this invention may include, downstream of the filter, a device for measuring the oxygen content of the inhaled air. This device will preferably provide a warning to a wearer when the oxygen content of the filtered inhaled air falls below a predetermined level. In a particularly preferred embodiment of the invention, the apparatus includes a source of compressed oxygen or other breathable gas that can be released into the inhaled air at a rate sufficient to maintain the oxygen content of the inhaled air above that predetermined level.

[0011] For different applications of the breathing apparatus, different filter types are employed. Each different type of filter alters the apparatus flow resistance. The demands placed on the breathing apparatus will also vary with each filter type as a filter is progressively used. It has been found that calibrating the apparatus prior to use such that the speed and rotation of the fan is set at an optimum base value results in a saving of power and

an increase in filter life.

[0012] A positive air pressure respirator apparatus may comprise a face piece or mask covering at least the mouth or nose of a wearer, a pump unit arranged to supply air to the space within the face piece or mask, an electric motor within the pump unit arranged to drive a fan, wherein the apparatus is provided with actuable control means adapted to cause the apparatus to undergo a calibration phase such that the speed of rotation of the fan is set at a predetermined optimum base value relative to the operating conditions then prevailing in the apparatus. The base value is preferably maintained substantially constant during any one period of operation of the apparatus or until the apparatus is recalibrated.

[0013] In a preferred embodiment, the apparatus includes an electronic data processing means which monitors and controls the speed of the motor so as to ensure adequate air flow at the mask of the apparatus.

[0014] Preferably, the actuable control means takes account of the filter type and/or flow resistance within the apparatus to set the optimum value of speed of rotation of the fan.

[0015] In one embodiment, the actuable control means would be manually operated by a user of the apparatus. In this embodiment, the actuable control means would include the electronic data processing means with the user entering parameters relevant to the filter type and/or the flow resistance so as to set the optimum speed of the fan prior to use.

[0016] In a second embodiment, the actuable control means would automatically set the apparatus to undergo a calibration phase. One means of automatic operation would involve the parameters of the filter type being coded onto the filter such that the details are detected by the electronic data processing means which automatically adjust the flow of air through the apparatus. The transmission of the coded information to the electronic data processing means could be by optical, electrical or magnetic transfer.

[0017] A second and more desirable means of automatic operation would involve use of a pressure sensor and/or flow measurement apparatus, each under the control of the electronic data processing means. The pressure sensor and/or flow meter would preferably be located proximate, and downstream of, the filter of the apparatus such that flow and pressure drop are automatically measured with detected values of air flow and pressure being fed to the electronic data processing unit. The electronic data processing unit would then automatically calculate the appropriate speed of rotation of the fan given the measured parameters.

[0018] In one embodiment, the pressure sensor comprises a silicone pressure transducer. In a preferred embodiment, the pressure sensor comprises a flexible membrane arranged to flex with changes in pressure, an ultrasound transmitter arranged to direct ultrasound at the membrane, an ultrasound receiver arranged to detect ultrasound reflected from the membrane, and an analysing means, the analysing means being capable of determining a parameter based on the transit time of the ultrasound between the transmitter, membrane and receiver and calibrated so as to provide an indication of air pressure to the electronic data processing means.

[0019] To compensate for changes in the transit time of the ultrasound between the transmitter, membrane and receiver caused by temperature variations, there is preferably located proximate the pressure sensor a temperature probe in communication with the analysing means, the analysing means applying a compensation algorithm to the transit time in accordance with the measured temperature.

[0020] In another embodiment, the flow measurement apparatus comprises an air flow restrictor such as an orifice plate or mesh and a pressure sensor adapted to measure the change in pressure across the restrictor.

[0021] In another embodiment, the flow measurement apparatus comprises a pressure sensor adapted to measure the change in pressure between the pump unit and the face piece or mask resulting from one or more air flow restrictors between the pump unit and mask. The air flow restrictor preferably comprises an air transfer hose which allows flow of air between the pump unit and face piece or mask.

[0022] In a further embodiment, the flow measurement apparatus comprises an ultrasound transmitter and an ultrasound receiver adapted to respectively transmit and detect ultrasound travelling along a portion of the air transfer hose. The flow rate is directly proportional to the time shift of the ultrasound travelling down the hose. one advantage of this method is that it places no flow restrictions on the air flow in the apparatus.

[0023] In a still further embodiment, the flow measurement apparatus comprises a thermistor placed in the air flow and heated to a temperature greater than ambient temperature, the flow rate being proportional to the cooling effect of the air flow on the heated thermistor.

[0024] Due to hygienic and safety reasons, the mask is preferably washed after each use. For these reasons it is not desirable to have electrical systems, or other apparatus vulnerable to breakage, in the mask.

[0025] The forced air breathing apparatus according to this invention preferably operates at a low pressure but at a relatively high flow rate. In preferred embodiments the apparatus is capable of delivering at least 150 litres of air per minute, preferably 300 litres of air per minute, and more preferably at least 500 litres of air per minute, to a wearer. In preferred embodiments the supply pressure of air to the air inlet valve admitting air to the face piece or mask is between zero and 10mBar, more preferably no more than 6mBar, above ambient reference pressure-. It is also preferred that the fan in the pump unit produces a pressure in this range. It is possible, however, to provide a regulator between a pump unit producing air at a higher pressure and the value means associated with the face piece or mask. In

this case the pump unit will supply air at a pressure of less than 1Bar, preferably less than 100mBar, and more preferably less than 20mBar. At these low pressures hose diameters must be so chosen as to avoid undue How-restrictions that would cause large pressure drops in the system.

Brief Description of the Drawings

[0026] In order that the nature of the invention may be better understood preferred forms thereof are hereinafter described by way of example with reference to the accompanying diagrammatic drawings, in which:

Figure 1 is a diagrammatic drawing of those parts of the apparatus with which the present invention is concerned, in the configuration adopted during the period in which air is being inhaled by the user;
Figure 2 is a view similar to Figure 1 showing the apparatus in the configuration adopted when air is being exhaled by the user;
Figure 3 is a view in cross-section of one form of exhaust valve according to the invention;
Figure 4 is a plan view from below of the valve shown in Figure 3;
Figure 5 is a view in cross-section through another form of exhaust valve according to the invention;
Figure 5(a) showing the valve during inhalation;
Figure (b) showing the valve in a stable closed condition; and
Figure 5(c) showing the valve during exhalation;
Figure 6 is a view in cross-section through a further form of exhaust valve according to the invention;
Figure 6(a) showing the valve during inhalation;
Figure 6(b) showing the valve in a stable closed condition; and
Figure 6(c) showing the valve during exhalation;
Figure 7 is a diagrammatic drawing of a still further form of the apparatus with which the present invention is concerned;
Figure 7(a) showing the apparatus during inhalation; and
Figure 7(b) showing the apparatus during exhalation.
Figure 8 is a diagrammatic drawing of yet another form of apparatus in which the present invention is concerned;
Figure 8(a) showing the apparatus during inhalation; and
Figure 8(b) showing the apparatus during exhalation.
Figure 9 is a schematic view of one embodiment of the respirator apparatus according to the fourth aspect of the present invention;
Figure 10 is a schematic view of one embodiment of a user interface for a respirator apparatus according to the fifth aspect of the present invention.

Best Mode of Carrying out the Invention

[0027] The apparatus shown in Figures 1 and 2 consists of a pump unit 10 enclosing an air space and an electric motor 11 driving a centrifugal fan 12. In addition to the parts shown there is a source of power for the motor, usually a rechargeable battery, and in addition a motor speed control unit of conventional construction. This unit monitors the speed of rotation of the fan 12 and controls the speed of the motor to cause it to operate at a substantially constant speed irrespective of whether air is being inhaled or exhaled by the user.

[0028] Air is drawn into the pump unit 10 through a conventional filter 13. The entry of air from the filter is controlled by the valve member 14 associated with the bellows 15 which closes the valve during exhalation of air as shown in Figure 2 and which is lightly biased to the open position by means of the spring 20 as shown in Fig. 1. During the inhalation of air as illustrated in Figure 1 the valve 14 is displaced by the spring 15 and the depression within the pump unit to allow air to enter the pump unit.

[0029] Means may be provided for adjusting the pressure at which the valve 14 closes. It is desirable to keep this as low as possible and for the valve to be arranged to open only for a time sufficient to allow the required amount of air to enter after which the valve closes. The system is balanced with the valve acting as a pressure regulator to minimise pressure fluctuations in the pump unit as much as possible to ensure a more or less instantaneous supply of air from the fan to the user as soon as inhalation commences.

[0030] The pump unit is connected by means of the duct 16 to an exhaust valve shown at 17. The duct 16 splits into two parts, a duct 18 which leads via a valve member 19 to the face piece or mask (20a) and also to an exhaust outlet 21 which during inhalation is closed by the valve member 22 which is lightly biased to the closed position by the spring 23 as shown in Figure 1. In certain embodiments of the invention the valve 22 could be replaced by a simple spring loaded exhalation valve.

[0031] The second branch 24 of the duct 16 leads to the rear of the valve member 22 which tends to maintain the valve in a pressure balanced condition.

[0032] The flow of air during inhalation is illustrated by the arrows shown in Figure 1. Air is drawn in through the open valve 14 to the fan 12 which generates a pressure to produce an air flow through the ducts 16 and 18 to the face piece or mask worn by the user. It will be seen that the valve 19 is maintained open by the air pressure on it and air flows freely to the user. The pressure of air in the duct 24 acts on the back of valve 22 to reinforce the action of the spring 23 and keep the valve closed.

[0033] The configuration of the apparatus during exhalation as shown in Figure 2 in which the valve 14 is closed. The valve 19 is also closed due to exhalation of

air by the user. The fan 12 which is maintained at a constant speed of rotation by the motor 11 is operating in a stalled condition and the pressure generated by it is not sufficient to open the valve 19 against the pressure of exhaled air. It does, however, apply pressure to the rear of the valve 22 but at a lower level than the exhalation pressure, thus allowing the valve 22 to be held open. Exhaled air can escape from the exhaust opening 21. Whereas the apparatus is shown in a purely diagrammatic manner in Figures 1 and 2, Figures 3 and 4 show in a more realistic manner one form of exhaust valve construction corresponding in function to the exhaust valve 17 shown in Figures 1 and 2. In this construction the duct 25 corresponds to the duct 16 in Figures 1 and 2, a pair of one way valves 26 correspond to the valve member 19 of Figures 1 and 2 and a pair of outlet apertures 27 correspond to the duct 18 of Figures 1 and 2 providing a connection to the face piece or mask. Thus, during inhalation, air from the pump unit enters the duct 25, passes through the valve 26 and is supplied to the face piece or mask through the outlet 27.

[0034] Within the center of the outlet valve is a diaphragm valve 28 lightly loaded by a spring 29 onto a seating 31. This valve has a central hollow stem 32 movable with the diaphragm. This has air inlet apertures 33 at its lower end and an air outlet 34 at its upper end. The diaphragm valve 28 corresponds to the valve 22 of Figures 1 and 2.

[0035] During exhalation air enters through the air inlets 27. The exhaled air exercises pressure on the diaphragm valve 28 and causes it to open against the spring 29. Air then passes the diaphragm of valve 28 and vents to atmosphere through the one way valves 35 at the top of the casing. The valves 35 which prevent the ingress of contaminated air in the-event of fan failure are not absolutely essential to the operation of the system and may be omitted.

[0036] The exhaust valve shown in Figures 3 and 4 has features not shown in Figures 1 and 2 in that when the hollow stem 32 is in the position shown in Figure 3, air under pressure from the pump unit can enter the apertures 33 and exert pressure on the upper surface of the diaphragm valve 28 reinforcing the action of the spring 29 and the situation is similar to that shown in Figures 1 and 2. Once, however, the diaphragm 28 moves upwardly it carries the member 32 with it. This has the effect of shutting off the air inlets 33 and opening the air outlet 34 thus releasing any air pressure above the diaphragm 28 through the one way valves 35.

[0037] The valve 40 includes an air inlet duct 41 connected to a source of positive air pressure (not shown), a first valve 42, a face mask 43 covering the mouth and nose of a wearer (as is shown in Fig. 5(a)), a second valve 44, and a discharge aperture 45 for the discharge of exhaled air to atmosphere.

[0038] The first valve 42 serves to admit air from the inlet duct 41 into the face mask 43 when the system pressure in the inlet duct 41 exceeds the pressure in the face mask 43. When the pressures are equal the valve 42 closes.

[0039] The second valve 44 serves to permit the passage of exhaled air from the face mask 43 through the discharge aperture 45 to atmosphere. The valve 44 comprises a diaphragm which is exposed on a first face 46 to the inlet duct 41 and the air pressure therein. A second face 47 of the diaphragm of valve 44 is arranged to bear against a valve seat 48 for the second valve 44. The area of the second face 47 of the diaphragm within the area defined by value seat 48 is exposed, when the valve is closed, to the pressure within the face mask 43. The remainder of the second face 47 of the diaphragm will be exposed to atmospheric pressure through discharge aperture 45 when the valve 44 is closed.

[0040] In operation air will flow from inlet duct 41 through valve 42 into the face mask 43 is equal to that in the inlet duct 41. The valve 42 will then close. If the wearer now exhales the pressure in the face mask 43 will rise. Once the rise is sufficient to overcome the force holding valve 44 in a closed position that valve will open and air will discharge from the face mask 43 through valve 44 and discharge aperture 45 to atmosphere.

[0041] The force holding the valve 44 in a closed position is the difference between the pressure on the first face 46 and the second face 47. As the pressure applied to the diaphragm from the inlet duct 41 and the face mask 43 will initially be equal it can be seen that the force holding the valve 44 closed is the difference between atmospheric pressure on that part of the second face that lies outside the valve seat 48 and the inlet duct pressure over a similar area. As this area is small relative to the area of the diaphragm which lies within the area defined by valve seat 48 even a small rise in pressure within the face mask is sufficient to open the outlet valve 44. As the area is small even a substantial increase in system pressure within the inlet duct will not raise greatly the exhalation pressure required to open the second valve 44.

[0042] The arrangement shown in Figs. 6(a) to 6(c) is essentially similar to that described with reference to Figs. 5(a) to 5(c) and similar parts are given the same numeric designation. In this embodiment the first valve 42 is disposed within the membrane of the second valve 44. The valve works in the manner described with reference to Figs. 5(a) to 5(c).

[0043] The arrangement shown in Figs. 7(a) and 7(b) is similar to the arrangement described with reference to Figs. 1 and 2 with two major exceptions. The first exception that the valve 40 of Figs. 6(a) to 6(c) has been substituted for valve 17 of Figs. 1 and 2. The second exception is that the filter 13 is moved from in front of the fan 12 to behind the fan 12. The pressure controlling the valve 14 is drawn from a duct 60 linking the filter 13 with the valve 40. In this way the opening and closing of the valve 14 more closely reflects the changes in pressure due to the breathing by a wearer due to inclusion of the pressure drop over the filter in the regulation.

[0044] Figures 8(a) and 8(b) show fan forced positive air pressure breathing apparatus according to this invention. The arrangement is similar to the arrangement described with reference to Figures 7(a) and 7(b) and similar parts are given the same numeric designation. In this case the fan operates at a high pressure and feeds high pressure air to a regulator 51. Air from the regulator 51 flows through hose 53 to valve 40.

[0045] A positive air pressure respirator is generally shown as 110 in Fig. 9. The apparatus includes a pump unit in which is situated an electric motor 111 driving a centrifugal fan 112. In addition to the above parts shown there is a source of power for the motor 111, usually a rechargeable battery (not depicted), and a motor speed control unit under microprocessor control 115.

[0046] Air is drawn into the respirator 110 through a filter 113, passes through the fan 112 and exits the apparatus 110 via the mask 114. The mask 114 is adapted to completely cover the mouth and nose of a wearer and is adjustable so as to fit snugly to the contours of the face of the wearer.

[0047] The microprocessor control 115 in the embodiment depicted monitors input from a pressure transducer 116 and a flow meter 117 and is thereby able to ascertain the flow resistance of the filter 113 being employed. In those cases where flow resistance is high, the microprocessor control 115 will note this and set the speed of rotation of the fan 112 at-a higher level to compensate thereby ensuring that adequate flow of air is available at the mask 114 on inhalation by the wearer.

[0048] In operation, the microprocessor control 115 will automatically undertake a measure of flow resistance and automatically adjust the speed of the fan 112 to the necessary level.

[0049] A positive air Purifying respirator is generally shown as 210 in Fig. 10. The apparatus includes a pump unit in which is situated an electric motor driving a centrifugal fan, a power source, usually a rechargeable battery, and a motor speed control unit under microprocessor control (all not depicted). Air is drawn into the respirator 210 through a filter, passes through the fan and exits the apparatus 210 through an air hose 211 and mask 212. The mask 212 is adapted to completely cover the mouth and nose of a wearer and is adjustable so as to fit snugly to the contours of the face of the wearer.

[0050] Performance of the apparatus 210 is monitored by a performance monitor located within the pump unit. The performance monitor controls a pressure transducer located proximate the fan, a flow meter located proximate the filter, a voltmeter monitoring the charge of the battery and a pressure. transducer 213 located in the apparatus 210 which measures the pressure in the space within the mask 212. The pressure transducer 213 is in communication with the space within the mask 212 via a flexible hose 214. The hose 214 is preferably connected to the mask 212 with a fitting which allows ready removal of the hose 214 after use of the apparatus 210.

[0051] Should air pressure either at the fan or within the mask 212, air flow or battery charge fall below a preset low level, the performance monitor issues a warning signal to the wearer.

[0052] The warning signal comprises-both an audible tone and an indicator light. The audible tone is generated by a speaker 215 within the apparatus 210, with the tone transmitted through the air transfer hose 211 to the mask 212. The light source is generated by a light emitting diode (LED) 216 with the light transmitted to the field of view of the wearer-in the mask 212 by an optical fibre 217.

[0053] Both the optical fibre 217 and air hose 211 are connected to the mask 212 by fittings which allow ready removal of these items from the mask 212 prior to it being cleaned.

Claims

1. A forced air breathing apparatus comprising a face piece or mask (20a) covering at least the nose or mouth of a wearer, a pump unit (10) arranged to supply air to a space within the face piece or mask (20a), an electric motor (11) within the pump unit (10) arranged to drive a fan (12) forming part of the pump unit (10), a filter (13) to filter air entering the face piece or mask (20a) and a valve means (40) controlling the flow of air from the pump unit (10) to the face piece or mask (20a) during inhalation and from the face piece or mask (20a) during exhalation, the valve means (40) including an air inlet valve (42) and an air outlet valve (44), the air outlet valve (44) being maintained in a closed position during inhalation through the air inlet valve (42) by air pressure from the pump unit (10) and being opened by exhaled air which also acts on the inlet valve (42) to prevent the entry of exhaled air to the pump unit (10);

   wherein the apparatus further includes means for maintaining and controlling the speed of the motor (11) so that the fan (12) rotates at a substantially constant speed irrespective of whether air is being inhaled or exhaled by the user.

2. A forced air breathing apparatus as claimed in claim 1 in which the fan (12) is a centrifugal fan.

3. A forced air breathing apparatus as claimed in claim 1 in which the apparatus includes a valve (14) controlling the flow of air through the pump unit (11), the valve (14) being arranged to close when the pressure present within the breathing apparatus downstream of the fan rises to a predetermined level.

4. A forced air breathing apparatus as claimed in claim 1 in which the apparatus is further provided with a

pressure sensor (116) and/or a flow measurement apparatus (117) adapted to measure the pressure of air in the apparatus and the flow of air through the apparatus, preferably at a location proximate, and downstream of, the filter; and a microprocessor control unit (115) to monitor input from the pressure sensor (116) and/or the measurement apparatus (117) and thereby ascertain the flow resistance of the filter.

5. A forced air breathing apparatus as claimed in claim 4 in which the pressure sensor (116) comprises a flexible membrane arranged to flex with changes in pressure, an ultrasound transmitter arranged to direct ultrasound at the membrane, an ultrasound receiver to detect ultrasound reflected from the membrane, and an analysing means, the analysing means being capable of determining a parameter based on the transit time of the ultrasound between the transmitter, the membrane and the receiver and calibrated so as to provide an indication of air pressure to the microprocessor control unit (115).

6. A forced air breathing apparatus as claimed in claim 5 in which a temperature probe is located proximate the pressure sensor (116), the temperature probe communicating to the analysing means a signal indicative of measured temperature to allow the analysing means to apply a compensating algorithm to the parameter based on the transit time in accordance with the measured temperature.

7. A forced air breathing apparatus as claimed in claim 1 in which the apparatus is adapted to deliver at least 150 litres of air per minute, preferably at least 300 litres of air per minute, more preferably at least 500 litres of air per minute, to a wearer.

8. A forced air breathing apparatus as claimed in claim 1 in which the apparatus is adapted to supply air to the air inlet valve (42) admitting air to the face piece or mask (20a) at a pressure between zero and 10mBar, more preferably no more than 6mBar, above ambient reference pressure.

9. A forced air breathing apparatus as claimed in claim 1 in which the filter (13) is positioned between the pump unit (10) and the face piece or mask (20a).

10. A forced air breathing apparatus as claimed in claim 9 in which the apparatus includes a valve (14) controlling the flow of air through the pump unit (10), the valve (14) being arranged to close When the pressure present within the breathing apparatus between the filter (13) and the face piece or mask rises (20a) to a predetermined level.

Patentansprüche

1. Beatmungsgerät, welches ein Gesichtsteil oder eine Gesichtsmaske (20a), welche/s zumindest die Nase oder den Mund des Trägers bedeckt, eine Pumpeinheit (10), um Luft in einen Raum innerhalb des Gesichtsteils oder der Gesichtsmaske (20a) zuzuführen, einen Elektromotor (11) innerhalb der Pumpeinheit (10), einen Ventilator (12) anzutreiben, welcher Teil der Pumpeinheit (10) ist, einen Filter (13) zum Filtern der Luft, welche in das Gesichtsteil oder die Gesichtsmaske (20a) eintritt, sowie eine Ventileinheit (40), welche den Luftstrom von der Pumpeinheit (10) zum Gesichtsteil oder der Gesichtsmaske (20a) während der Inhalation und vom Gesichtsteil oder der Gesichtsmaske (20a) weg während der Exhalation steuert, aufweist, wobei die Ventileinheit (40) ein Lufteinlassventil (42) und ein Luftauslassventil (44) aufweist, wobei das Luftauslassventil (44) während der Inhalation durch das Lufteinlassventil (42) durch Luftdruck von der Pumpeinheit (10) in einer geschlossenen Position gehalten und durch die ausgeatmete Luft geöffnet wird, welche außerdem auf das Einlassventil (42) wirkt, um das Eintreten ausgeatmeter Luft in die Pumpeinheit (10) zu verhindern;

wobei das Gerät ferner Mittel zum Beibehalten und Steuern der Geschwindigkeit des Motors (11) beinhaltet, so dass sich der Ventilator (12) mit einer im Wesentlichen konstanten Geschwindigkeit dreht, ungeachtet dessen, ob vom Benutzer Luft eingeatmet oder ausgeatmet wird.

2. Beatmungsgerät nach Anspruch 1, bei dem der Ventilator (12) ein Radialventilator ist.

3. Beatmungsgerät nach Anspruch 1, bei dem das Gerät ein Ventil (14) aufweist, welches den Luftstrom durch die Pumpeinheit (11) steuert, wobei das Ventil (14) so angeordnet ist, dass es sich schließt, wenn der im Beatmungsgerät vorherrschende Druck stromabwärts des Ventilators auf ein vorbestimmtes Niveau ansteigt.

4. Beatmungsgerät nach Anspruch 1, bei dem das Gerät ferner mit einem Drucksensor (116) und/oder Durchflussmessgerät (117), welcher/s so eingestellt ist, dass er/es den Luftdruck im Gerät und der Luftstrom durch das Gerät, bevorzugt an einem Punkt in der Nähe und stromabwärts des Filters, misst; sowie mit einer Mikroprozessorsteuereinheit (115) zum Überwachen der empfangenen Daten vom Drucksensor (116) und/oder Messgerät (117) und somit zur Sicherstellung des Strömungswiderstandes des Filters ausgestattet ist.

5. Beatmungsgerät nach Anspruch 4, bei dem der Drucksensor (116) eine flexible Membran, die so

angeordnet ist, dass sie sich bei Druckänderungen biegt, einen Ultraschall-Transmitter, der so angeordnet ist, dass er den Ultraschall auf die Membran richtet, einen Ultraschall-Empfänger zum Erkennen des von der Membran reflektierten Ultraschalls und ein Analysegerät aufweist, wobei das Analysegerät zur Bestimmung eines Parameters basierend auf der Übertragungszeit des Ultraschalls zwischen dem Transmitter, der Membran und dem Empfänger in der Lage und so kalibriert ist, dass es eine Angabe des Luftdrucks zur Mikroprozessorsteuereinheit (115) liefert.

6. Beatmungsgerät nach Anspruch 5, bei dem sich eine Temperatursonde in der Nähe des Drucksensors befindet, wobei die Temperatursonde ein Signal an das Analysegerät liefert, welches die gemessene Temperatur anzeigt, um es dem Analysegerät zu ermöglichen, einen Ausgleichsalgorithmus auf den Parameter basierend auf der Übertragungszeit in Übereinstimmung mit der gemessenen Temperatur anzuwenden.

7. Beatmungsgerät nach Anspruch 1, bei dem das Gerät so eingestellt ist, dass es an den Träger mindestens 150 Liter Luft pro Minute, bevorzugt mindestens 300 Liter Luft pro Minute, bevorzugter mindestens 500 Liter Luft pro Minute, abgibt.

8. Beatmungsgerät nach Anspruch 1, bei dem das Gerät so ausgebildet ist, dass es Luft an das Einlassventil (42) abgibt, welches die Luft mit einem Druck zwischen null und 10 mBar, bevorzugter nicht mehr als 6 mBar über dem umgebenden Referenzdruck, an das Gesichtsteil oder der Gesichtsmaske abgibt.

9. Beatmungsgerät nach Anspruch 1, bei dem der Filter (13) zwischen der Pumpeinheit (10) und dem Gesichtsteil oder der Gesichtsmaske (20a) positioniert ist.

10. Beatmungsgerät nach Anspruch 9, bei dem das Gerät ein Ventil (14)aufweist, welches den Luftstrom durch die Pumpeinheit (10) steuert, wobei das Ventil (14) so angeordnet ist, dass es sich schließt, wenn der innerhalb des Beatmungsgerätes zwischen dem Filter (13) und dem Gesichtsteil oder der Gesichtsmaske (20a) vorherrschende Druck auf ein vorbestimmtes Niveau ansteigt.

Revendications

1. Respirateur à air forcé comprenant un élément facial ou masque (20a) couvrant au moins le nez ou la bouche d'un utilisateur, une unité de pompe (10) aménagée pour fournir de l'air à un espace à l'intérieur de l'élément facial ou masque (20a), un moteur électrique (11) à l'intérieur de l'unité de pompe (10) aménagé pour entraîner une partie formant ventilateur (12) de l'unité de pompe (10), un filtre (13) pour filtrer l'air entrant dans l'élément facial ou masque (20a) et un moyen de soupape (40) contrôlant le débit d'air à partir de l'unité de pompe (10) jusqu'à l'élément facial ou masque (20a) pendant l'inhalation et à partir de l'élément facial ou masque (20a) pendant l'exhalation, le moyen de soupape (40) comprenant une soupape d'entrée d'air (42) et une soupape de sortie d'air (44), la soupape de sortie d'air (44) étant maintenue dans une position fermée pendant l'inhalation à travers la soupape d'entrée d'air (42) par la pression d'air de l'unité de pompe (10) et étant ouverte par l'air exhalé qui agit aussi sur la soupape d'entrée (42) pour empêcher l'entrée d'air exhalé dans l'unité de pompe (10);

le respirateur comprenant en outre un moyen pour maintenir et contrôler la vitesse du moteur (11) de sorte que le ventilateur (12) tourne à une vitesse sensiblement constante que l'air soit exhalé ou inhalé par l'utilisateur.

2. Respirateur à air forcé selon la revendication 1, dans lequel le ventilateur (12) est un ventilateur centrifuge.

3. Respirateur à air forcé selon la revendication 1, dans lequel le respirateur comprend une soupape (14) contrôlant le débit d'air à travers l'unité de pompe (10), la soupape (14) étant aménagée pour se fermer lorsque la pression présente à l'intérieur du respirateur en aval du ventilateur atteint un niveau prédéterminé.

4. Respirateur à air forcé selon la revendication 1, dans lequel le respirateur est en outre doté d'un capteur de pression (116) et/ou d'un dispositif de mesure de débit (117) adaptés pour mesurer la pression d'air dans le respirateur et le débit d'air traversant le respirateur, de préférence à un emplacement proche et en aval du filtre, et d'une unité de contrôle à microprocesseur (115) pour surveiller les entrées du capteur de pression (116) et/ou du dispositif de mesure (117) et assurer ainsi la résistance au débit du filtre.

5. Respirateur à air forcé selon la revendication 4, dans lequel le capteur de pression (116) comprend une membrane flexible aménagée pour fléchir avec les changements de pression, un émetteur d'ultrasons aménagé pour diriger des ultrasons sur la membrane, un récepteur d'ultrasons pour détecter les ultrasons réfléchis par la membrane, et un moyen d'analyse, le moyen d'analyse étant capable de déterminer un paramètre basé sur le temps de déplacement des ultrasons entre l'émetteur, la

membrane et le récepteur et étalonné de manière à fournir une indication de pression d'air à l'unité de contrôle à microprocesseur (115).

6. Respirateur à air forcé selon la revendication 5, dans lequel une sonde de température est située à proximité du capteur de pression (116), la sonde de température communicant au moyen d'analyse un signal indicatif de la température mesurée pour permettre au moyen d'analyse d'appliquer un algorithme de compensation au paramètre basé sur le temps de déplacement selon la température mesurée.

7. Respirateur à air forcé selon la revendication 1, dans lequel le respirateur est adapté pour fournir au moins 150 litres d'air par minute, de préférence au moins 300 litres d'air par minute, et plus préférablement au moins 500 litres d'air par minute, à un utilisateur.

8. Respirateur à air forcé selon la revendication 1, dans lequel le respirateur est adapté pour fournir de l'air à la soupape d'entrée d'air (42) alimentant en air l'élément facial ou masque (20a) à une pression située entre zéro et 10 mbars, de préférence n'excédant pas 6 mbars, au-dessus de la pression de référence ambiante.

9. Respirateur à air forcé selon la revendication 1, dans lequel le filtre (13) est positionné entre l'unité de pompe (10) et l'élément facial ou masque (20a).

10. Respirateur à air forcé selon la revendication 9, dans lequel le respirateur comprend une soupape (14) contrôlant le débit d'air à travers l'unité de pompe (10), la soupape (14) étant aménagée pour se fermer lorsque la pression présente à l'intérieur du respirateur entre le filtre (13) et l'élément facial ou masque (20a) atteint un niveau prédéterminé.

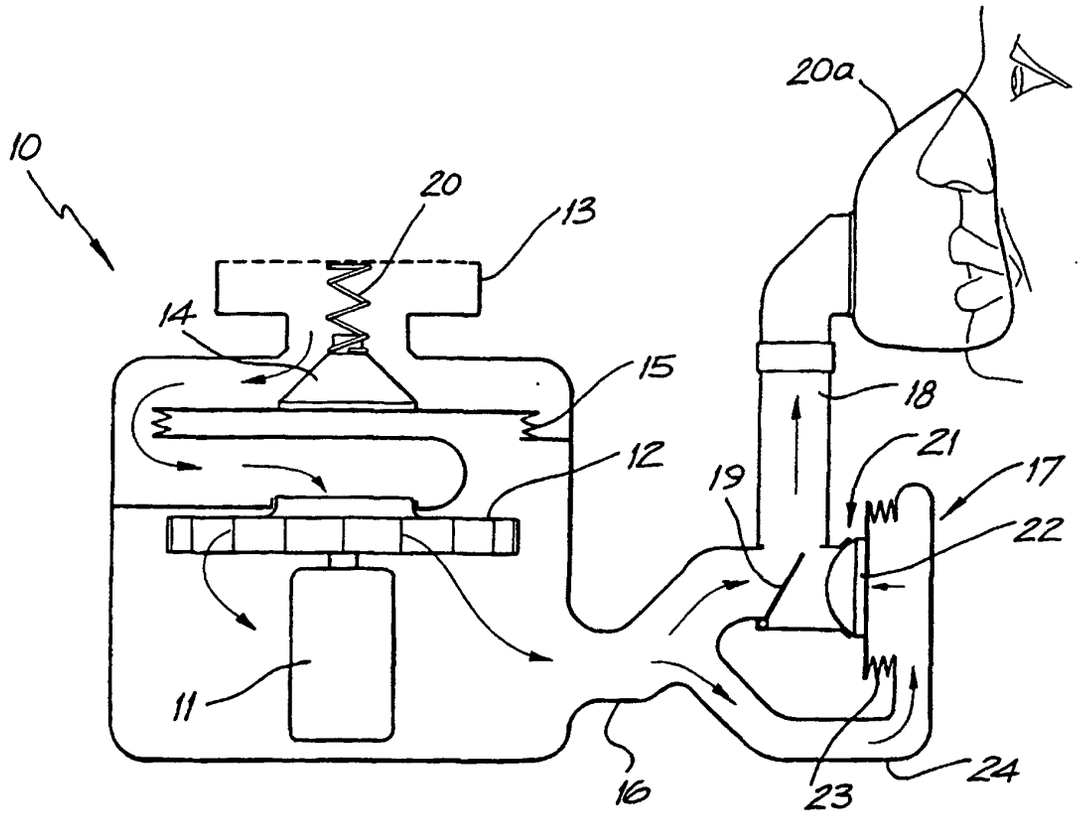

10
20
13
14
15
12
11
16
20a
18
21
17
19
22
23
24

FIG. 1

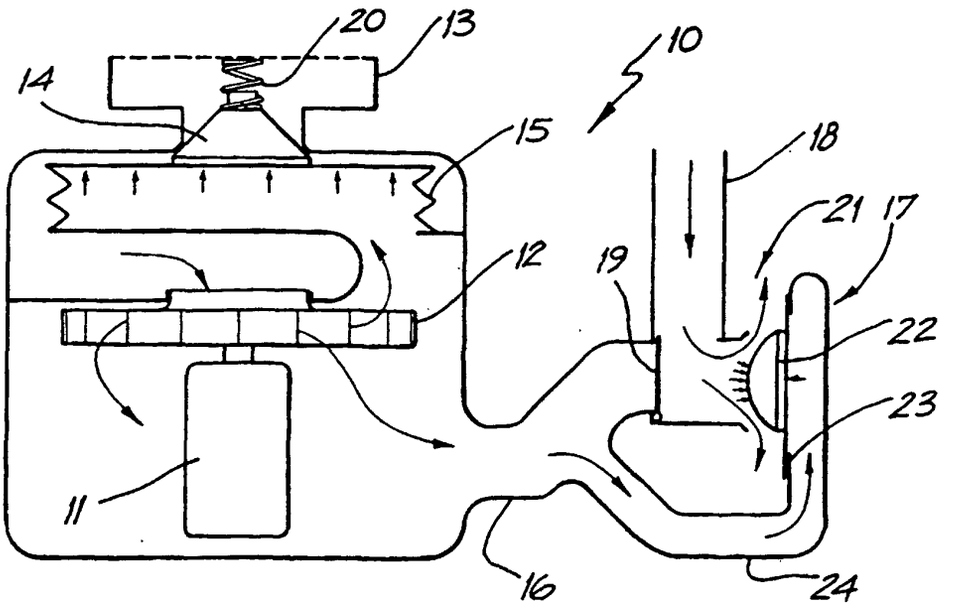

20
13
14
10
15
18
21
17
12
19
22
23
11
16
24

FIG. 2

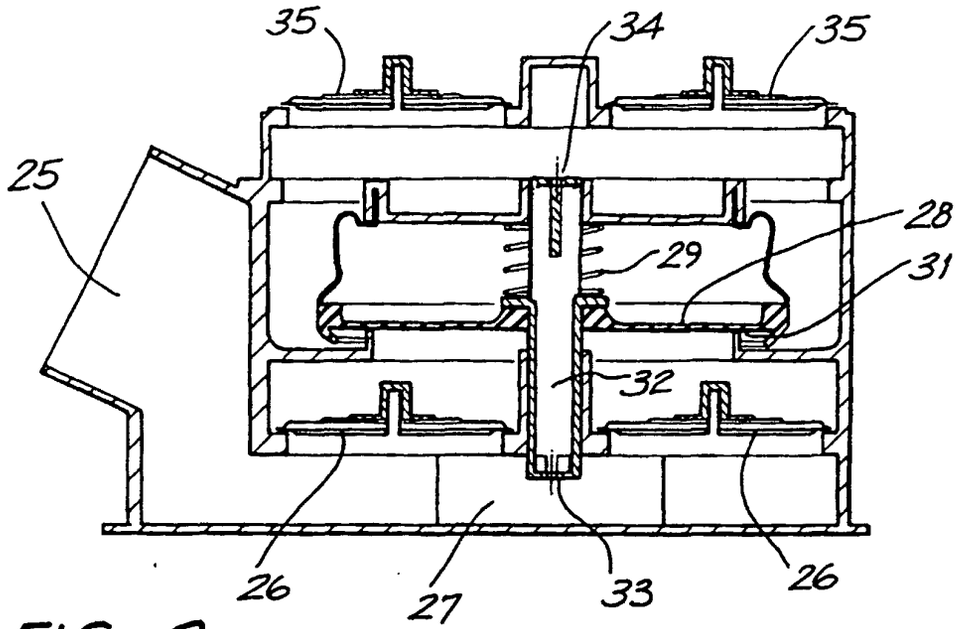


FIG. 3

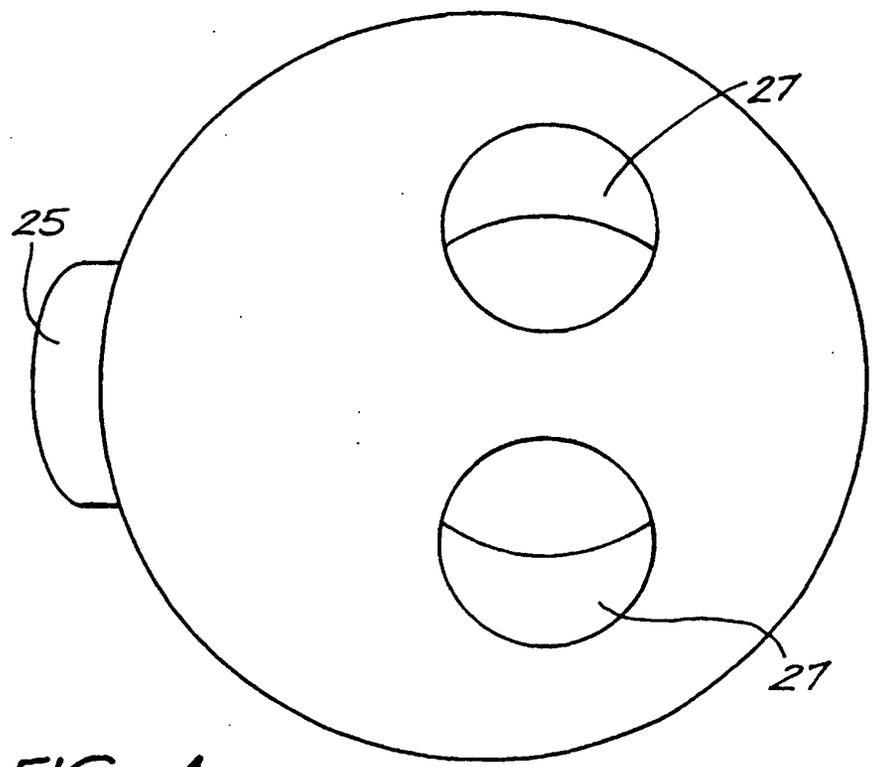


FIG. 4

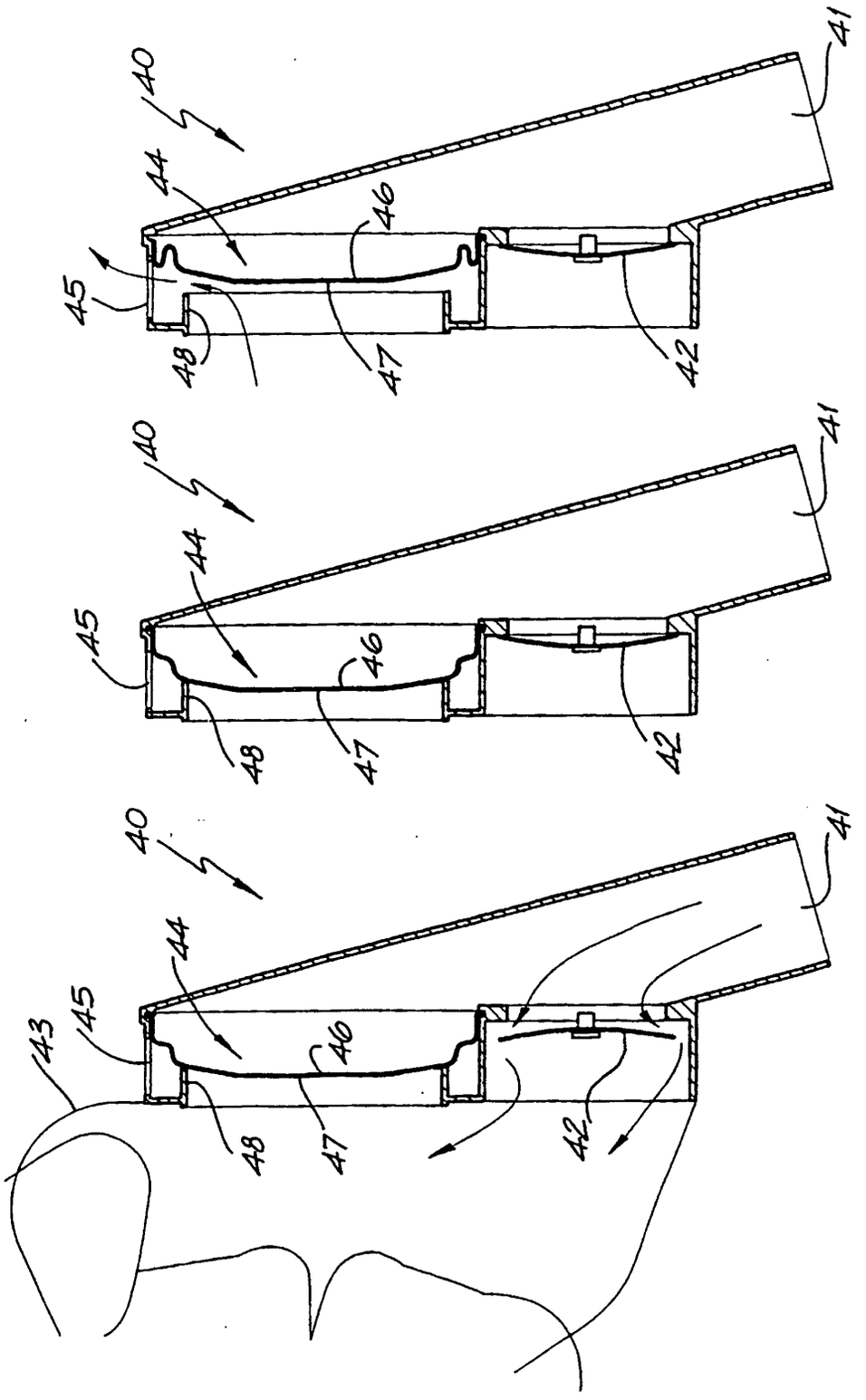


FIG. 5(a)

FIG. 5(b)

FIG. 5(c)

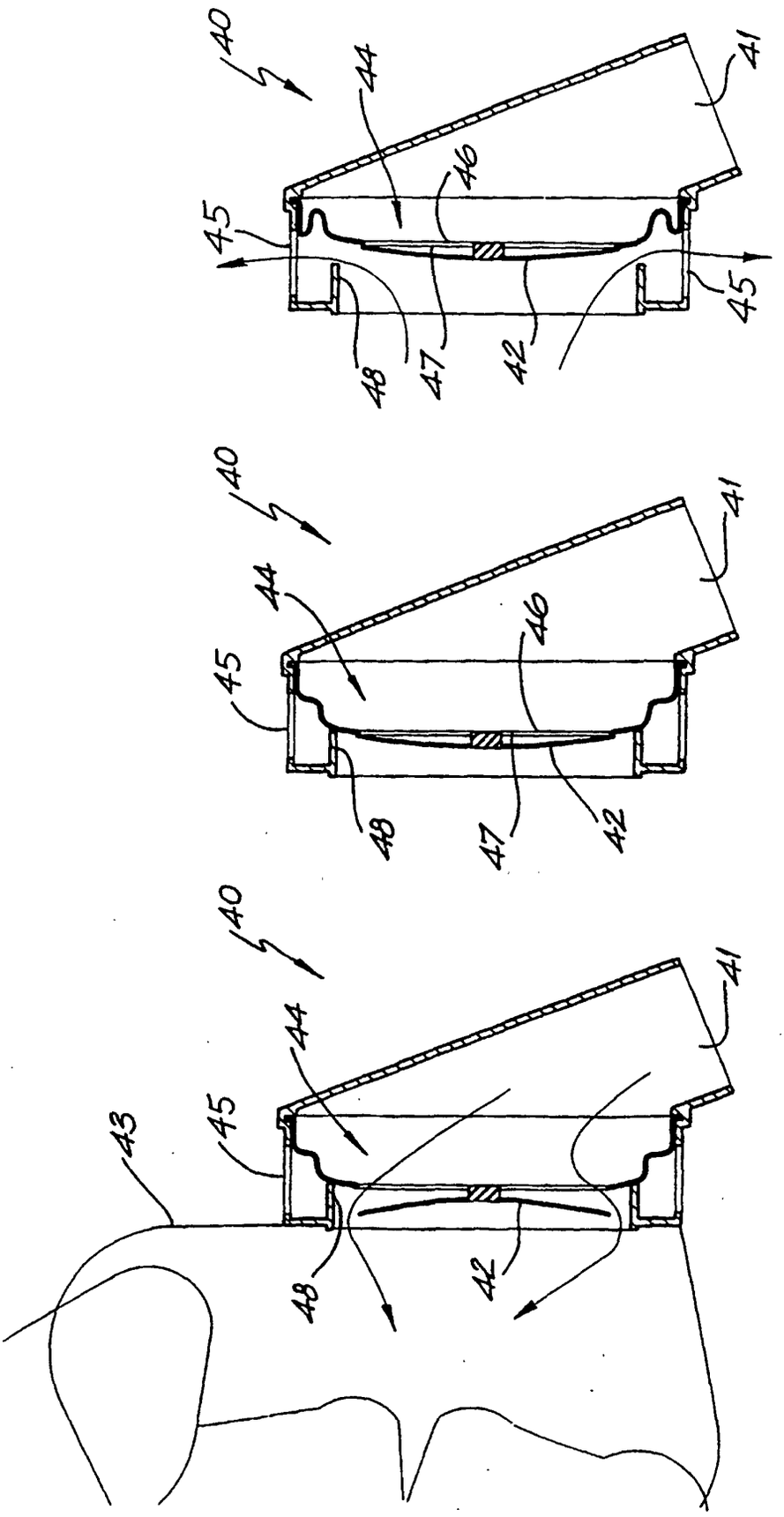


FIG. 6(c)

FIG. 6(b)

FIG. 6(a)

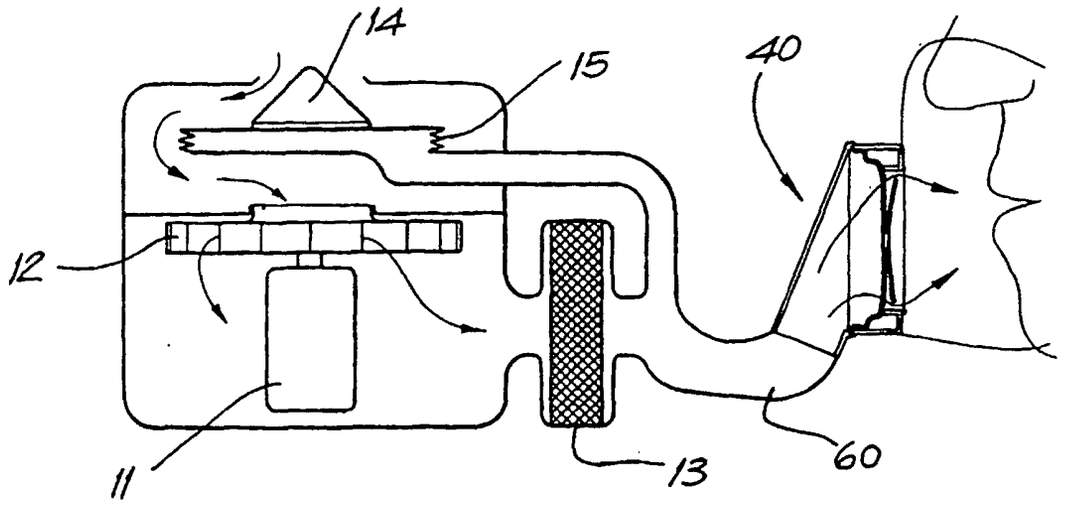


FIG. 7(a)

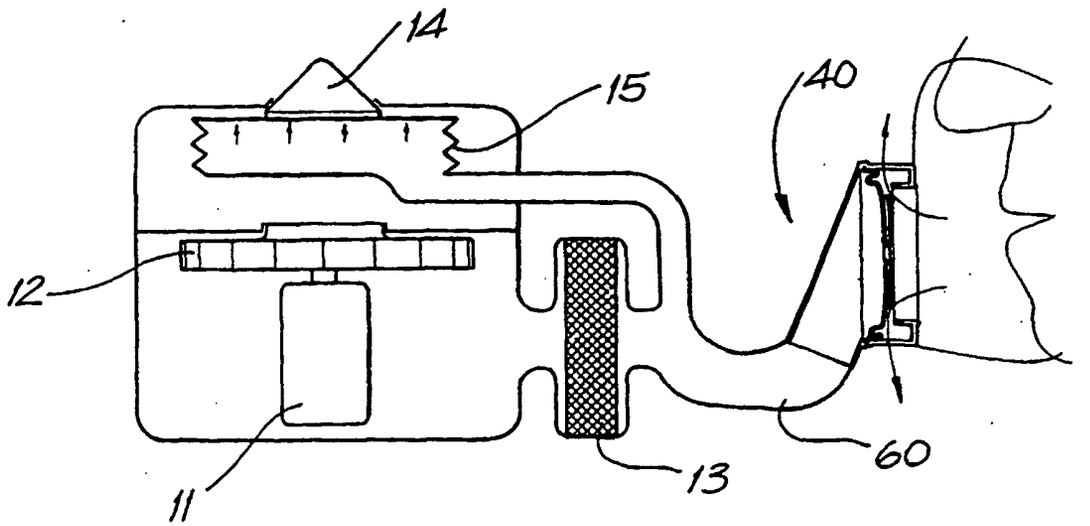


FIG. 7(b)

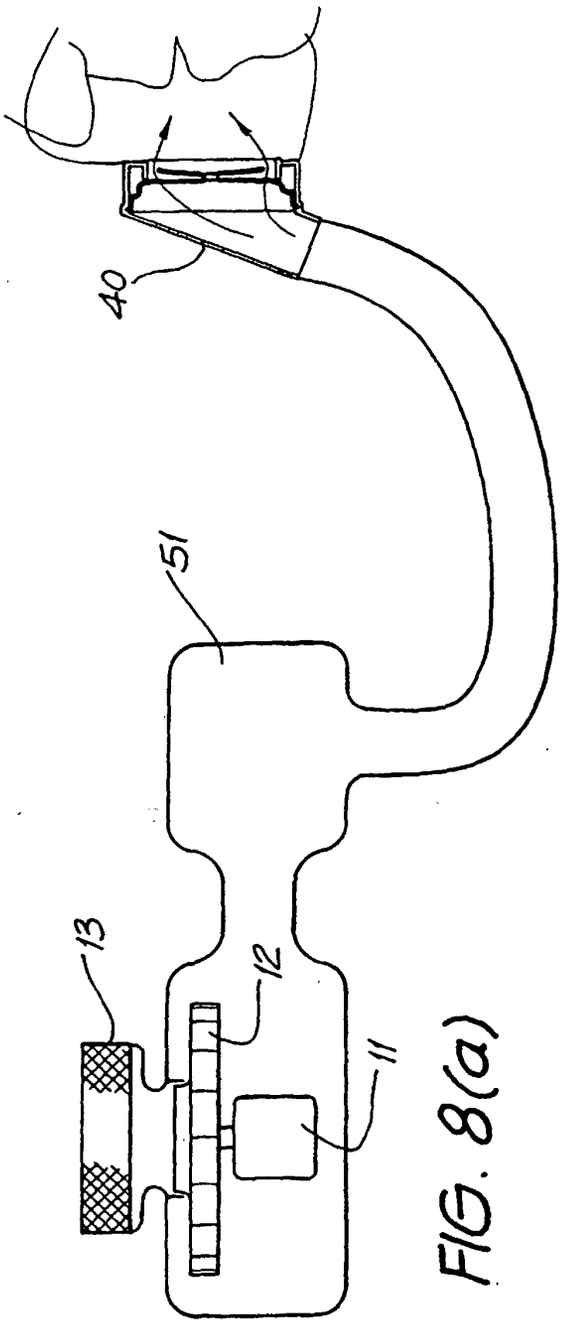


FIG. 8(a)

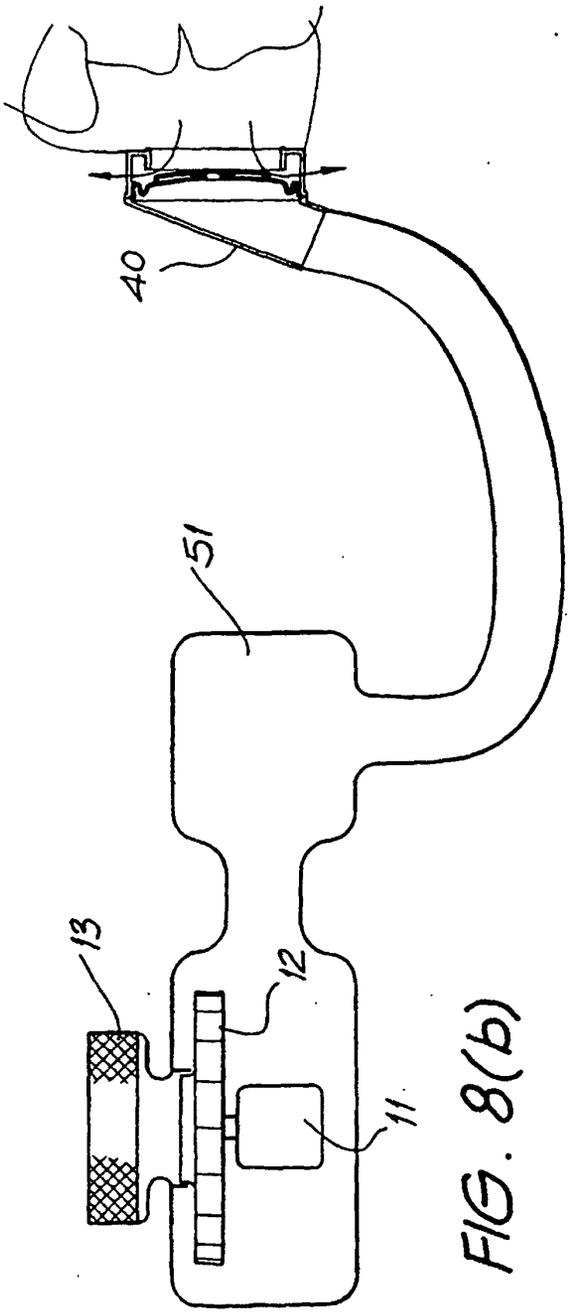


FIG. 8(b)

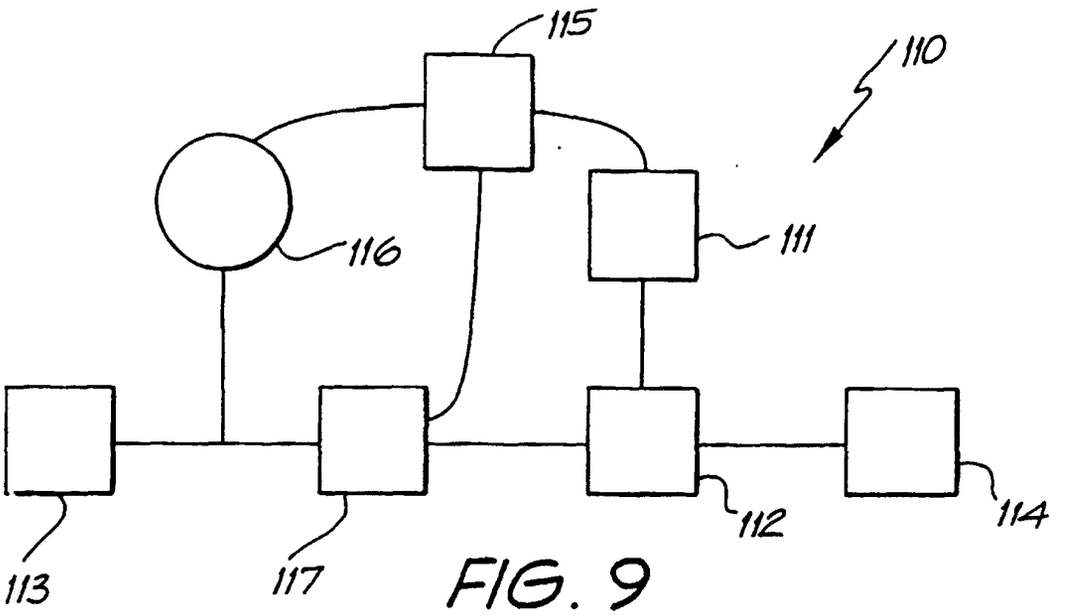


FIG. 9

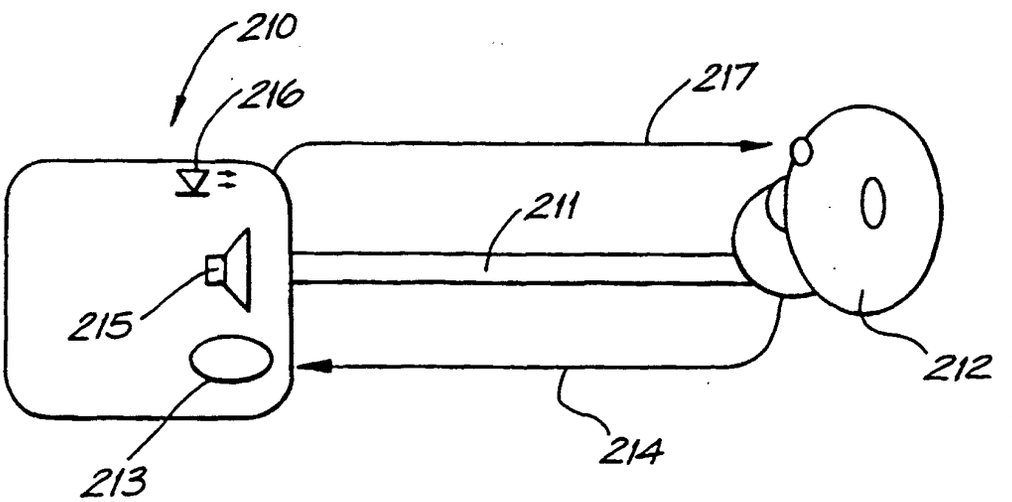


FIG. 10