United States Patent

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[54] THERAPEUTIC INTERMITTENT POSITIVE PRESSURE RESPIRATOR

6 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **128/145.5,** 128/194, 128/201, 128/208, 137/102
[51] **Int. Cl.** **A62b 7/00**
[50] **Field of Search** ..... 128/145.5-145.8, 201, 203, 208, 185, 194; 137/63(R), 64, 102

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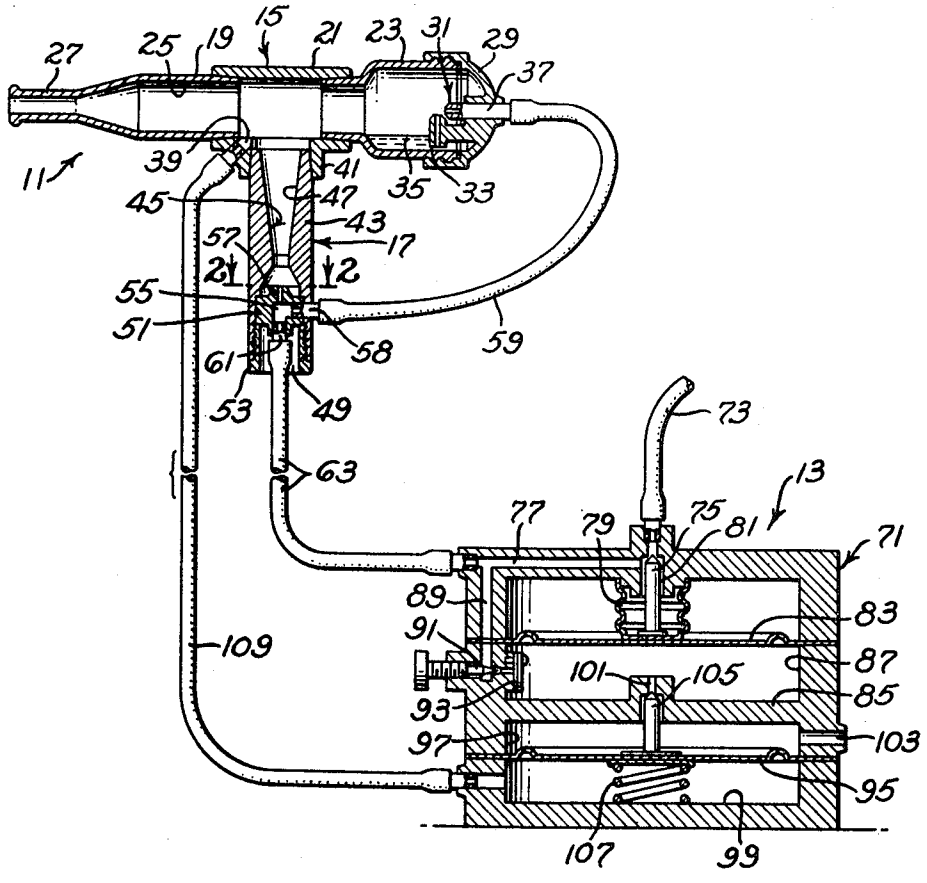
ABSTRACT: An intermittent positive pressure breathing device. A handheld respirator for connection to a pressure source by a flexible line and providing for manual control by the patient or automatic control by the inspiration of the patient. A bistable pressure valve controlled by the start of inspiration for regulating air flow.



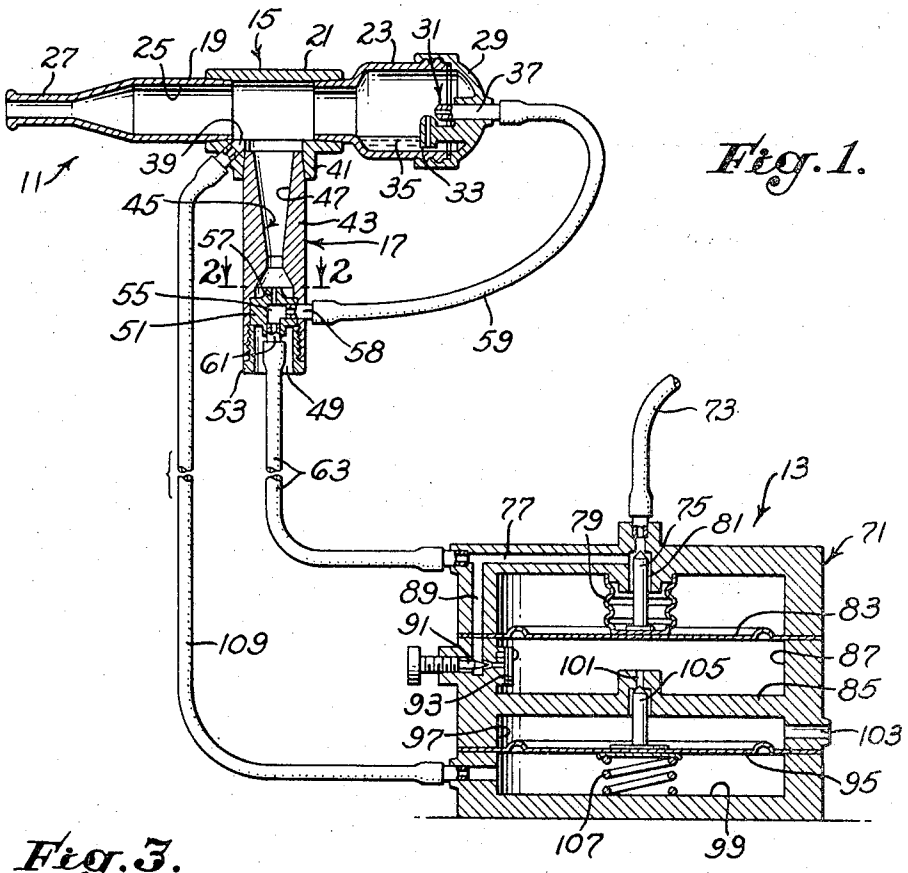


Fig. 1.

Fig. 3.

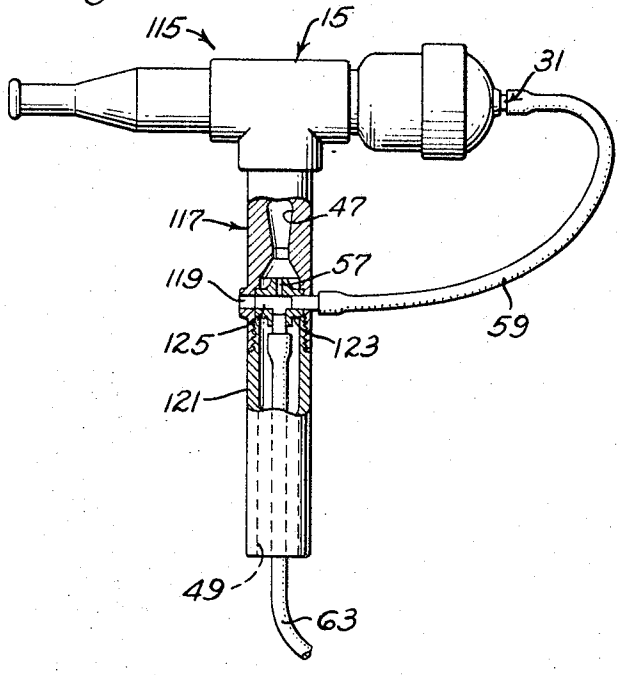
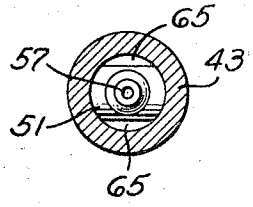


Fig. 2.



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THERAPEUTIC INTERMITTENT POSITIVE PRESSURE RESPIRATOR

This is a continuation application of application Ser. No. 531,933, filed Mar. 4, 1966, for Therapeutic Respirator, now abandoned.

This invention relates to a therapeutic respirator and more particularly to a compact handheld respirator.

Many persons who suffer from various respiratory illnesses or defects require at least periodic assistance in breathing. Conventional respirators are quite bulky, complex, and expensive. The air supplied by these respirators comes entirely from a remotely located machine. This air is then forced through large diameter, cumbersome hoses to the mask worn by the user.

Accordingly, an object of this invention is to provide a compact and inexpensive respirator of simple construction in which the large diameter, cumbersome hoses are not required.

Another object of this invention is to provide a respirator which can be held by hand during use.

A further object of this invention is to provide a handheld respirator into which atmospheric air is directly induced.

Another object of this invention is to provide a handheld respirator into which air is directly induced and which will supply medication from a reservoir contained therein to the patient.

Another object of this invention is to intermittently interrupt the flow of primary air to the handheld respirator thereby causing intermittent induction of secondary or atmospheric air into the respirator.

A further object of this invention is to provide a respirator in which the quantity of air in each pulse of air and the interval between each pulse of air can easily be varied over a wide range.

It is an object of this invention to interrupt the flow of primary air to the respirator by bleeding such primary air directly to the atmosphere. More particularly, an object of this invention is to provide conduit means for supplying the primary air to the respirator and aperture means in the conduit means for bleeding fluid from the conduit means to prevent operation of ejector means. In actual operation, the aperture means is formed in the handle of the respirator and may be opened and closed by the finger of the user to thereby provide complete control as to the amount of air in each pulse and the time interval between each pulse of air.

Another object of this invention is to automatically vary the time interval between each pulse of air supplied to the user in response to the breathing requirements of the user. A particular object of this invention is to provide a respirator including a body having a mouthpiece sized for insertion into the mouth of a user, the body having a passageway therein exposed at the mouthpiece, and ejector means for inducing atmospheric air into the passageway of the body and through the mouthpiece of the user. The ejector means may include a tube secured to the body and having an ejector passage therein communicating with the passageway of the body, the ejector passage being open to the atmosphere to define an induced air inlet. The ejector means induces air through the induced air inlet into the ejector passage. The ejector means is connectible to a source of primary fluid under pressure and is operable in response thereto. The programming of the respirator may be controlled by an aperture in the conduit means which supplies the primary fluid to the ejector means. Alternatively, the programming of the respirator may be accomplished by an automatic valve which is responsive to the breathing cycle of the user.

The invention, both as to its organization and the method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawing in which:

FIG. 1 is a longitudinal sectional view through one embodiment of the respirator and automatic regulator therefor;

FIG. 2 is a sectional view taken along line 2–2 in FIG. 1 and shows the insert and induced air ports of the ejector; and

FIG. 3 is a side elevational view partially in section of another embodiment of respirator.

Referring to the drawing and in particular to FIG. 1 thereof, reference numeral 11 designates a handheld respirator which is controlled by a bistable regulator or valve 13. The respirator 11 includes a body 15 with an ejector 17.

The body 15 is elongated and includes a mouthpiece 19, a mixing chamber 21, and a reservoir or nebulizer 23. A passageway 25 is exposed at the outlet of the mouthpiece 19 and interconnects the mouthpiece and the reservoir 23. In the embodiment illustrated, the mouthpiece 19 and the reservoir 23 are formed separately and secured to the mixing chamber 21 in axial alignment therewith as illustrated. If desired, these three pieces may be integrally formed. The mouthpiece 19 has an end portion 27 which is adapted for insertion into the mouth of the user.

The reservoir 23 may be closed by a threaded cap 29 which carries an aspirator 31. The aspirator 31 includes a hollow stem 33 integral with the cap 29 and extending downwardly into a liquid 35. The liquid 35 will usually be a type of medication which should be breathed by the user. The aspirator 31 also includes an axially extending nozzle 37 arranged at substantially a right angle to the axis of the stem 33.

The mixing chamber 21 has a pressure-sensing port 39 and a downwardly extending boss 41. The ejector 17 includes an ejector handle or tube 43 which fits within the boss 41. The tube 43 has an ejector passage 45 therein defining a venturi nozzle 47 at the end thereof adjacent the boss 41 and an induced air inlet 49 at the other end thereof.

An insert 51 is held within the ejector passage 45 adjacent the inlet of the nozzle 47 by a tubular retaining nut 53. The insert 51 has a bore 55 extending axially the rethrough and defining a relatively small diameter orifice 57 which is coaxial with the venturi nozzle 47. A length of small diameter tubing 58 extends through lateral openings in the insert 51 and the tube 43. A flexible conduit 59 interconnects the tubing 58 and the nozzle 37. A connector 61 secures a primary air supply line or conduit 63 to the insert 51. As shown in FIG. 2, the insert 51 is spaced at two points along its periphery from the interior wall of the tube 43 to define induced air ports 65.

The regulator 13 includes a housing 71 connected to a source of primary air (not shown) through a supply line 73. A normally open valve 75 mounted in passage means 77 controls the flow of primary air from the supply line 73 to the conduit 63. The valve 75 is maintained in the normally open position by a spring (not shown) or a bellows 79 which is sealed to the housing 71 and which communicates with the passage means 77 through an annular gap 81 between the valve 75 and the housing.

A diaphragm 83 and a wall 85 of the housing 71 form an operating chamber or timing chamber 87 which receives primary air through the passage means 77, a lateral passage 89, a needle valve 91, and a check valve 93. The diaphragm 83 acts as a valve closure means for closing the valve 75.

The wall 85 and a second diaphragm 95 define an exhaust manifold 97 and the housing 71 and the diaphragm 95 form a demand cavity 99. Air can be exhausted from the operating chamber 87 through an outlet 101 in the wall 85, the exhaust manifold 97, and an exhaust port 103 in the housing to the atmosphere. A valve 105, which is seated in the outlet 101 controls the exhausting of air from the operating chamber 87.

A spring 107 normally biases the valve 105 to the closed position. The pressure in the demand cavity 99 and the spring 107 control the movements of the valve 105 and hence the exhausting of air from the operating chamber 87. A conduit 109 interconnects the cavity 99 and the pressure-sensing port 39 in the body 15 thereby causing the pressure in the demand cavity to be substantially the same as the pressure at the port 39.

The operation of the device is as follows. Primary air is supplied to the ejector 17 through the supply line 73, the normally open valve 75, the passage means 77, the conduit 63, and the bore 55. The primary air is under pressure and is therefore forced through the orifice 57 and through the nozzle 47. This

causes secondary or atmospheric air to be induced through the induced air inlet 49, through the ports 65 and from there through the nozzle 47, the mixing chamber 21, and the mouthpiece 25 to the user. Simultaneously, primary air is forced through the conduit 59 to the aspirator 31. This air passes through the nozzle 37 of the aspirator 31 and picks up some of the liquid 35 in the stem 33. This fluid stream or spray from the reservoir 23 passes into the mixing chamber 21 where it mixes with the primary and secondary air from the ejector 17. The pressure in the system is of course sufficient to cause the air and the spray from the reservoir 23 to pass through the mouthpiece 19 to the user.

Without the regulator 13, the respirator 11 would continuously supply air and a medicated vapor from the reservoir 23 to the user. The purpose of the valve 13 is to cause the ejector 17 and hence the respirator 11 to operate intermittently to supply pulses of induced air to the user in synchronism with the breathing requirements of the user. The regulator 13 accomplishes this purpose by periodically interrupting the flow of primary air into the ejector 17.

Thus, as primary air flows to the ejector 17, it also flows through the annular gap 81 into the bellows 79. This causes the bellows 79 to expand thereby opening the normally open valve 75 a greater amount. Primary air also flows through the lateral passage 89, the needle valve 91, and the check valve 93 to the operating chamber 87. When the pressure in the operating chamber 87 increases a predetermined amount, it forces the flexible diaphragm 83 toward the bellows 79 and acts to quickly and tightly close the normally open valve 75. At this time, the flow of primary air to the ejector 17 is interrupted, and, accordingly, the respirator 11 furnishes no more air to the user. Thus, the closure of the valve 75 marks the end of inspiration.

In utilizing the respirator 11, exhalation will normally occur back through the body 15, the ejector 17, and the inlet 49 to atmosphere. When the user desires to take a second breath and begin inspiration, a slight drop in pressure will occur at the pressure-sensing port 39. Because the pressure-sensing port 39 and the demand cavity 99 are in terconnected by the conduit 109, a similar pressure drop occurs in the demand cavity. When this pressure drop in the cavity 99 is sufficient to overcome the biasing force of the spring 107, the diaphragm 95 immediately causes the valve 105 to open thereby venting the operating chamber through the outlet 101, the exhaust manifold 97 and the exhaust port 103. Simultaneously with the venting of the operating chamber 87, the bellows 79 returns the normally open valve 75 to its normally open position. The cycle is then repeated. The valve 105 and the diaphragm 95 act as control means for controlling the intervals between the pulses of air that are supplied by the respirator 11. The action of the bistable regulator 13 is very rapid so that there is no undue delay between the beginning of inspiration and the supply of air to rush through the respirator.

The amount of air supplied by respirator 11 in each pulse can be adjusted by adjusting the needle valve 91. Thus, if the needle valve 91 is open a large amount, the operating chamber 87 fills more rapidly to cause the valve 75 to close more rapidly. This results in a lesser quantity of air being supplied by the respirator 11 in each pulse. Conversely, partially closing the needle valve 91 results in a larger amount of air being supplied in each pulse.

It is apparent therefore that the regulator 13 provides complete adjustability both as to the quantity of air supplied in each pulse and as to the time interval between pulses. The time interval is automatically controlled by the user as he begins inspiration whereas the amount of air furnished in each pulse is manually adjustable. The respirator 11 is of such a size that it can be conveniently held in the hand. Because the secondary air is induced in the handheld unit, the conduit 63 need only be large enough to supply a small amount of primary air for operating the ejector 17. Of course, the intermittent supply of primary air also causes the aspirator 31 to operate intermittently.

FIG. 3 illustrates another respirator 115 which eliminates the need for the regulator 13. Corresponding parts of the respirators 11 and 115 are designated by corresponding reference numerals. The body 15 of the respirator 115 is identical to the body 15 of the respirator 11 except that the pressure-sensing port 39 is omitted. The respirator 115 has an ejector 117 which is identical to the ejector 17 except that a laterally extending aperture 119 is formed in the latter and an elongated tubular nut 121 is employed. The aperture 119 is preferably formed upstream of and closely adjacent the nozzle 47.

An insert 123 is disposed within the ejector 117 and is identical to the insert 51 except for a laterally extending aperture 125 which is coaxial with the aperture 119. The apertures 119 and 125 are large relative to the orifice 57.

The operation of the respirator 115 is as follows: Primary air is directly supplied to the insert 123 through the supply conduit 63. If the aperture 119 is open, substantially all of the primary air will pass therethrough to the atmosphere. This is so because this is the path of least resistance for the air. Any of the primary air which does pass through the orifice 57 or the conduit 59 will be negligible. When the user desires to inhale, he need only place a finger over the aperture 119 thereby preventing the primary air from exhausting therethrough. When this occurs, the primary air will be forced through the orifice 57 to induce flow of secondary or atmospheric air through the induced air inlet 49 into the ejector 117 and the body 15 to the user. Other primary air will flow through the conduit 59 to operate the aspirator 31 as described above in connection with the embodiment of FIG. 1. When the user has received sufficient air for a single breath, he removes his finger from the aperture 119 to allow the primary air to exhaust therethrough to atmosphere. This causes the respirator 115 to cease operating. Thus, the apertures 119 and 125 serve as a respirator for causing the ejector to operate intermittently in synchronism with the breathing requirements of the user.

The venturi nozzle 47 is preferred for use in the ejector 17 because of its high efficiency for this particular application. In addition, because of the low output pressure of the venturi, it will not damage the lungs and thus accommodates the compliance of the lungs.

The respirator of FIG. 3 is completely adjustable both as to the quantity of air received in each breath or pulse and as to the time interval between breaths. This complete adjustability is achieved by merely placing and removing the finger from the aperture 119. Like the respirator 11, the respirator 115 can be easily held in the hand and only requires a source of primary air under pressure for its operation. The respirators 11 and 115 may be constructed of rubber or molded plastic material and it is apparent that such a construction would be both simple and inexpensive. This is made possible by locating the ejector in the handle of the handheld respirator.

Many changes, modifications, and substitutions may be made by one having ordinary skill in the art without necessarily departing from the spirit and scope of this invention.

I claim:

1. In a compact respirator adapted for connection to a supply of a first fluid under pressure, the combination of:

a body sized for manual grasping and support by a user and having outlet means for delivering at least said first fluid into the mouth of the user, said body having a passageway therein exposed at said outlet means;

said body including ejector means for inducing air into said passageway of said body and through said outlet means to the user, said ejector means including a tube having an ejector passage and an ejector orifice therein communicating at one end with said passageway, said ejector passage being open to the atmosphere to define an induced air inlet, said passageway and ejector passage defining a constantly open exhalation path of such short length from said outlet means to said inlet as to substantially eliminate rebreathing by the user;

first conduit means connecting said ejector orifice to the supply of the first fluid under pressure whereby flow of said first fluid through said ejector means provides the user with a mixture of the first fluid and induced air;

regulator means associated with said first conduit means for intermittently supplying the first fluid under pressure to the ejector means to cause the latter to operate intermittently and induce and supply air to the user in pulses responsive to the breathing requirements of the user, said regulator means including:

a body including means defining a timing chamber and a demand chamber;

a normally open control valve in said first conduit means between the supply of the first fluid and said ejector means;

passage means connecting said first conduit and said timing chamber;

a metering valve and a check valve connected between the output of said control valve and said timing chamber in said last-named passage means;

a first diaphragm forming a wall of said timing chamber and coupled to said control valve for urging said control valve closed as pressure in said timing chamber builds up;

a pneumatically driven member of smaller effective area than said first diaphragm connected to the output of said control valve and developing a force opposing the force of said first diaphragm;

a vent line;

a normally closed vent valve connecting said timing chamber to said vent line;

a second diaphragm forming a wall of said demand chamber and coupled to said vent valve for urging said vent valve to open as pressure in said demand chamber decreases; and

a pressure communication line connecting said demand chamber to said body passageway.

2. In a compact respirator adapted for connection to a supply of a first fluid under pressure, the combination of:

a body sized for manual grasping and support by a user and having outlet means for delivering at least said first fluid into the mouth of the user, said body having a passageway therein exposed at said outlet means;

said body including ejector means for inducing air into said passageway of said body and through said outlet means to the user, said ejector means including a tube having an ejector passage therein communicating at one end with said passageway, said ejector passage being open to the surrounding atmosphere to define an induced air inlet, said passageway and ejector passage defining a constantly open exhalation path of such short length from said outlet means to said inlet as to substantially eliminate rebreathing by the user;

first conduit means for connecting said ejector means to the supply of the first fluid under pressure whereby flow of said first fluid through said ejector means introduces into said body the mixture of the first fluid and induced air;

a normally open valve associated with said first conduit means and having an open position for supplying the first fluid through said conduit to said ejector passage and a closed position for blocking fluid flow;

valve-closing means for closing said normally open valve after a predetermined amount of said first fluid has passed therethrough, said valve-closing means retaining said normally open valve in the closed position;

control means responsive to a predetermined pressure drop in said passageway of said body created by the user's beginning inspiration for acting on said valve-closing means to cause the latter to allow said normally open valve to return to its normally open position;

second conduit means interconnecting said control means and said passageway of said body, providing bistable regulator operation with an open condition and a closed condition; and

said valve-closing means being pressure-responsive and including a chamber, said chamber being supplied with the first fluid from said normally open valve by passage means, said valve-closing means closing said normally open valve in response to a predetermined pressure in said chamber, and said control means being responsive to the beginning of inspiration to vent said chamber thereby reducing the pressure therein below said predetermined pressure and allowing said normally open valve to open, and a needle valve and a check valve in said passage means, said needle valve controlling the rate of flow of the first fluid into said chamber and thereby controlling the amount of air induced by said ejector means, said check valve preventing backflow from said chamber to said passage means.

3. In a compact respirator adapted for connection to a supply of a first fluid under pressure, the combination of:

a body sized for manual grasping and support by a user, and having outlet means comprising a mouthpiece for delivering at least said first fluid into the mouth of the user, said body having a passageway therein exposed at said outlet means;

said body including ejector means for inducing air into said passageway of said body and through said outlet means to the user;

said ejector means including a tube having an ejector passage therein communicating at one end with said passageway, said ejector passage being open to the atmosphere to define an induced air inlet, said ejector means including an ejector orifice cooperatively related to said ejector passage to cause atmospheric air to be induced through said induced air inlet and into said ejector passage when fluid under pressure is admitted to said ejector orifice;

said body passageway and ejector passage defining a constantly open exhalation path of such short length from said outlet means to said induced air inlet as to substantially eliminate rebreathing by the user;

first conduit means for connecting said ejector orifice to the supply of the first fluid under pressure whereby flow of said first fluid through said ejector means provides the user with a mixture of the first fluid and induced air;

means for supplying a second fluid to said passageway of said body, said means comprising a reservoir operatively associated with and immediately adjacent said body for containing said second fluid with said passageway interconnecting said reservoir and said outlet means, and aspirator means in said reservoir for supplying said second fluid to said passageway from said reservoir; and

control means associated with said first conduit means for bleeding fluid therefrom and for causing said ejector means and said aspirator means to intermittently and simultaneously supply their respective fluids through said passageway of said body to the user.

4. A respirator as defined in claim 3 wherein said control means comprises an opening providing a vent from said first conduit means to atmosphere, said opening being positioned on said body to be selectively closable by the user.

5. A respirator as defined in claim 3 wherein said first conduit means introduces the first fluid under pressure into said orifice, and said control means includes an opening in said first conduit means providing communication between said first conduit means and the atmosphere for bleeding fluid from said first conduit means.

6. A respirator as defined in claim 5 including second conduit means upstream of said orifice for supplying some of the first fluid under pressure to said aspirator means to operate the latter.