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Lafourcade

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[54] **BREATHING AID APPARATUS**

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[52] **U.S. Cl.** **128/145.8**; 128/145.6; 128/188; 128/209; 137/514.5

[51] **Int. Cl.** **A61m 16/00**

[58] **Field of Search** 128/145.8, 145.5, 277, 128/145.6, 142.3, 188, 191, 184, 273, 146.3, 146.4, 146.5, 209; 251/22, 50; 138/43; 137/117, 514.5, 525

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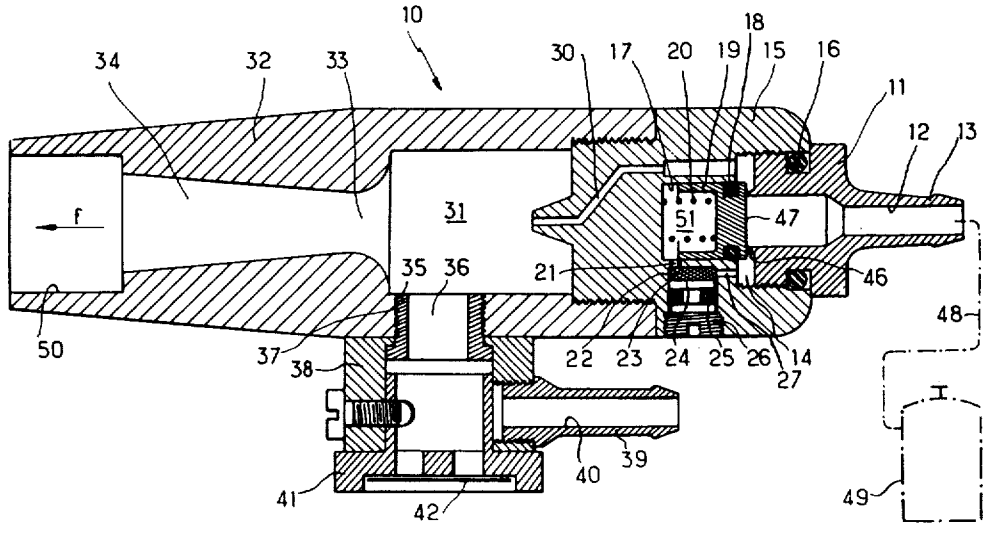
Primary Examiner—Richard A. Gaudet
Assistant Examiner—Henry J. Recla
Attorney, Agent, or Firm—Hane, Baxley & Spiecens

[57] **ABSTRACT**

An artificial respiration apparatus comprising a tip connectable to a source of gas under pressure, said tip including a bore hole; a valve seat at the end of said bore hole facing away from the source; an outlet connectable to the respiratory system of a patient; a movable valve member cooperating with said valve seat to close said bore hole, a spring cooperating with said movable valve member and biasing the same against said valve seat, a housing including a first chamber communicating with said source of gas and also with said outlet when the moving valve member is not in contact with the valve seat; and a second chamber in which said spring is housed, one wall of said second chamber being formed of said movable valve member, a channel communicating said first chamber with said second chamber, a pellet of porous material disposed in said channel which produces a loss of pressure therein; and a pressure screw cooperating with said pellet for varying the compression thereof, thereby adjusting the flow of gas from said first chamber to said second chamber.

9 Claims, 15 Drawing Figures



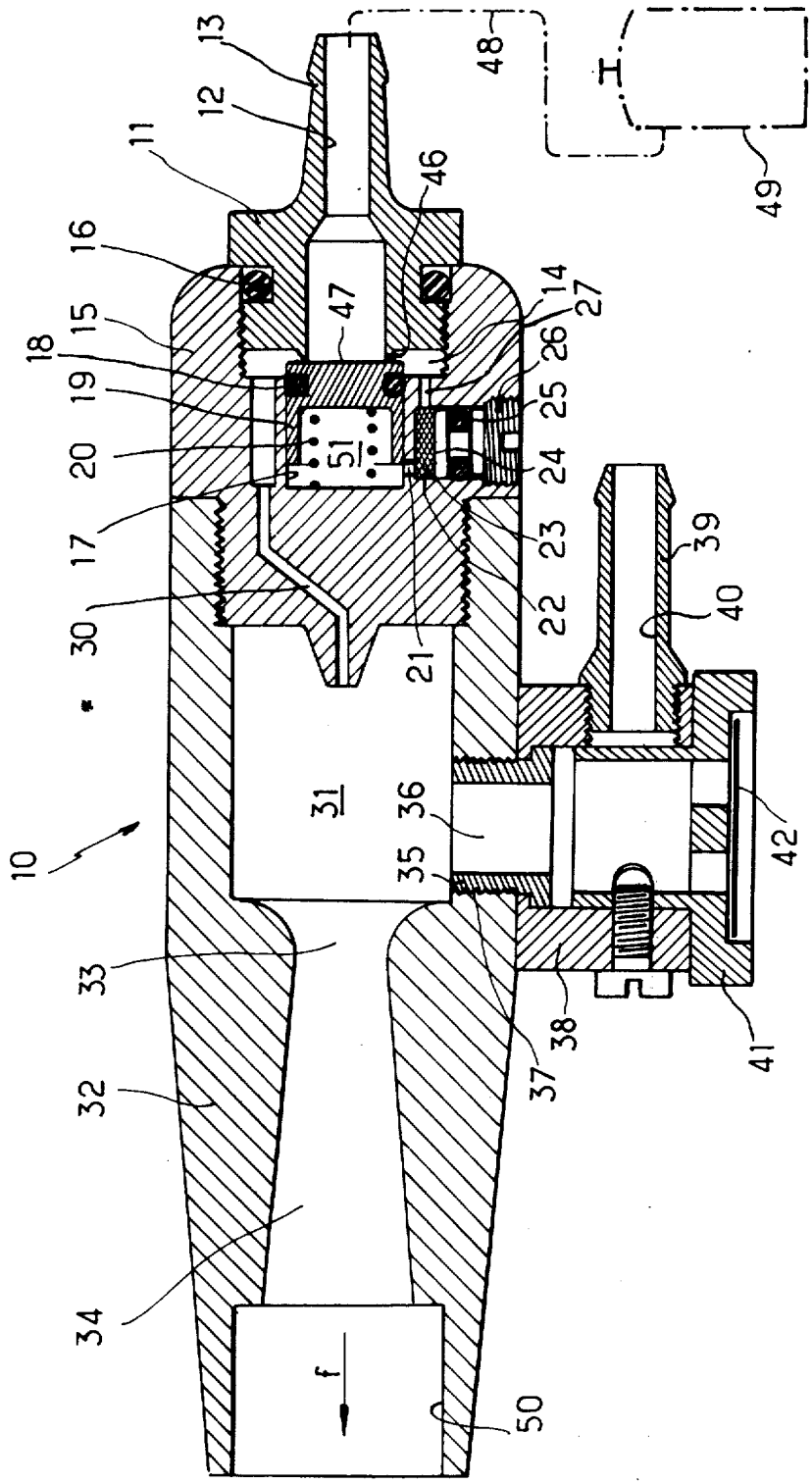

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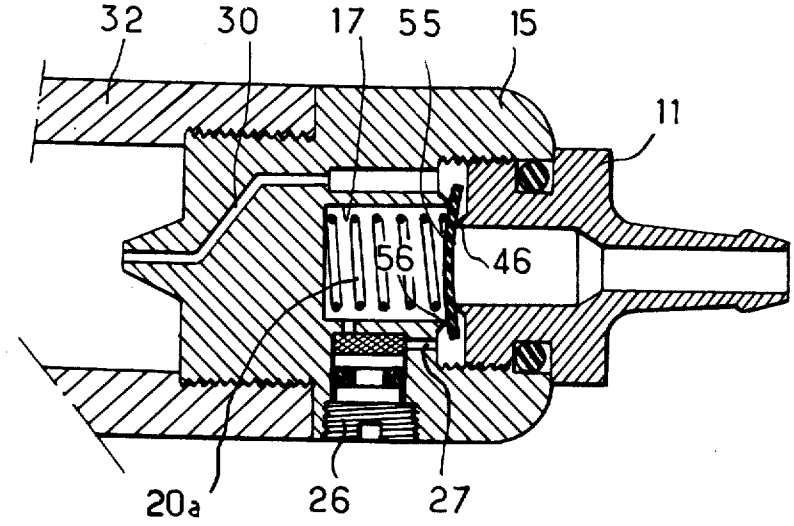
FIG. 1

FIG. 2



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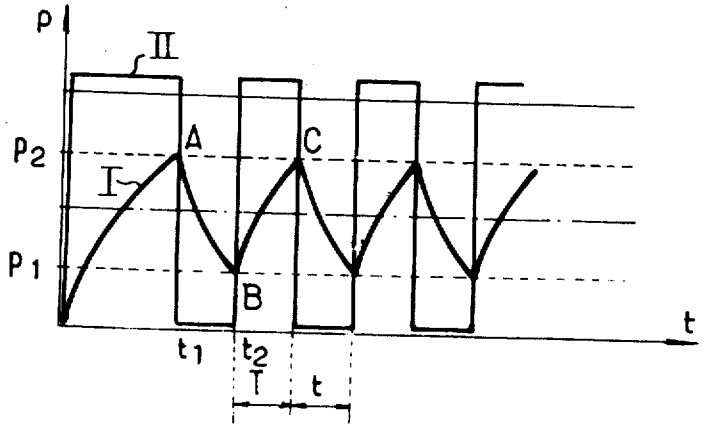

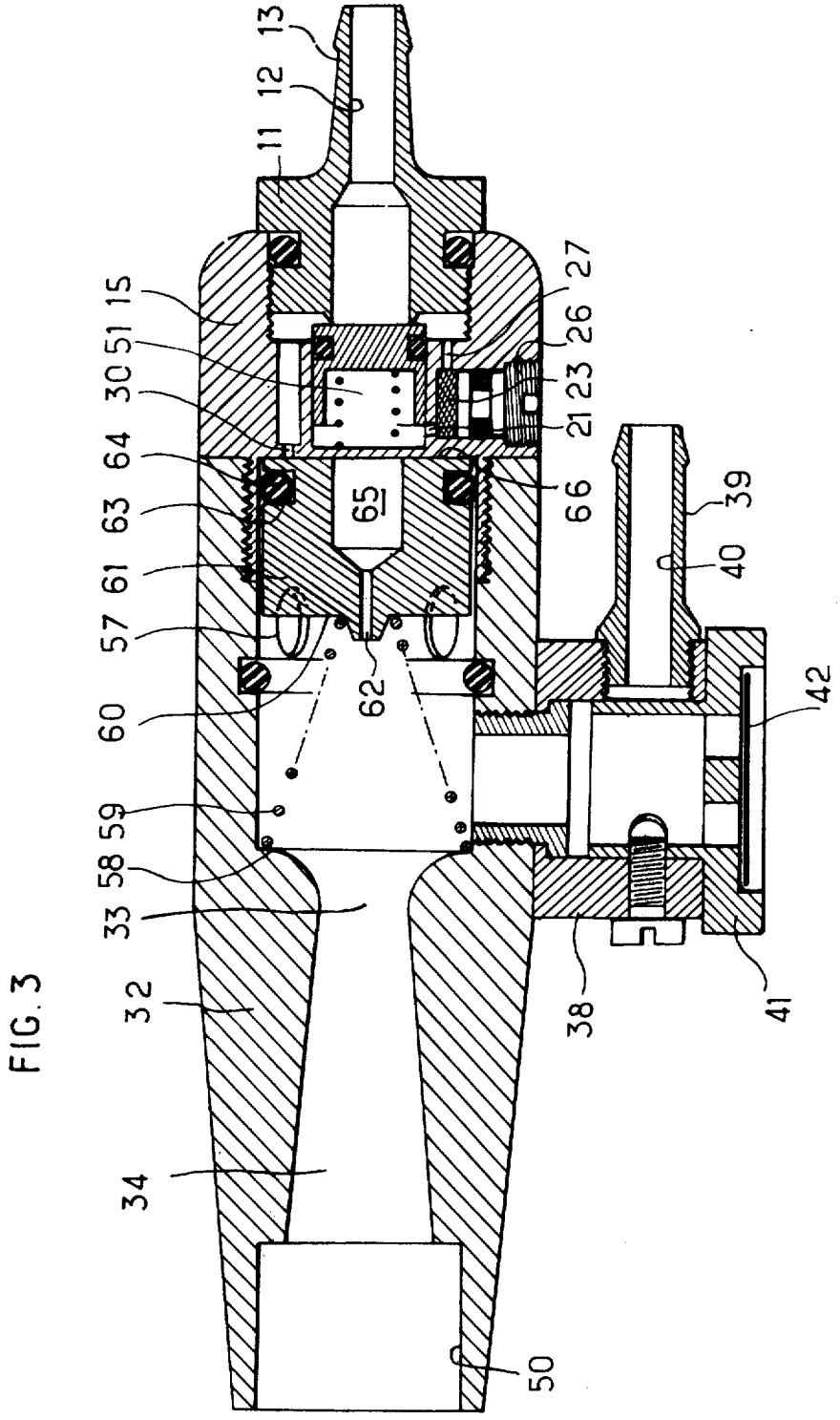
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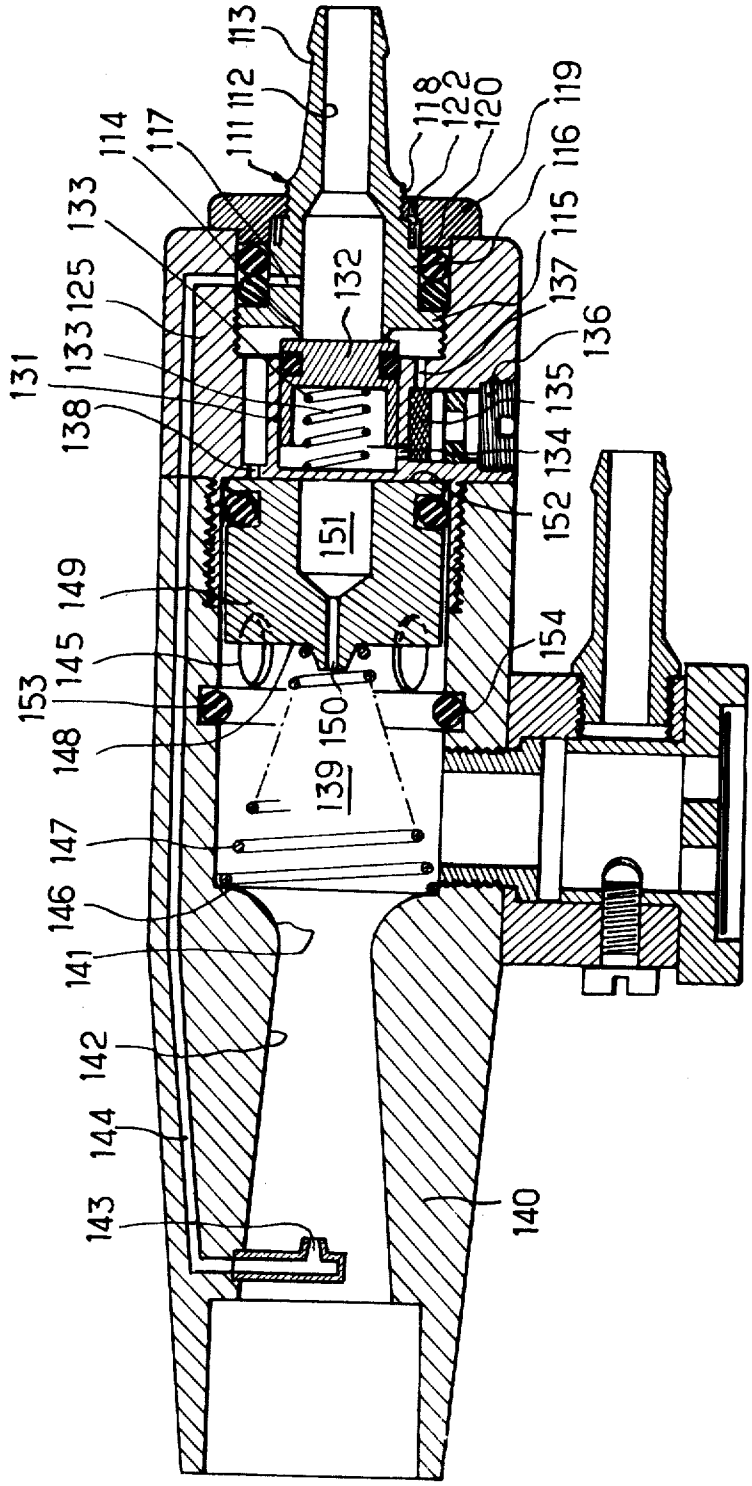
FIG. 3

FIG.5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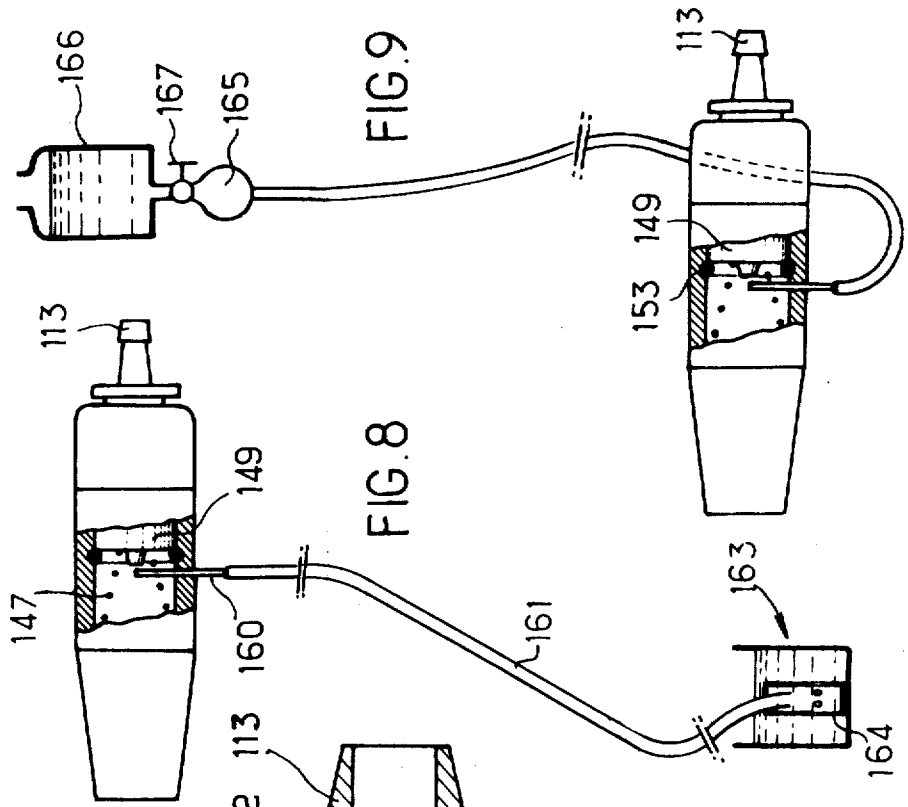

FIG. 9

FIG. 8

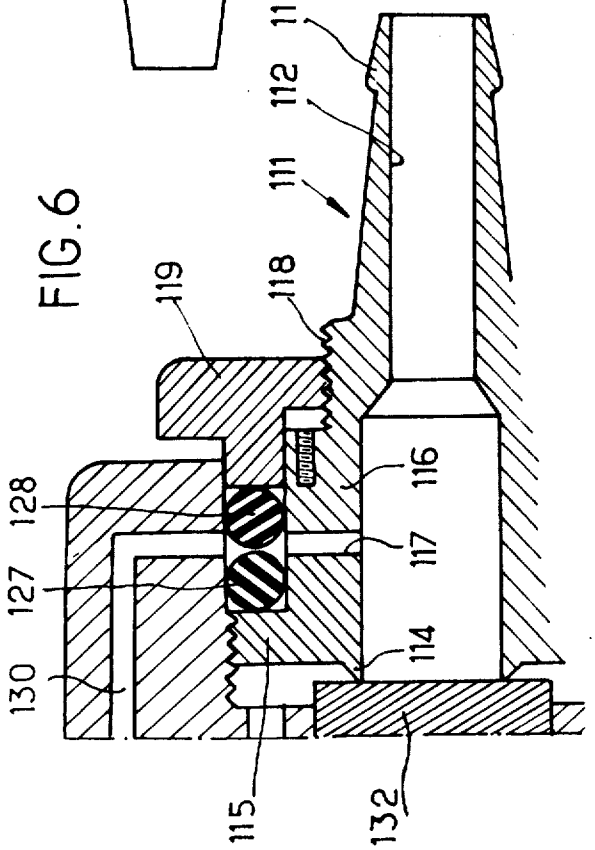

FIG. 6

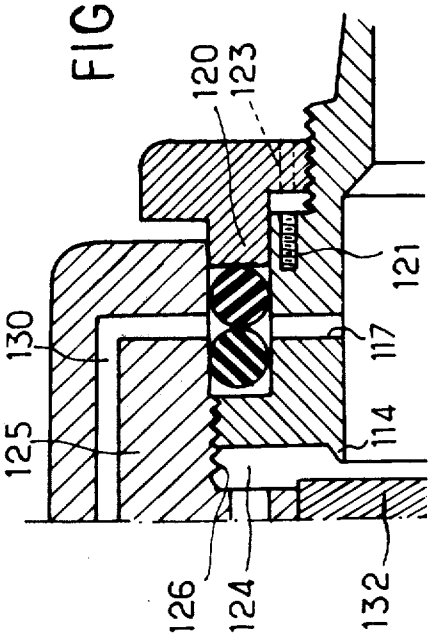

FIG. 7

FIG. 10

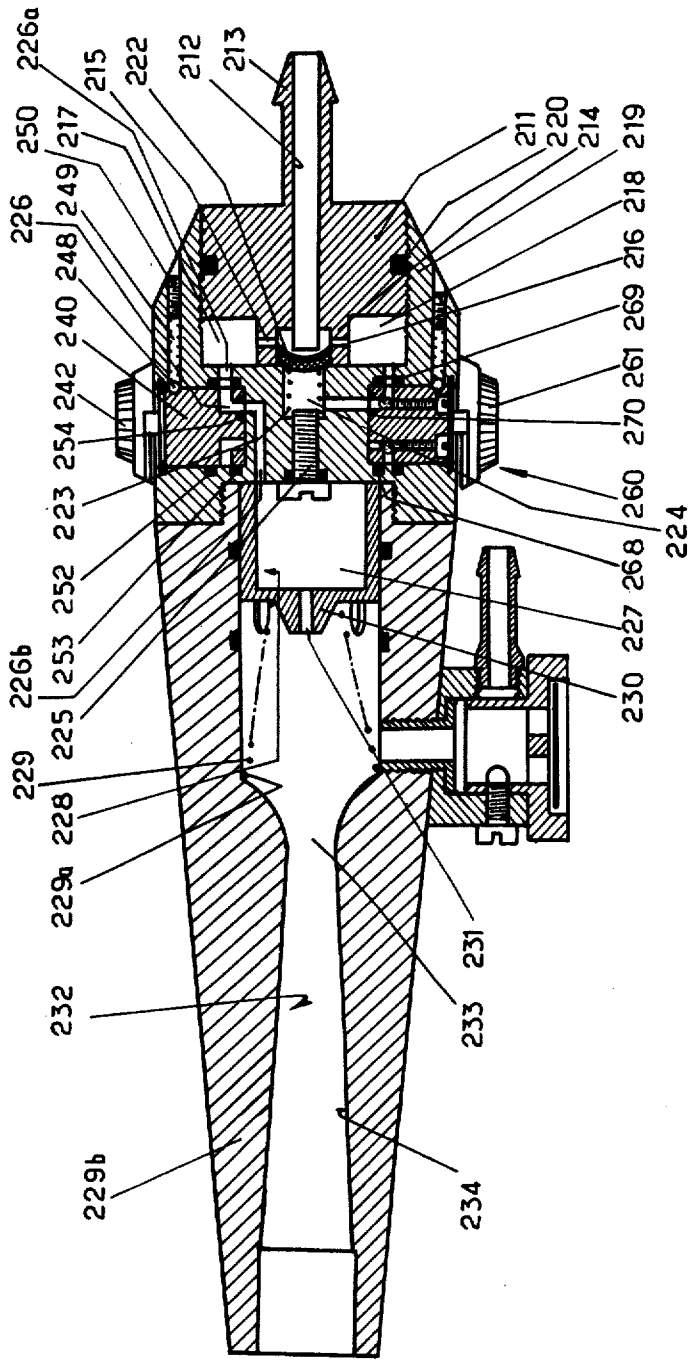
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FIG. 11

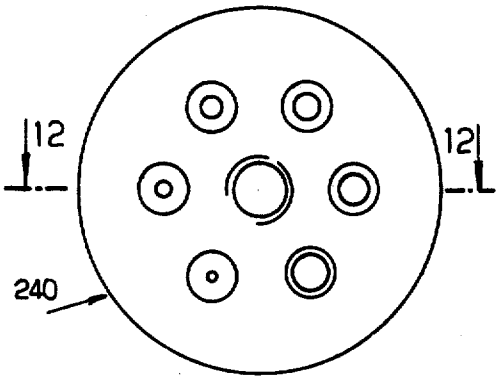


FIG. 13

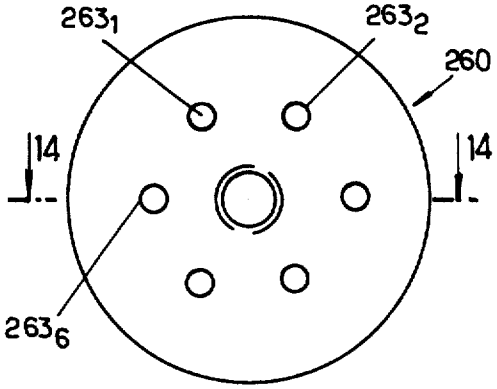


FIG. 12

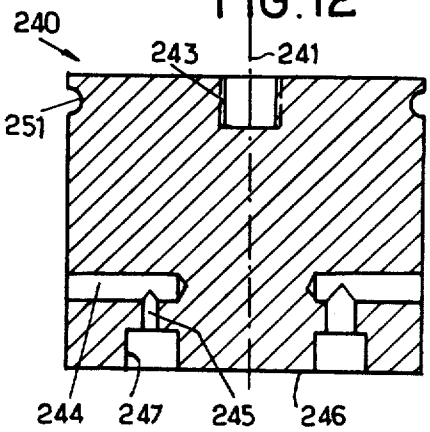


FIG. 14

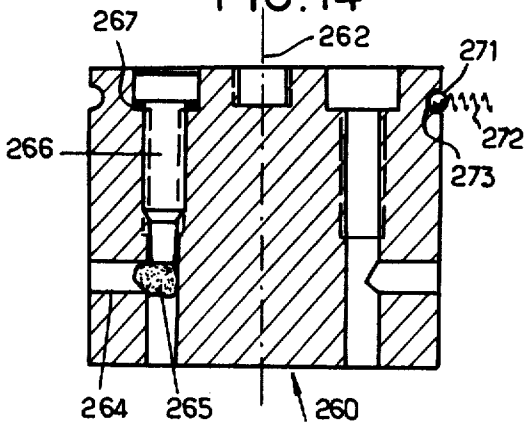
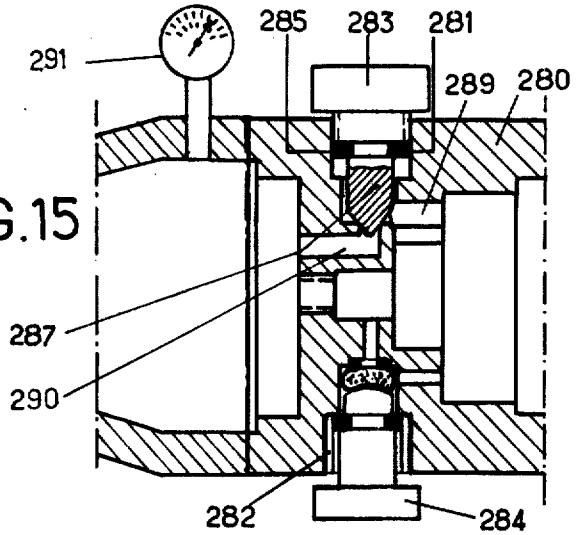


FIG. 15



BREATHING AID APPARATUS

The present invention relates to a breathing aid apparatus and concerns an apparatus suitable for ensuring the inhaling phase of the pulmonary breathing of a user whose breathing out phase is controlled by his respiratory muscles as well as an apparatus which, while ensuring the enhaling phase of the pulmonary respiration, assists the breathing out phase of said breathing.

Such apparatus as the operating power of which is provided by a source of compressed gas, advantageously the source of the gas to be blown into the patient's lungs, are already known. In these apparatus, means are provided for controlling the breathing cycle, i.e. the sequence of fresh gas insufflation and of ventilation of the breathing system ventilation periods, by means of pneumatic logic circuits.

However, owing to the relatively large number of components required for constituting the logic circuits, such as valves, fluid throttle means, etc., a relatively large apparatus is required and which is consequently difficult to transport, particularly in the case of first aid to the injured persons. In addition, the large number of components increases the cost of the equipment without increasing their reliability.

One general aim of the invention is to provide a breathing aid apparatus of particularly simple design, with a reduced number of components, and consequently of low cost, which remedies the drawbacks of known apparatus as particularly an apparatus of reduced dimensions which is thus well suited to a plurality of operating conditions.

It is also a purpose of the invention to provide such an apparatus for simply and reliably humidifying gases or a mixture of gases blown into the lungs of a user, as is for example necessary in the case of anaesthesia, and whose working parameters particularly frequency, flow rate and the ratio of the fresh gas insufflation time to the breathing out time of stale air in an elementary cycle, can be adjusted easily.

The breathing aid apparatus according to the invention, comprising an end piece suitable for connection to a source of pressurized gas to be blown into a patient's lungs, and means deriving their operating power from the gas source and a circuit in derivation form a said source in which is inserted an adjustable throttling means, for periodically connecting the gas source to the output of the device suitable for connection to the patient's pulmonary system, is characterised in that said means are constituted by a single automatic servo-controlled valve, the mobile member of which is subjected to an elastic force applied in the same direction as that of the pressure in the circuit in derivation.

The invention will be fully understood by means of the following description given for the purposes of example and with reference to the attached drawings wherein:

FIG. 1 represents a longitudinal cross-section of a first embodiment of a device according to the invention;

FIG. 2 is a part view analogous to that of FIG. 1 but for an alternative embodiment;

FIG. 3 is a view analogous to that of FIG. 1, but for another embodiment;

FIG. 4 is a graph;

FIG. 5 is a view analogous to that of FIG. 1, but for yet another embodiment;

FIG. 6 is a larger scale view of a part of the device represented in FIG. 5 for a first state;

FIG. 7 is a view analogous to that of FIG. 6 but for another state of the device;

FIG. 8 illustrates the functioning of means for humidifying gas blown by a device according to the invention;

FIG. 9 is a view analogous to that of FIG. 8, but for an alternative embodiment;

FIG. 10 is a view analogous to that of FIG. 1, but for yet another embodiment;

FIG. 11 is a top view on a large scale of a member of the device represented in FIG. 10;

FIG. 12 is a cross-section along line 12—12 of FIG. 11;

FIG. 13 is a top view of another member of the device represented in FIG. 10;

FIG. 14 is a cross-section view along line 14—14 of FIG. 13;

FIG. 15 is a part longitudinal cross-section of another embodiment of a device according to the invention.

First, referring to FIG. 1, the breathing aid apparatus according to the invention comprises a first end piece 11 with a longitudinal bore 12 the althrough having a cross-sectional area *s* and whose mouthpiece 13 is suitable for connection to a source of pressurized gas to be blown into the lungs of a patient, for example oxygen or a mixture of oxygen and another gas. At its end opposite that connected to the gas source, end piece 11 is shaped into a collar 46, or valve seat, surrounding bore 12 which emerges in a chamber 14 provided in body 15, screwed to piece 11 with a seal 16 interposed between pieces 11 and body 15. The central portion of body 15 comprises a cavity 17, extending from chamber 14, in which is mounted a piston 19 with a working face 47 having an area *S*, a seal 18 being interposed, the piston being biased by a spring 20 bearing against the bottom of cavity 17. A channel 21 emerges in the cavity and connects it to a radial chamber 22 of body 15 housing an element 23 causing a considerable pressure drop, such as a pellet of porous polyurethane foam or analogous material, acted upon by a compression piston 24 bearing a seal 25 and displaceable by the operation of a screw 26.

A channel 27 connects the chamber 14 to chamber 22 and a longitudinal through bore 30 of body 15 connects chamber 14 to a chamber 31 provided in a body 32, screwed onto body 15, and shaped to form a venturi with a neck 33 and flared portion downstream from chamber 31 in the direction taken by the gas (arrow *f*) flowing from the pressurized gas source towards the patient.

A sleeve 38 is attached to the wall of body 32 by means of an internal thread 37 and a screw 35 having a longitudinal through bore 36; a mouthpiece 39 is integral with said sleeve and possesses a longitudinal bore 40 suitable for connection to a source of gas different from that introduced through mouthpiece 13, for example air or anaesthizing gas. A needle type device 41 is rotatably mounted in sleeve 38 for interconnecting chamber 31, as desired with the gas source suitable for connection to mouthpiece 39.

The lower portion of needle device 41 is provided with a non return valve 42 opening outwardly for decompressing chamber 31 if necessary by discharge into the atmosphere.

The device according to the invention functions as follows:

After connecting to mouthpiece **13** a pipe **48** the other end of which is connected to a pressurized gas source **49,** for example a cylinder of compressed oxygen, which is reduced to a pressure *P*, the outlet **30** of body **32** is connected to the pulmonary system of a patient whose breathing said device is intended to ensure, the means for connection between outlet **50** and the pulmonary system being of any suitable known type, for example a mask, a cannula, a tube or analogous device.

In a first mode of use, connection between chamber **31** and bore **40** of mouthpiece **39** is cut off by the needle device **41** and, in the initial state, the spring **20** presses face **47** of piston **19** against collar **46.** The relative pressure *P* in bore **12,** together with the relative pressure *p* in chamber **51,** defined by cavity **17** and piston **19,** are zero. When gas cylinder **49** is opened, a relative pressure *P* is set up in bore **12** and the forces then acting upon the piston are, on the one hand, that set up by spring **20,** having a value R, which tends to maintain piston **19** against collar **46** and, on the other hand, that of value *Ps* tending to displace piston **19** in the direction of arrow *f*.

If a value below *Ps*, for example *Ps*/**2,** is selected for the force *R* applied by spring **20,** the pressure against face **47** is larger and piston **19** is displaced in the direction of arrow *f* against the bias of spring **20** which is compressed. The gas from cylinder **49** fills chamber **14** in which the pressure is equal to *P;* the gas then flows from cylinder **49** through conduit **30,** chamber **31** flared portion **34** to the patient's pulmonary system, the gas flow rate being a function of the inside cross-section of conduit **30** which is here precalibred and, if necessary, can be adjusted by a variable throttle means such as a needle valve. Simultaneously, owing to the pressure differences in chambers **51** and **14,** there is a flow of fluid between said chambers through channel **27,** pressure drop member **23** and conduit **21.** By analogy with the law whereby a current is set up in an electric circuit comprising a resistor and a capacitor (the volume of chamber **51** corresponding to an electric capacitor and element **23** causing a high loss of charge corresponding to an electrical resistor), pressure *p* in chamber **51** increases from zero value to a value p_2 in accordance with a substantially expenential law, whose parameters depend on volume *V* in chamber **51** and the resistance to the flow of fluid through compressed porous pellet **23,** this resistance being adjustable by operating screw **26.**

When the pressure *p* in chamber **51** reaches the value p_2 such that:

$$Sp_2 + R = SP$$

i.e. for a value:

$$p_2 = P - \frac{R}{S}$$

piston **19** is displaced in the opposite direction to that represented by arrow *f* and face **47** comes into contact with collar **46,** blocking bore **12.** The flow of fluid through bore **30** is then cut off, and the device does not supply the patient with gas. The pressure is zero in chamber **14** and gas then circulates between chambers **51** and **14** through channel **21,** the porous pellet **23** and channel **27,** this circulation decreasing pressure *p* from value p_2 previously reached at moment t_1 to a pressure value p_1 reached at moment t_2 and such that:

$$p_1 S + R = sP$$

i.e.

$$p_1 = \frac{sP}{S} - \frac{R}{S}$$

Owing to this pressure value in chamber **51,** the pressure acting on face **47** of piston **19** again becomes preponderant and piston **19** is displaced in the direction of arrow *f*, unblocking the outlet of bore **12,** reconnecting the gas supply to the patient and triggering a cycle analogous to the one above described.

Curves I and II respectively in FIG. **4** represent the variations in pressure and instantaneous flow of gas blown into the lungs of the patient, in a graph the abscisses of which is the time axis and the ordinate of which is the pressure and flow axes.

Time *T* during which the gas from source **49** is blown into the lungs of the patient, on one hand, and time *t* during which communication between the source and the patient is cut off, on the other hand, as well as the frequency of the respiratory cycle and the flow rate for gas blown in, can be determined, for a given pressure value *P*, by suitable selecting the force *R* of spring **20,** the resistance to fluid flow afforded by pellet **23,** the cross-section of bore **30** and the surface to surface ratio *S*/*s* of the working surfaces of piston **19** and bore **12.** Thus, if the following ratio is chosen:

$$\frac{s}{S} = \frac{1}{2}$$

and a value of *R* is selected equal to *PS*/4, times *T* and *t* are equal, pressure p_1 being equal to *P*/4 and pressure p_2 equal to 3*P*/4.

During the phases of the cycle corresponding to portions AB of curve I in FIG. **4,** i.e. during the patient's expiratory phase, the stale air escapes from the device through non-return valve **42.** The invention here exploits the fact that, owing to the relatively high velocity of the gases at the outlet of bore **30** into chamber **31,** a depression is set up upstream of neck **33,** in relation to the gas flow direction represented by the arrow *f* and, if said depression is regulated to a value of the order of 30 mb by appropriately selecting the dimensions of the constituent members of the device, the requisite security means for artificial respiration devices in order to avoid pulmonary overpressure in the case of an excessive blown gas rate, or obstruction of the respiratory canals, are obtained, valve **42** becoming operative for a pressure of over 30 mb at outlet **50** of the device. In another mode of use of the device according to the invention, needle member **41** fully or partially opens the outlet of bore **40** of mouthpiece **39** communicating with the atmosphere, thus providing the mixture in a given proportion of gas from source **49** and ambiant air then drawn in by the depression obtaining in chamber **31.**

In yet another mode of use, a source of anaesthizing gas, for example a container supplied with a suitable gas at a known flow rate, is connected to mouthpiece **39** and it is then a mixture of gas from source **49** and

gas from the container connected to mouthpiece **39** which is blown into the lungs of the patient.

In the embodiment represented in FIG. **2**, which is designed and functions in an analogous manner to that of FIG. **1**, piston **19** is replaced by a membrane **55** bearing on the one hand, against a collar **56** surrounding the outlet of cavity **17** and, on the other hand, against collar **46** surrounding the outlet of bore **12**, a spring **20***a* being interposed between membrane **55** and the bottom of cavity **17**.

In the embodiment represented in FIG. **3**, in order to provide additional security, body **32** is provided with orifices **57** and, substantially at right angles to neck **33** of the venturi, a shoulder **58** against which bears the extremity of a spring **59** the other extremity of which cooperates with the face **60** of a piston **61**, a groove **63** of which is provided with a seal **64**. This piston has a bore **62** therethrough connected to a cavity **65** emerging on face **66** of piston **61** opposite bore **30** of body **15**. In this embodiment, in the state wherein gas flow is cut off between source **49** and the patient, spring **59** maintains piston **61** away from holes **57**, so that the patient can, if necessary breathe freely through these holes. In the inhaling phase, actuated by the device, the pressure exerted on face **66** of piston **61** overcomes the bias of spring **59**, so that piston **61** is displaced towards neck **33** of the venturi, blocking holes **57**; the device then functions in an analogous manner to that of the embodiment represented in FIG. **1**. In this embodiment, the switch-over to natural spontaneous breathing on the part of the patient can be made without disconnecting the device simply by cutting off gas supply, so that a failure or an accidental interruption of supply does not entail the risk to see the patient's pulmonary system cut off.

Reference is now made to FIGS. **5** to **7** concerning an embodiment of an breathing aid apparatus suitable, not only for ensuring the inhaling phase of pulmonary respiration, but also for assisting the breathing out phase.

In this embodiment, the device comprises an end piece **111** having a longitudinal bore **112** therethrough whose mouthpiece **113** is suitable for connection to the source of pressurized gas to be blown into the lungs of a patient. The extremity of piece **111** remote from mouthpiece **113** is shaped to form a collar **114**, or a valve seat, adjacent to a flange **115** having a threaded periphery connected to mouthpiece **113** by a sleeve **116** with a smaller outside diameter than flange **115** and which has a radial through bore **117**. At the extremity of sleeve **116** adjacent to mouthpiece **113**, one portion of the outer face of piece **111** comprises a thread **118** engaging with the internal thread of a ring **119**, which is advantageously knurled, comprising an annular collar **120** whose internal diameter is substantially equal to that of sleeve **116** and whose external diameter is substantially that of flange **115**. In order to adjust the position of ring **119** in relation to piece **111**, the latter comprises tapped blind holes **121**, (FIG. 7), distributed in a ring coaxial with piece **111** and with which screws A **122** passing through coaxial bores **123** of ring **119** are suitable for cooperating.

At its extremity adjacent to collar **114**, bore **112** emerges in a chamber **124** provided in a body **125** assembled to piece **111** by screwing flange **115** in a tapped bore **126** of body **125**. Two O-rings **127** and **128** being interposed between sleeve **116** and said body opposite the outlet of a through channel **130** of body **125** facing the outlet of bore **117** of piece **111**. In its central portion, body **125** is shaped to form a cavity **131** in which is mounted a piston **132**, a seal being interposed, the piston being biased by the action of a spring **133** bearing against the bottom of the cavity in which emerges a channel **134** connecting it to a radial chamber of body **125** containing an element **135** causing a considerable pressure drop, such as a pellet of porous polyurethane or analogous material, which is subjected to the action of a compression piston that can be displaced by operating a screw **136**.

A channel **137** connects a chamber **124** to the radial chamber of body **125** and a bore **138** connects chamber **124** to a chamber **139** provided in a body **140** prolonging body **125** to which it is screwed and which is shaped to form a venturi with a neck **141** and a flared portion **142** downstream from chamber **139**, in the direction in which gas from the pressurized gas source flows towards the patient. At the downstream extremity of flared portion **142**, in the flow direction above defined, is located a nozzle **143** whose calibrated orifice, which is substantially aligned with the axis of the device, communicates with a bore **144** of body **140** prolonging channel **130** of body **125**.

Chamber **139** is provided with orifice **145** and, substantially at right angles to the neck **141** of the venturi, a shoulder **146** supports the extremity of a spring **147** whose other extremity engages the face **148** of a piston **149** housed in said chamber and pierced by a bore **150** communicating with a cavity **151** which emerges on face **152** of the piston opposite bore **138** of body **125**.

In body **140**, beyond orifices **145** in the direction of gas circulation from the source towards the patient, a recess **153** houses an O-ring **154** projecting on the internal wall of chamber **139**.

In the state represented in FIG. **5**, ring **119** is adjacent to body **125** and collar **120** presses O-rings **127** and **128** together, thus preventing any gas flow from the pressurized gas source through channel **117**; the device functions in an identical manner to that of the embodiment represented in FIG. **1** or FIG. **3**.

If it is also desired to assist the breathing or ventilation phase of the pulmonary system, ring **119** is unscrewed in order to be spaced from body **125** by an adjustable predetermined distance as represented in FIGS. **6** and **7**.

During the patient's inhaling phase, piston **132** is removed from collar **114**, (FIG. 7): chamber **124** is at the pressure of the gas source connected to end **113** and, owing to the non-sealing screw assembly of piece **111** to body **125**, this pressure applies a greater force on O-ring **127** than that applied by the pressure obtained in conduit **117**, so that O-ring **127** is pressed in sealing engagement against O-ring **128** abutting collar **120**. Channel **130** does not communicate with the pressurized gas source. and the inhaling phase takes place as with the apparatus of the previous embodiments.

During the expiratory phase, piston **132** is in contact with collar **114** and chamber **124** is no longer connected to the gas supply source (FIG. **6**). Under the effect of the pressure obtaining in bore **117**, O-ring **127** comes into contact with flange **115** and O-ring **128** remains in contact with flange **120** whose face opposite flange **115** is at a precisely predetermined distance from said flange, so that there is a pressure drop in the gas circulating between bore **117** and channel **130**. The gas from the pressurized gas source is then sent through

bore **117**, channel **130** and bore **144** to nozzle **143** which circulates it through venturi **141**, this circulation setting up a depression which brings about and favours the ventilation phase of the pulmonary system of the patient to whom the device is connected. This device then ensures, successively, the inspiratory and expiratory phases of pulmonary respiration.

According to the invention, prevision is also made for humidifying the gas blown into the lungs of the patient, by disposing, downstream from O-ring **154** — in the flow direction of the gas from the pressurized gas source towards the patient—and in the vicinity of the axis of bore **150**, a capillary tube **160**, (FIG. **8**), connected by a hose **161** to a liquie container **163**, which, in its most simple form, is a glass in which the extremity of a tube provided with a strainer **164** is immersed. The high speed accurately located gas flow from bore **150** pulverizes the humidifying liquid in a quantity depending on the height between the output of capillary tube **160** and collector **163** to create a fine spray of humidifying liquid particles in the blown gas, as required, for example, when anaesthizing or carrying out analogous operations.

In the embodiment according to FIG. **9**, the extremity of hose **161** remote from capillary tube **160** is not immersed in a humidifying reservoir but is connected, for example, by a chamber **165**, communicating with a dropping bottle **166**, a valve **167** being interposed. Bottle **166** may then be disposed above the respiratory device and, by adjusting with valve **167**, the number of drops supplied for each inspiration is determined for precisely dosing the quantity of liquid to be sprayed.

Reference is now made to FIGS. **10** to **14** concerning another embodiment of a device according to the invention, which, for clarity, is represented as a device of the same type as that in FIG. **2**, but which may be of the type represented in FIG. **5**.

The device according to this embodiment comprises an end piece **211** having a longitudinal bore **212** therethrough which also runs along mouthpiece **213** suitable for connection to the source of pressurized gas to be blown into the lungs of a patient. At its extremity opposite that connected to the pressurized gas source, piece **211** is shaped to form a sleeve **214** pierced by two radiating bores **215** and **216** which emerge respectively in chambers **217** and **218** provided between the outer periphery of sleeve **214** and the interval surface of member **219**, screwed to piece **211**, a seal **220** being interposed. Substantially opposite sleeve **214**, member **219** provides a seat **221** for a membrane **222** housed in said sleeve and biased by spring **223** bearing against the bottom of a chamber **224**, the force of the spring being adjustable by means of a screw **225**.

Chamber **217** communicates through a channel **226** with the internal chamber **227** of a tubular piston **228** the bottom **230** of which is pierced by a bore **231** and which is biased by the action of a spring **229** which bears against a shoulder **229***a* of an mouthpiece **229***b* integral by screwing with member **219** and which comprises a venturi **232** with a neck **233** and flared portion **234** the extremity of which is suitable for connection to the pulmonary system of a patient by any appropriate means.

Channel **226** is, in fact, constituted by three portions end to end, two of which **226***a* and **226***b* are provided in member **219** and which are suitable for interconnection by a third portion provided in barrel member **240**, (FIGS. **10**, **11** and **12**), rotatably mounted about its axis **241** in member **219**, O-rings **252**, and **254** being interposed. The body of barrel member **240** possesses a blind hole **243** for attaching a knurled operating button **242** and it comprises, for putting the two portions **226***a* and **226***b* of channel **226** in communication, a certain number of passages at right angles (**6** in the example represented) each comprising (FIG. **12**), a radial arm **244** in which emerges a longitudinal arm **245** extended, on the end face **246** of the barrel member, by a forward hole **247**. As represented in FIG. **11**, the arms **245**, uniformly distributed angularly about axis **241**, have different predetermined diameters for supplying six different blowing rates for the same supply pressure. Each of the flow rates is read off a graduated annular zone surrounding operating button **242**, provided with an index, the precise location of each of its six positions being ensured by a snap-locking means such as a ball **248** suitable for cooperating with semi-circular grooves **251** in the barrel body against which bears a spring **249** the force of which can be adjusted by means of a screw **250**.

An apparatus somewhat analogous to that described above for controlling the blowing rate is provided for controlling the blowing frequency, i.e. the number of breathing cycles per minute. As represented in FIGS. **10**, **13** and **14**, the blowing frequency control means comprise a barrel member **260** with an *x* axis **262** and a control button **261** pierced by bores, six in the example represented, uniformly disposed angularly about said axis and represented at 263_1, 263_2, etc . . . 263_6. In each of bores **263** emerges a radial bore **264** for connecting chamber **218** with cavity **224**, a member **265** causing a high pressure drop being interposed in the junction zone of each bore **263** and **264** associated therewith. Member **265** is, for example, a pellet of porous polyurethane foam or teflon material, compression of which is adjustable by means of a needle screw **266** bearing an O-ring **267** and cooperating with an internal thread of bore **263**.

O-rings **268**, **269** and **270** contribute to tight communication between chamber **218** and cavity **224**.

In a manner analogous to that described above in connection with the blow rate control barrel, a ball **271** biased by a spring **272** is suitable for cooperating with grooves **273** of the body of barrel **260** for precisely locating it in one of the six positions corresponding to the six bores **263** to each of which is attributed a frequency that is predetermined and preset in the workshop by actuating needle screw **266** on member **265** with which it cooperates. By suitably adjusting needle screw **266**, it is possible, for example, to attribute to bores **263** values of 15, 20, 25, 30, 40, 50 cycles per minute.

FIG. **15** represents another embodiment of the device according to the invention wherein the flow control means and the blowing frequency control means are continuously adjustable, means being provided on the unit for displaying the real blowing rate and frequency at any moment.

In this embodiment, body **280** of the device possesses tapped bores **281** and **282** with which blowing rate and frequency adjusting screws **283** and **284** respectively cooperate. Screw **283**, which is provided, in a shoulder formed by its body, with a sealing O-ring **285**, is pierced by a longitudinal hole **287** which emerges in a diametral bore **288** for setting a channel **289** connected to the source of pressurized gas to be blown, not represented,

in communication with the chamber of an annular piston, also unrepresented, whose role analogous to that of piston **228** of the previous form of embodiment. Said chamber is connected, by means of a pneumatic circuit in which is inserted an non-return valve and adjustable pressure release means, to a pressure gauge **291** which continuously displays the flow rate of gas blown in accordance with the pressures obtaining in said chamber.

Screw **284**, interposed between a cavity and a chamber analogous to cavity **224** and chamber **218** in the previous embodiment, enables the blowing frequency to be continuously adjusted by greater or lesser compression of an element causing a high pressure drop analogous to that represented at **265** in FIG. **14**. This embodiment functions as follows:

The flow rate for gas to be blown set at a given value, for example 10 liters per minute, by operating screw **283**, is displayed on the pressure gauge **291** during the inhaling phase during which the source of pressurized gas communicates with the user's pulmonary system. When, through actuating the periodic flow device, communication between the pressurized gas source and the user is cut off, the pressure displayed by pressure gauge **291** decreases progressively owing to the presence of the non-return valve and the escape means provided on the circuit interconnecting the pressure gauge and the piston chamber, until a new inspiratory phase begins which again causes said pressure gauge to display the flow rate regulated by means of screw **283**. The displayed flow rate again decreases when the inhaling phase ceases and the oscillating flow rate indication resistered by the pressure gauge, which is representative of the blowing frequency, can be indicated on an appropriate scale of the pressure gauge which then simultaneously and continuously indicates both blowing frequency and rate.

I claim:

1. An artificial respiration apparatus comprising:

a tip connectable to a source of gas under pressure, said tip including a bore hole;

a valve seat at the end of said bore hole facing away from the source;

an outlet connectable to the respiratory system of a patient; and

means for controlling the flow of gas permitting it to pass from the source of gas to said outlet during the inhalation phase of the patient but preventing said flow during the exhalation phase of the patient, said means comprising a movable valve member cooperating with said valve seat to close said bore hole, a spring cooperating with said movable valve member and biasing the same against said valve seat, a housing including a first chamber communicating with said source of gas and also with said outlet when the moving valve member is not in contact with the valve seat; and a second chamber in which said spring is housed, one wall of said second chamber being formed of said movable valve member, channel means causing said first chamber and said second chamber to communicate with each other, a pellet of porous material disposed in said channel means, said pellet introducing a loss of pressure in the channel means; and a pressure screw cooperating with said pellet for varying the compression thereof, variation of the compression of the pellet permitting adjustment of the flow of gas between said first and second chambers.

2. The apparatus according to claim **1** wherein said outlet is formed by the throat portion of a venturi, the apparatus further comprising a nozzle between said outlet and a neck portion of the venturi, said nozzle having an orifice directed towards said neck portion, a channel connecting said nozzle to said bore hole, and means interposed in said channel for selectively interrupting and establishing pneumatic communication between said bore hole and said nozzle, said means including an annular third chamber of adjustable length surrounding said bore hole, a displaceable member defining one of transverse walls of said third chamber for modifying the length thereof, and two toroidal gaskets in said third chamber, said gaskets being movable by the action of pressure forces, placement of said two gaskets in contact with each other interrupting said pneumatic communication when said movable valve member is out of engagement with said valve seat, said communication being open when said movable valve member is in engagement with said valve seat whereby a flow of gas in the direction opposite that during the inhalation phase is established in the venturi during the exhalation phase.

3. An artificial respiration apparatus comprising:

a tip connectable to a source of gas under pressure, said tip including a bore hole;

a valve seat at the end of said bore hole facing away from said source, the axis of said valve seat being coaxial with the axis of said bore hole;

an outlet connectable to the respiration system of a patient; and

means for controlling the flow of gas, said means permitting the gas flow to pass from the source of gas to said outlet during the inhalation phase of the patient but preventing said flow during the exhalation phase of the patient, said means including a servo-controlled valve, said valve comprising a movable member cooperating with said valve seat, elastic means biasing said movable member toward said valve seat to close said bore hole in response to the action of said movable member being subjected to the pressure of gas from said source of gas and to the action of a differential pressure acting in the same direction as the elastic means, said differential pressure being obtained from said source of gas by means introducing an adjustable loss of pressure in a flow circuit provided between said valve seat and the face side of the movable member upon said elastic means acts.

4. The apparatus according to claim **3** wherein said elastic means is a spring, the apparatus comprising further means for adjusting the force developed by said spring, said spring force controlling the ratio of the duration of engagement of said movable valve member with said valve seat relative to the duration of non-engagement of said movable valve member with said valve seat.

5. The apparatus according to claim **3** wherein said movable valve member comprises a piston tightly slidable in a further chamber, said elastic means being disposed in said further chamber, and said flow circuit including said means for introducing an adjustable loss of pressure discharges into said further chamber.

6. The apparatus according to claim **3** wherein said movable valve member comprises a deformable diaphragm forming an end wall of a further chamber in which said elastic means is disposed and into which dis-

charges said flow circuit including said means for introducing an adjustable loss of pressure.

7. The apparatus according to claim 3 further comprising:

a. means for controlling the flow of gas fed to the patient, said means being interposed between said bore hole and said outlet and including a first rotary barrel having a plurality of channels of different cross-sectional area, a member for setting said barrel and means for indexing the position of the barrel in order to adjust the flow to a value selected from among a plurality of predetermined values; and

b. means for controlling the number of phases of inhalation per unit of time, said means comprising a second rotary barrel interposed in said flow circuit and provided with a plurality of means for introducing an adjustable loss of pressure, an operating member, and means for indexing the position of said second barrel so that said number of phases of inhalation per unit of time is adjustable to a value selected from among a plurality of predetermined values.

8. The apparatus according to claim 3 further comprising a non-return valve disposed between said bore hole and said outlet, and an adjustable leak means for adjusting the flow through said non-return valve.

9. The apparatus according to claim 3, comprising further a chamber disposed in the gas flow and having a venturi neck upstream in the direction of flow of the gas from the source of gas towards said outlet, a thin capillary tube; a tank of liquid for moistening the gas coming from the source of gas, and a connection connecting said tank to said tube the discharge end of which into the apparatus is substantially flush with the axis of said venturi neck so that the flow of gas coming from said source obtains a high speed atomizing said liquid thereby producing a fine mist of liquid particles in the gas fed to the patient.

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