

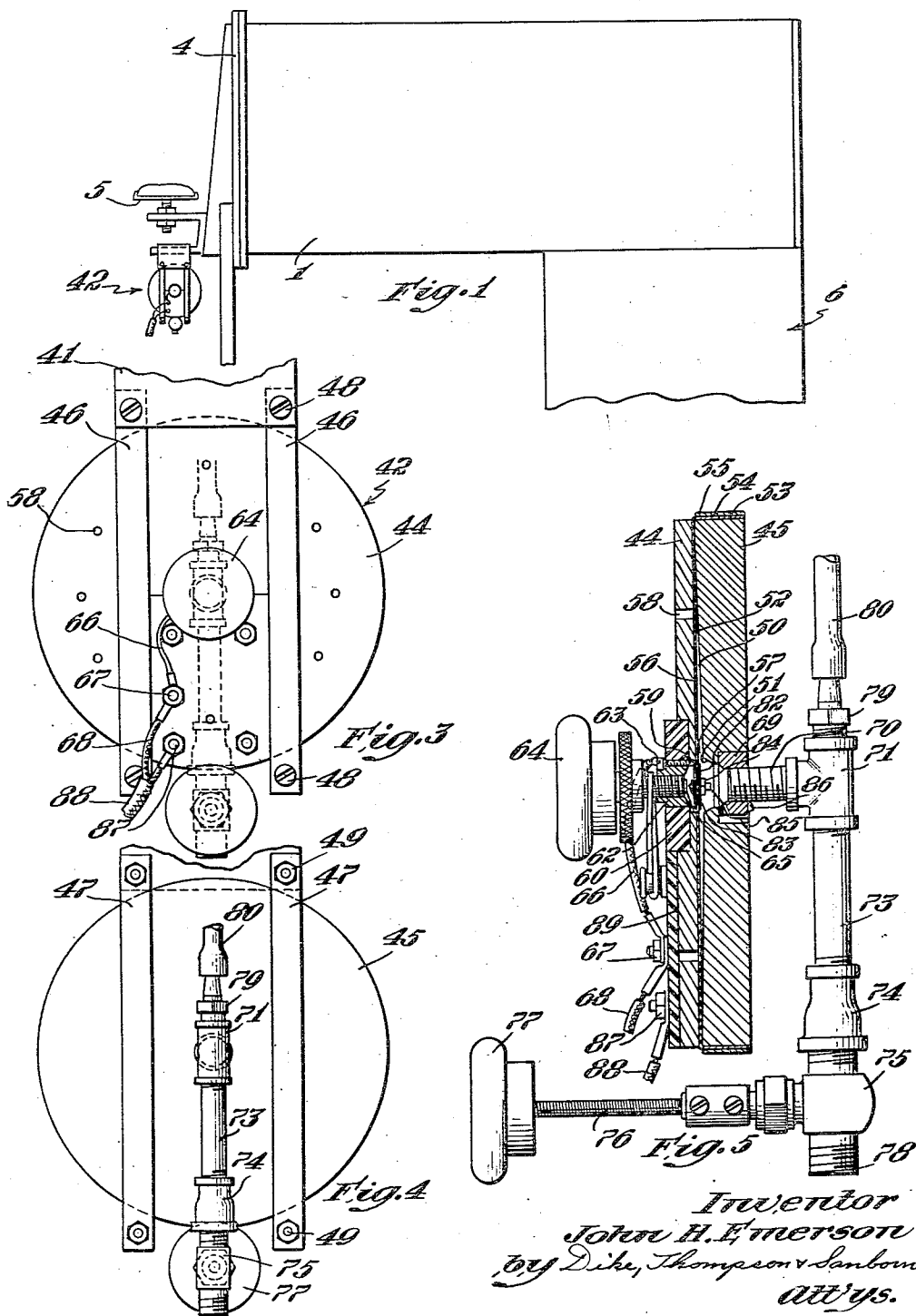
Dec. 18, 1956

J. H. EMERSON
ARTIFICIAL RESPIRATOR

2,774,348

Filed May 31, 1952

3 Sheets-Sheet 1



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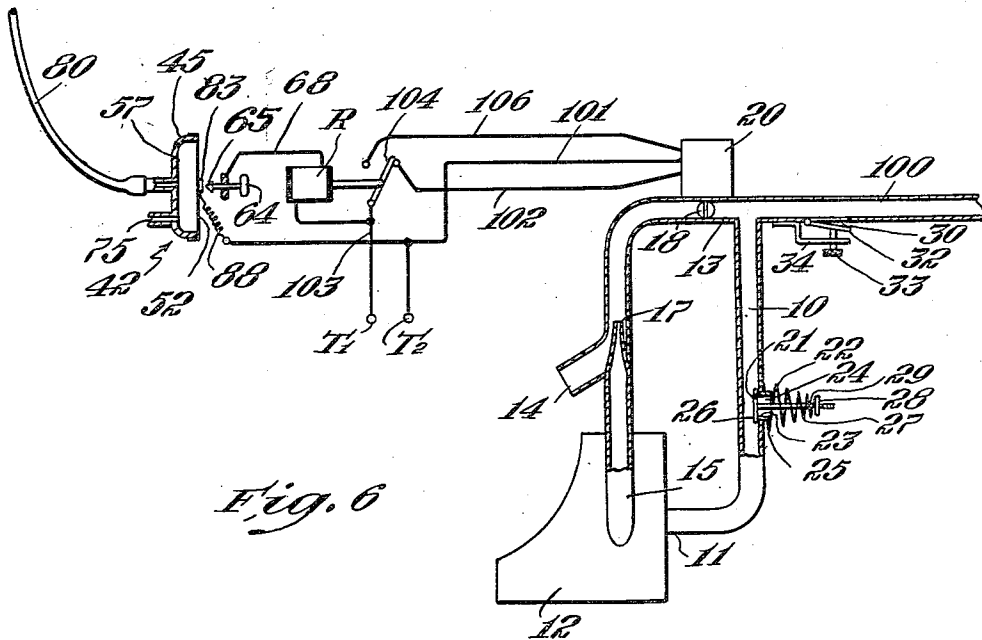
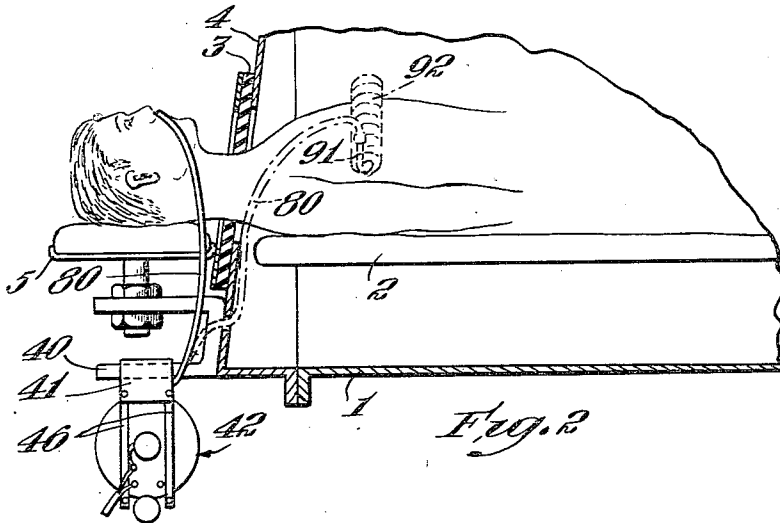
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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

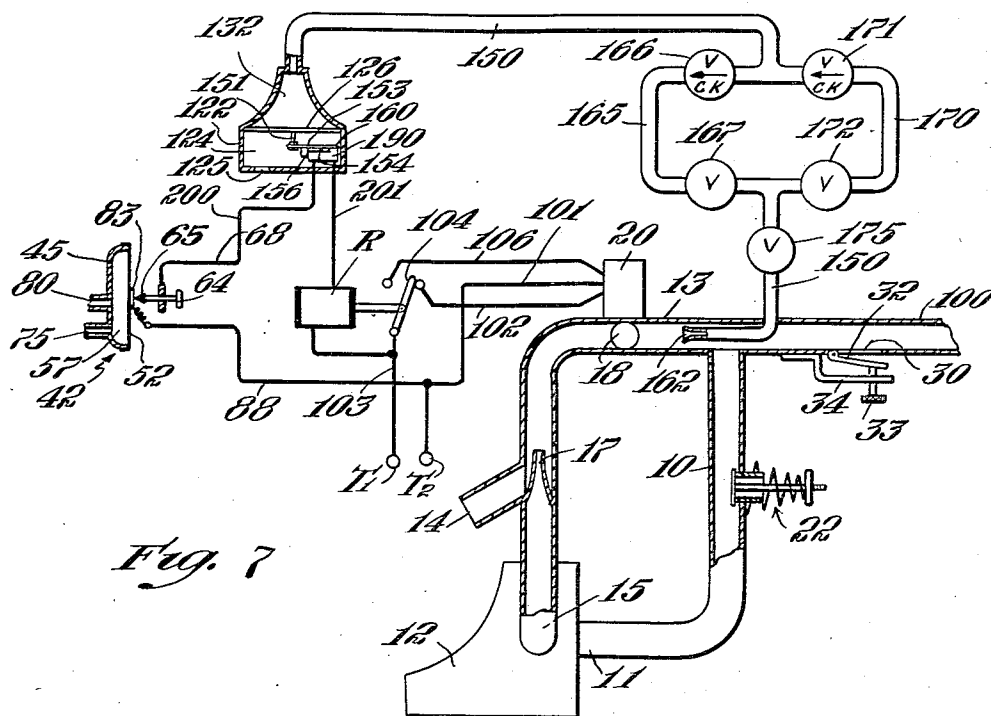


Fig. 7

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1

2,774,348

ARTIFICIAL RESPIRATOR

John H. Emerson, Arlington, Mass.

Application May 31, 1952, Serial No. 290,856

23 Claims. (Cl. 128—30)

This invention relates to apparatus for producing artificial respiration in a patient and more particularly to the type of artificial respirator where the patient's chest and/or abdomen are enclosed in a casing and are subjected to alternating negative and substantially atmospheric or positive pressures to assist him to breathe under conditions where either the patient, by himself, is capable of initiating inhalation but is incapable of adequately completing it, as for example in bulbar polio cases or in polio cases where the patient's breathing muscles are not completely paralyzed. In some aspects the apparatus of this invention is also capable of use with a patient who is completely incapable of initiating any breathing action whatsoever as in polio cases where the patient's muscles are completely paralyzed.

One object of the invention is to provide an artificial respirator which is pneumatically controlled either by the patient himself or by a pneumatic system which is operated by variations of pressure within the respirator casing.

Another object is to provide an artificial respirator wherein the patient himself controls the initiation of the commencement of the negative pressure cycle when he consciously or subconsciously initiates inhalation.

Another object is to provide an artificial respirator wherein the patient himself initiates the commencement of both the negative pressure or inhalation period and the atmospheric or positive pressure or exhalation period when he initiates inhalation and initiates exhalation.

A further object is to provide an artificial respirator with two pneumatic controls, one operated by the patient himself when he initiates inhalation and the second operated by a pneumatic system connected with the interior of the casing so that the latter pneumatic control functions in the event the patient becomes unable to initiate inhalation or in the event the first pneumatic control fails to function for any other reason.

Another object of the invention is to provide an artificial respirator with a novel pneumatic control.

A further object of the invention is to provide a pneumatic control for an artificial respirator which is so sensitive that the patient can operate it himself by the subconscious initiation of an inhalation without any noticeable effort and without being conscious of himself controlling the apparatus.

Other objects of the invention are to provide an artificial respirator of the character described which is of simple, compact and durable construction, which is accurate and dependable in use and which is economical to manufacture and to maintain in operation.

Other and further objects and advantages of the invention will be pointed out in the following description and by reference to the accompanying drawings wherein

Fig. 1 is a side elevation of one form of respirator with which the invention may be utilized, showing one position where the patient-initiated control may be installed;

Fig. 2 is a side elevation similar to Fig. 1 with part of

2

the respirator casing broken away and shown in vertical section, and showing the position of the patient and alternate means by which the patient-initiated control device may be interconnected to the patient;

Fig. 3 is an enlarged elevation of a pneumatically operated switch for one embodiment of pressure control device embodying the invention;

Fig. 4 is a rear elevation of the device of Fig. 3;

Fig. 5 is an enlarged side elevation of the device of Fig. 3 with parts shown in vertical section;

Fig. 6 is a schematic view of the device for creating variations of pressure within a respirator casing including a patient-initiated control for the pressure creating device;

Fig. 7 is a schematic view of another embodiment of the invention showing the combination of a patient-initiated control and an automatic control, the patient-initiated control being normally utilized and the automatic control becoming operative if the patient control fails.

Referring to Figs. 1, 2 and 6 of the drawings, the respirator is here shown by way of example as comprising the usual substantially air-tight respirator casing 1 which forms an enclosure for the patient's body up to his neck. The patient reclines upon a horizontal bed 2 (Fig. 2) within the casing and his neck extends through a restricted orifice in a collar 3 of sponge rubber material at the end 4 of said casing, his head resting upon the headrest 5 and exposed to the atmosphere. It is to be understood, however, that the enclosure for the patient's chest may comprise a conventional "chest respirator" wherein the substantially air-tight casing forms an enclosure for at least part of the patient's chest. Such a respirator sometimes encloses the entire chest, sometimes part of the chest and part of the abdomen.

Beneath the opposite end of the respirator a compartment 6 (Fig. 1) is provided in which is disposed an apparatus schematically shown in Fig. 6 and which includes a negative pressure conduit 10 communicating at one end with the interior of the respirator casing through the conduit 100. At the opposite end 11 of the conduit 10 a motor operated suction blower 12 of any desired construction is provided for continuously creating negative pressure within the negative pressure conduit 10. An atmospheric conduit 13 communicates with the delivery conduit means 100 and thus with the interior of the casing 1 and with the atmosphere through the port 14. The exhaust tube 15 extends from the suction blower 12 into the atmospheric conduit 13 and it is provided at the end adjacent to the port 14 with a venturi 17 having a restricted orifice. An electrically operated butterfly valve 18 is provided in the atmospheric conduit 13.

The valve 18 is opened and closed by suitable means here shown as a double acting solenoid 20 which is energized by one circuit to close the valve and energized by another circuit to open the valve as will hereinafter be described.

When the valve 18 is closed, the suction blower 12 creates negative pressure in the negative pressure conduit 10 and in the respirator casing 1 and this negative pressure causes expansion of the patient's chest and lungs and thus causes an inhalation. When the valve 18 is opened the exhaust air from the suction blower which has up to this point passed out to the atmosphere through the atmosphere port 14, passes through the conduit 13 to the casing 1. When it passes through the venturi 17 it draws in air through the atmosphere port 14 thereby increasing the volume of gas transmitted to the casing and more rapidly neutralizing the negative pressure in the casing and building up the pressure therein to atmospheric or positive. This variation in pressure acts upon the patient's chest and creates a forced exhalation.

The negative pressure conduit 10 is provided with an atmospheric pressure gas inlet port 21 providing communication between the atmosphere and the interior of the negative pressure conduit 10, the inflow of air being controlled by a suitable valve 22 here shown for example as comprising a cylindrical casing 23 having a central bore 24, the inner end of the casing constituting a valve seat 25. A disk 26 constituting a valve is shown in seated position and is resiliently urged outwardly to seated position by means of a helical spring 27 having its inner end in contact with the outer end of the casing 23 and its outer end engaging the head 28 of a stem 29 fast to the disk. This is a safety valve and it opens only when the negative pressure within the conduit 10 exceeds a predetermined amount, in which event the valve 22 is moved inwardly compressing the spring and admitting gas under atmospheric pressure to the conduit 10 and thereby decreasing the amount of negative pressure in the conduit until the spring returns the valve to its normal seated position.

The conduit 10 is provided with an outlet port 30 providing communication between the atmosphere and the interior of this conduit, the outflow of air being controlled by a suitable valve here shown by way of example as a valve 32 which is moved to closed position by negative pressure within the conduit but which opens to an adjustable predetermined extent determined by the position of the regulating screw 33 supported by the plate 34 when the pressure of the air within the conduit reaches substantially atmospheric pressure. Accordingly, this valve functions as a leak for positive pressure and by adjusting the amount it can open, the size of the leak is controlled and the maximum positive pressure which can be created in the casing is likewise controlled.

Supported on a bracket 40 of the headrest 5 by suitable means such as a hook 41 is a pneumatic switch 42 (Figs. 1 to 6 inclusive) comprising a housing formed by preferably disk shaped front and rear plates 44 and 45 of aluminum or other suitable material and held together by suitable means here shown as pairs of spaced parallel clamps 46 and 47 engaging the outer faces of the plates 44 and 45 and being held together by screws 48 and nuts 49.

The inner face 50 of the plate 45 is very slightly concave (Fig. 5) and is formed adjacent its center with a central bore 51. Between the inner faces of the plates is disposed a flexible diaphragm 52 of suitable material as vinyl plastic, the peripheral edge 53 of the diaphragm extending outwardly over the peripheral edge 54 of the plate 45 and there held in position by the peripheral clamp 55.

The diaphragm cooperates with the inner faces of the plates to define an atmospheric pressure chamber 56 between the diaphragm and plate 44 and a valve chamber 57 between the diaphragm and the plate 45.

The plate 44 is provided with a plurality of ports 58 so that the atmospheric pressure chamber 56 is in free communication with the atmosphere at all times. Plate 44 is further provided with a central transverse bore 59 to receive the reduced end of an insulating collar 60 of suitable plastic insulating material which is connected to the outer face of the plate 44 by screws (not shown) and is formed with a central bore to receive an internally and externally threaded bushing 62. The bushing in turn receives an externally threaded adjusting screw 63 provided with a knob 64, the inner end of the screw carrying a switch contact 65 which is electrically connected through the screw 63, wire 66, contact 67 and wire 68 to one wire of a circuit.

The central bore 51 of the plate 45 at its outer end receives an internally threaded metallic bushing 69 which in turn threadedly receives the inner end of a conduit 70, the opposite end of the conduit being connected to a stem of a T coupling 71. One end of the base of the T coupling threadedly receives a conduit 73 at the opposite end of which is connected by suitable means as the coupling 74 a conventional needle valve 75, the needle valve being adjustable through the stem 76 and adjusting knob 77 and having a port 78 in communication with the atmosphere.

The opposite end of the base of the T coupling threadedly receives a nipple coupling 79 to which is frictionally connected a flexible tube 80 which in turn communicates with the patient in a manner hereinafter to be described.

Disks 82 of suitable material such as rubber are provided on both sides of the diaphragm adjacent its central portion and carry the other switch contact 83 which extends through the disks and diaphragm and is held in place by a nut 84 on the valve chamber side of the diaphragm. The contact 83 is electrically connected through the wire 85, screw 86, plate 45, clamps 46 and 47 and screws 49 and plate 44 to the terminal 87 and to wire 88, the opposite wire of the circuit. The terminal 67 is insulated from the terminal 87 by suitable means as an insulating plate 89 of suitable insulating material connected to the outer face of plate 44.

With reference to Fig. 2, the outer end of the flexible tube 80 may be either connected to the upper lip of the patient directly beneath one nostril by suitable means as by a strip of adhesive tape or inserted in his mouth or (as shown in dot-dash); extend through a hole in the head end of the casing and thence to the nipple 91 of the tubular breathing belt 92 which is strapped about the chest of the patient. The breathing belt 92 comprises a hollow flexible strip of rubber tubing having a pleated side wall and closed ends and which when the patient's lungs and chest are expanded is extended creating negative pressure within the member 92 and tube 80 and within the valve chamber 57.

In either case, negative pressure is created in the tube 80 at the initiation of each period of inhalation which pressure is transmitted through the tube 80, couplings 79 and 71, and conduit 70 into the valve chamber 57, thereby to subject the diaphragm to negative pressure when the patient himself initiates an inhalation.

From the foregoing it is clear that upon initiation by the patient of the period of inhalation, the negative pressure is created in the valve chamber 57 causing the diaphragm to move toward the inner face of plate 45, thereby to open the normally closed contacts 65 and 83. During the period of the patient's inhalation atmospheric pressure is allowed to leak back through port 78, needle valve 75, coupling 74, conduit 73, coupling 71 and conduit 70 into the valve chamber at a predetermined rate regulated by the needle valve so that upon the termination of the normal period of inhalation the pressure within the valve chamber 57 is almost immediately returned to substantially atmospheric and then the diaphragm returns automatically to its normal position with the contacts 65 and 83 in closed position.

Opening of the contacts 65 and 83 de-energizes the relay R to close the circuit T1, 104, 102, 20, 101, T2, energizing the solenoid 20 which moves the valve 18 to closed position, thereby initiating the negative pressure cycle within the casing to assist the patient's inhalation during the remainder of his period of inhalation.

Closing of the contacts 65 and 83 energizes relay R which opens the first circuit and closes the circuit T1, 104, 106, 20, 101 and T2, thereby causing the solenoid to move the valve 18 to open position. This terminates the negative pressure cycle and causes atmospheric or positive pressure to be built up in the respirator casing, thus aiding the patient during exhalation.

When the tube 80 is attached with its end adjacent to the patient's nostril there is a space between its open end and the patient's nostril so that when the patient's lungs are fully expanded and air ceases to be drawn in through his nose from the atmosphere negative pressure is no longer created at the end of the tube 80 and air under atmospheric pressure enters the open end of the tube and it quickly neutralizes the negative pressure in the chamber 57. Hence, the pneumatic switch may be used without the needle valve 75 when the tube 80 is interconnected with the patient at his nostril. The same is true with the end of the tube located between the patient's lips.

5

When the tube 80 is connected with the chest operated member 92, however, the needle valve 75 or its equivalent must be used to create atmospheric pressure in the valve chamber promptly after the patient's lungs have been fully expanded at which time the extension of the chest operated member 92 is discontinued.

In all cases the needle valve is useful to adjust the length of time necessary to neutralize the negative pressure in the chamber 57. The patient can also himself initiate the exhalation cycle by commencing to exhale into the tube, thereby creating positive pressure therein.

From the foregoing description it will be apparent that by utilizing the embodiment of Figs. 1 to 6 the patient himself initiates each period of inhalation and that operation of the device is much more satisfactory than that of the customary artificial respirator in which periods of inhalation and exhalation of predetermined duration are forced upon the patient.

The embodiment of Fig. 7

The embodiment of Fig. 7 essentially comprises an apparatus wherein the patient normally controls the actuation of the butterfly valve 18 through a patient operated pneumatic switch similar to the one shown in Fig. 6 of the drawings but a second automatic pneumatic switch similar to the one shown in Fig. 3 of applicant's copending application Serial No. 416,858, filed March 17, 1954 is provided to take over operation of the valve 18 in the event of failure of the patient operated pneumatic switch.

In this embodiment the pneumatic system represented by the blower 12, conduits 10, 13, 100 and 15, venturi 17, atmospheric port 14 and safety valves 32 and 22 operate in the same manner as described in connection with the embodiment of Fig. 6.

The pneumatically operated switch element 42 is of the construction illustrated in Figs. 1 to 6 of the drawings and the tube 80 is interconnected with the patient either at his nostril, lips or chest in the manner illustrated in Figs. 1 and 2 and as described in connection with the description of the embodiment of Figs. 1 to 6 of the drawings. Pneumatic switches 42 and 190 are adjusted to cooperate with each other so that the apparatus is ordinarily patient controlled by means of switch 42 but in case pneumatic switch 42 becomes inoperative, pneumatic switch 190 automatically takes over to automatically control the breathing cycle.

The second double acting automatic, pneumatic switch 190 is mounted in the housing 122 and is located in the lower chamber 124 thereof. The port 125 affords continuous communication between the interior of the chamber 124 and the atmosphere.

The diaphragm 126, made of rubberized fabric or other suitable flexible material, has its edge secured to the housing 122 and it forms one wall of the substantially air-tight chamber 132.

The switch arm 153 is mounted for pivotal movement about the axis 160 and it is normally retained in the position illustrated in Fig. 7 by the permanent magnet 156. When it is in said position one of the circuits hereafter described is closed by the spring pressed plunger 154. When the switch arm is moved upwardly a sufficient distance about the axis 160 the spring pressed plunger 154 is elevated by the spring (not shown) and this action opens the first mentioned circuit and closes another circuit.

The arm 153 is elevated about its pivotal connection by the wire 151, the lower end of which is secured about the switch arm 153 and the upper end of which is attached to the center of the diaphragm 126.

When sufficient negative pressure is created in the chamber 132, said negative pressure acts upon the center of the diaphragm 126 and moves it upwardly a sufficient distance so that the lower end of the wire 151 elevates the free end of the switch arm 153 and it snaps

6

away from the magnet 156, thus permitting the plunger 154 to move upwardly following the arm.

When the negative pressure in the chamber 132 is neutralized to substantially atmospheric pressure or to positive pressure, the diaphragm 126 returns to the normal position illustrated in Fig. 8 and the arm 153 is moved downwardly into contact with the upper surface of the magnet 156. This action correspondingly depresses the plunger 154 and causes another circuit to be energized as more fully described hereafter.

The interior of the chamber 132 is connected to the interior of the respirator casing 1 by the transfer conduit 150, one end of which communicates with the top of the valve chamber 132 and the other end of which is provided with a slight flared portion 162 which, in the embodiment illustrated, is located in the atmospheric conduit 13 so that it may more readily receive atmospheric and positive pressure created in the atmospheric conduit.

The transfer conduit 150 is provided with a negative pressure by-pass conduit 165 and an atmospheric by-pass conduit 170. The check valve 166 in the negative pressure by-pass conduit is normally closed but it is opened by the creation of negative pressure in the negative pressure by-pass 165 and it is automatically closed when the pressure in said by-pass is returned to at least substantially atmospheric pressure. The valve 167 located in the negative pressure by-pass may be a needle valve or any other means for controlling the effective size of the passage in the negative pressure by-pass.

The check valve 171 is opened by the creation of substantially atmospheric or positive pressures in the atmospheric by-pass conduit 170 and is closed by negative pressure therein. The valve 172 in the atmospheric by-pass may be a needle valve or any other means for controlling the effective size of the passage in the atmospheric by-pass 170.

The valve 175 located in the transfer conduit 150 may be a needle valve or any other means for controlling the effective size of the passage in the transfer conduit.

As in the embodiment illustrated in Fig. 6 of the drawings, the valve 32 functions as a leak for positive pressure created in the conduit 100. It consists of the plate 34, regulating screw 33, port 30 and the valve 32 which is pivotally connected to the conduit 100 at one end. It serves to control the maximum amount of positive pressure created within the respirator casing.

With the butterfly valve 18 in closed position, the negative pressure creating means 12 creates negative pressure in the respirator casing, causing a period of inhalation by the user. At the same time, negative pressure is created in the transfer conduit 150 and in the by-pass conduits 165 and 170. The negative pressure in the atmospheric by-pass 170 closes the check valve 171 whereas the negative pressure in the negative pressure by-pass 165 opens the check valve 166 so that negative pressure is transmitted to the chamber 132 of the pneumatic switch element.

Eventually sufficient negative pressure is built up in the chamber 132 to elevate the center of the diaphragm 126, the outer end of the switch arm 153 and the contact plunger 154. The amount of time required to build up the required amount of negative pressure in the chamber 132 depends upon the adjustment of the needle valve 167.

When the switch arm 153 is thus elevated by the diaphragm 126, a circuit is completed through the double acting solenoid 20 as hereafter described and it opens the butterfly valve 18. This terminates the period of inhalation by the user and permits air under positive pressure to flow from the venturi 17 and port 14 through the atmospheric conduit 13 and the conduit 100 to the interior of the respirator casing 1, thus neutralizing the negative pressure previously built up therein and returning it to atmospheric or positive pressure.

Opening of the valve 18 also causes air under positive pressure to enter the transfer conduit 150 and to neu-

tralize the negative pressure theretofore present therein. This air under positive pressure closes the check valve 166 and opens the check valve 171 and it passes through the atmospheric by-pass 170 and thence to the valve chamber 132 of the pneumatically operated switch. Eventually it neutralizes the negative pressure previously built up in the chamber 132 and the pressure therein becomes substantially positive. The center of the diaphragm 126 then is returned to its lowered position and the wire 151 moves the free end of the switch arm 153 downwardly to the position shown in Fig. 8. The amount of time required for this operation depends upon the adjustment of the needle valve 172 since said valve controls the rate of flow of gas through the conduit 170.

When the switch arm 153 has been returned to its lowered position, the contact plunger 154 is lowered, the circuit previously energized is opened and another circuit hereafter described is closed which causes the solenoid 20 to rotate the butterfly valve 18 to closed position. This shuts off the supply of positive pressure in the atmospheric conduit 13 and causes the exhaust from the venturi 17 to be vented to the atmosphere through the port 14. Negative pressure is now built up in the respirator casing 1 by the suction blower 12, the period of exhalation is terminated and the next period of inhalation is commenced.

From the foregoing description, it will be understood that the needle valves 167 and 172 may be manipulated to provide a longer period of inhalation than of exhalation or vice versa.

The needle valve 175 located in the transfer conduit 150 may be used to adjust the duration of the combined periods of exhalation and of inhalation. When the needle valve 175 is adjusted toward closed position, gas passes through the transfer conduit 150 at a smaller volume per unit of time and consequently the duration of the combined periods of exhalation and inhalation is increased. Conversely, when the valve 175 is adjusted toward open position, the duration of the combined periods of exhalation and inhalation is decreased because gas passes through the transfer conduit in greater volume during a given period of time.

From the foregoing description, it will be understood that the action of switch 190 may be adjusted by the three needle valves 175, 167 and 172 so as to automatically produce a period of inhalation of any desired duration followed by a period of exhalation of any desired duration and to provide a combined period of exhalation and of inhalation of any desired duration.

With the butterfly valve 18 in open position, positive pressure is created within the respirator casing 1 by the blower 12. Upon the initiation of a period of inhalation by the patient, negative pressure is created in the valve chamber 57 of the pneumatically operated switch 42 through the tube 80 and said pressure opens the contacts 65, 83 by moving the center of the diaphragm 52 inwardly of the valve chamber 57. This opens the circuit T1, 103, R, 201, 190, 200, 68, 65, 83, 88 and T2. Opening this circuit causes the relay to close the circuit T1, 103, 104, 102, 20, 101 and T2 energizing the solenoid 20, which moves the butterfly valve 18 to closed position, thereby initiating the negative pressure cycle within the casing 1 to assist the patient's inhalation during the remainder of the period of inhalation.

During the period of inhalation, atmospheric pressure is allowed to leak through the needle valve 75 into the valve chamber 57 to nearly counteract the negative pressure which continues to be transmitted to the chamber 57 through the tube 80. Upon termination of the normal period of inhalation the patient's lungs and chest are fully expanded and the creation of negative pressure in the tube 80 either at the patient's nose, or lips or by the member 92 about his chest (depending upon which connection is used) is discontinued and the pressure within the valve chamber 57 is almost immediately returned to

substantially atmospheric pressure whereupon the diaphragm 52 automatically returns to its normal position closing the contacts 65 and 83. This causes the circuit T1, 103, R, 201, 190, 200, 68, 65, 83, 88, and T2 to be closed and the relay closes the circuit T1, 103, 104, 106, 20, 101, and T2 thereby causing the solenoid to move the valve 18 to open position. This terminates the negative pressure cycle and causes atmospheric or positive pressure to be built up in the respirator casing 1 thus aiding the patient during exhalation.

When the period of exhalation has been completed, the patient again initiates a period of inhalation, moving the diaphragm 52 inwardly of the valve chamber 57 and opening the contacts 65 and 83 to thus initiate the next period of aided inhalation.

By means of the needle valve 175 in the transfer conduit 150, the auxiliary pneumatic switch 190 may be adjusted to take over operation of the valve 18. For example, when a patient normally breathes eighteen times per minute, by controlling the apparatus through the switch 42, the needle valve 175 is closed to such an extent that when the butterfly valve 18 is under operation of the pneumatic switch 190 through the transfer conduit 150, it will produce twelve breathing cycles per minute. With the needle valve 175 thus adjusted and with the pneumatic switch 42 producing eighteen breathing cycles per minute under control of the patient, the pneumatic switch 190 does not function while the switch 42 is functioning because during each period of inhalation insufficient negative pressure is built up in the valve chamber 132 to actuate the diaphragm 126 sufficiently to operate the switch 190. During each period of exhalation the switch 190 is likewise inoperative.

When the pneumatic switch 42 becomes inoperative, however, because the patient himself is unable to initiate an inhalation or for any other reason, the contacts 65 and 83 remain in normal closed position, the switch 190 takes over control of the butterfly valve 18 through the relay R and produces respiration at the rate of twelve cycles per minute or at whatever rate the valve 175 has been set to produce. Under such operation with valve 18 open, positive pressure is transmitted to the respirator casing and through the transfer conduit 150, valve 175, positive by passes 170, valve 171 and thence to the chamber 132. When sufficient positive pressure builds up in the chamber 132 the diaphragm 126 is moved downwardly and causes the contacts of the switch 190 to be opened. This opens the circuit T1, 103, R, 201, 190, 200, 68, 65, 83, 88, and T2 and causes the relay to close the circuit T1, 103, 104, 102, 20, 101 and T2 energizing the solenoid 20 which moves the butterfly valve 18 to closed position thereby initiating the negative pressure cycle within the casing 1 to produce an inhalation.

With the valve 18 closed and negative pressure being created within the respirator casing by the suction blower 12, sufficient pressure is eventually created in the chamber 132 to elevate the center of the diaphragm 126 and through the wire 151 to elevate the switch arm 153 from the magnet 156, thus closing the circuit T1, 103, R, 201, 190, 200, 68, 65, 83, 88 and T2 and relay then closes the circuit T1, 103, 104, 106, 20, 101 and T2 thereby causing the solenoid to move the valve 18 to open position. This terminates the negative pressure cycle and causes positive pressure to be built up in the respirator casing, thus aiding the patient during exhalation.

From the foregoing description, it will be apparent that the apparatus of Fig. 7 provides an artificial respirator with two pneumatic controls, one operated by the patient himself and which is normally in use and another operated by a pneumatic system connected with the interior of the respirator casing and which functions in the event the patient becomes unable to initiate inhalation himself or in the event the first pneumatic control fails to function for any other reason.

Other suitable pressure responsive members may be substituted for the diaphragms 52 and 126.

It should be understood that the pressure in chamber 132 can be cyclically controlled in accordance with the manner shown in Fig. 2 of applicant's copending application Serial No. 416,858, rather than by the construction shown in Fig. 7.

While in the embodiment of Fig. 8 positive pressure enters the end 162 of the transfer conduit 150 the apparatus will function equally well if alternate cycles of negative and substantially atmospheric pressures are used as in the embodiment disclosed in Fig. 2 of applicant's copending application Serial No. 416,858, filed March 7, 1954.

While I have shown and described embodiments of the invention, it is to be understood that this disclosure is for the purpose of illustration only and that various changes and the substitution of equivalent elements may be made without departing from the spirit and scope of the invention as set forth in the appended claims.

I claim:

1. Apparatus for producing artificial respiration comprising a substantially air-tight respirator casing to receive and enclose at least part of the user's chest but with his head exposed to the atmosphere, means for continuously creating negative pressure, a negative pressure conduit having one end communicating with said pressure creating means and the other end communicating with the interior of the casing, an atmospheric conduit providing communication between the interior of the casing and the atmosphere, a valve in the atmospheric conduit movable to open and closed positions and which, when in open position, admits gas from the atmosphere through the atmospheric conduit to the casing to assist the user's exhalation and substantially to neutralize the negative pressure created in the casing by said pressure creating means during each period of inhalation, electrically operated means to actuate said valve, and a pneumatically operated switch for controlling said electrically operated means, a tube for interconnecting the user with the pneumatically operated switch, said tube adapted to be so connected to the user that initial expansion of the user's lungs upon the initiation by the user of an inhalation creates negative pressure in said tube, and a diaphragm in said pneumatically operated switch which is actuated by said negative pressure to control the circuit to said electrically operated means whereby said valve is closed upon the initiation of each period of inhalation by the user thus causing negative pressure to be created in the casing by said negative pressure creating means thereby to aid the user during the remainder of each period of inhalation.

2. The combination of claim 1 also comprising a substantially air-tight chamber on one side of the diaphragm of said pneumatically operated switch, one end of said user interconnecting tube communicating with said chamber, a passage providing communication between said chamber and the atmosphere and means for controlling the effective size of said passage, whereby after the cessation of the creation of negative pressure at the user end of said tube the pressure in said chamber is returned to at least substantially atmospheric pressure by the flow of air through said passage from the atmosphere.

3. Apparatus for producing artificial respiration comprising a substantially air-tight respirator casing to receive and enclose at least part of the user's chest but with his head exposed to the atmosphere, means for continuously creating negative pressure, a negative pressure conduit having one end communicating with said pressure creating means and the other end communicating with the interior of the casing, an atmospheric conduit providing communication between the interior of the casing and the atmosphere, a valve in the atmospheric conduit movable to open and closed positions and which, when in open position, admits gas from the atmosphere through the atmospheric conduit to the casing to assist the user's exhalation and substantially to neutralize the negative

pressure created in the casing by said pressure creating means during each period of inhalation, electrically operated means to actuate said valve, and a pneumatically operated switch for controlling said electrically operated means, a tube for interconnecting the user with said pneumatically operated switch, said tube adapted to be so connected to the user that initial expansion of the user's lungs upon the initiation by the user of an inhalation creates negative pressure in said tube, a diaphragm in said pneumatically operated switch which is actuated by said negative pressure to control a circuit to said electrically operated means, whereby said valve is adapted to be closed upon the initiation of each period of inhalation by the user, thereby to aid the user during the remainder of each period of inhalation, a second pneumatically operated switch for controlling said electrically operated means when said first pneumatically operated switch fails to function for a predetermined period of time, a transfer conduit providing communication between said second pneumatically operated switch and the interior of the casing, a check valve in said conduit which is moved to open position by negative pressure in the conduit and to closed position by at least substantially atmospheric pressure in the conduit, whereby said second switch is adapted to be moved in one direction by negative pressure created in said transfer circuit by said means for continuously creating negative pressure.

4. The combination of claim 3 also comprising a substantially air-tight chamber on one side of the diaphragm of said first pneumatically operated switch, one end of said user interconnecting tube communicating with said chamber, a passage providing communication between said chamber and the atmosphere and means for controlling the effective size of said passage, whereby after the cessation of the creation of negative pressure at the user end of said tube the pressure in said chamber is returned to at least substantially atmospheric pressure by the flow of air through said passage from the atmosphere.

5. Apparatus for producing artificial respiration comprising a substantially air-tight respirator casing to receive and enclose at least part of the user's chest but with his head exposed to the atmosphere, means for continuously creating negative pressure, a negative pressure conduit having one end communicating with said pressure creating means and the other end communicating with the interior of the casing, an atmospheric conduit providing communication between the interior of the casing and the atmosphere, a valve in the atmospheric conduit movable to open and closed positions and which, when in open position, admits gas from the atmosphere through the atmospheric conduit to the casing to assist the user's exhalation and substantially to neutralize the negative pressure created in the casing by said pressure creating means during each period of inhalation, electrically operated means to actuate said valve, and a pneumatically operated switch for controlling said electrically operated means, a tube for interconnecting the user with said first pneumatically operated switch, said tube adapted to be so connected to the user that initial expansion of the user's lungs upon the initiation by the user of an inhalation creates negative pressure in said tube, a diaphragm in said pneumatically operated switch which is actuated by said negative pressure to control a circuit to said electrically operated means, whereby said valve is adapted to be closed upon the initiation of each period of inhalation by the user, thereby to aid the user during the remainder of each period of inhalation, a second pneumatically operated switch for controlling said electrically operated means when said first pneumatically operated switch fails to function for a predetermined period of time, a transfer conduit providing communication between said second pneumatically operated switch and the interior of the casing, a check valve in said conduit which is moved to open position by negative pressure in the conduit and to closed position by at least substantially atmospheric pressure in

the conduit and means for controlling the effective size of the transfer conduit, whereby the amount of time necessary for sufficient negative pressure to be transmitted through said transfer conduit to the second pneumatically operated switch may be adjusted so that the second switch will not operate to control said electrically operated means until a predetermined period of time has elapsed during which said first pneumatically operated switch fails to control said electrically operated means.

6. Apparatus for producing artificial respiration comprising a substantially air-tight respirator casing to receive and enclose at least part of the user's chest but with his head exposed to the atmosphere, means for continuously creating negative pressure, a negative pressure conduit having one end communicating with said pressure creating means and the other end communicating with the interior of the casing, an atmospheric conduit providing communication between the interior of the casing and the atmosphere, a valve in the atmospheric conduit movable to open and closed positions and which, when in open position, admits gas from the atmosphere through the atmospheric conduit to the casing to assist the user's exhalation and substantially to neutralize the negative pressure created in the casing by said pressure creating means during each period of inhalation, electrically operated means to actuate said valve, and a pneumatically operated switch for controlling said electrically operated means, a tube for interconnecting the user with said pneumatically operated switch, said tube adapted to be so connected to the user that initial expansion of the user's lungs upon the initiation by the user of an inhalation creates negative pressure in said tube, a diaphragm in said pneumatically operated switch which is actuated by said negative pressure to control a circuit to said electrically operated means, whereby said valve is adapted to be closed by initiation of each period of inhalation by the user, thereby to aid the user during the remainder of each period of inhalation, a second pneumatically operated switch for controlling said electrically operated means when said first pneumatically operated switch fails to function for a predetermined period of time, a transfer conduit providing communication between said second pneumatically operated switch and the interior of the casing, a negative pressure by-pass conduit in said transfer conduit, an atmospheric by-pass conduit in said transfer conduit, a negative pressure check valve in said negative pressure by-pass conduit which is moved to open position by negative pressure in said negative pressure by-pass conduit and to closed position by at least substantially atmospheric pressure therein, a substantially atmospheric pressure check valve in said atmospheric by-pass conduit which is moved to open position by at least substantially atmospheric pressure in said atmospheric by-pass conduit and to closed position by negative pressure therein, whereby said switch is adapted to be moved in one direction by negative pressure created in said negative pressure by-pass conduit and in the other direction by at least substantially atmospheric pressure created in said atmospheric by-pass conduit and means for controlling the effective size of the transfer conduit.

7. Apparatus for producing artificial respiration comprising a substantially air-tight respirator casing to receive and enclose at least part of the user's chest but with his head exposed to the atmosphere, means for continuously creating negative pressure, a negative pressure conduit having one end communicating with said pressure creating means and the other end communicating with the interior of the casing, an atmospheric conduit providing communication between the interior of the casing and the atmosphere, a valve in the atmospheric conduit movable to open and closed positions and which, when in open position, admits gas from the atmosphere through the atmospheric conduit to the casing to assist the user's exhalation and substantially to neutralize the negative pressure created in the casing by said pressure creating means during each period of inhalation, electrically op-

erated means to actuate said valve, and a pneumatically operated switch for controlling said electrically operated means, a tube for interconnecting the user with said pneumatically operated switch, said tube adapted to be so connected to the user that initial expansion of the user's lungs upon the initiation by the user of an inhalation creates negative pressure in said tube, a diaphragm in said pneumatically operated switch which is actuated by said negative pressure to control a circuit to said electrically operated means, whereby said valve is adapted to be closed upon the initiation of each period of inhalation by the user, thereby to aid the user during the remainder of each period of inhalation, a second pneumatically operated switch for controlling said electrically operated means when said first pneumatically operated switch fails to function for a predetermined period of time, a transfer conduit providing communication between said pneumatically operated switch and the interior of the casing, a negative pressure by-pass conduit in said transfer conduit, an atmospheric by-pass conduit in said transfer conduit, a negative pressure check valve in said negative pressure by-pass conduit which is moved to open position by negative pressure in said negative pressure by-pass conduit and to closed position by at least substantially atmospheric pressure therein, a substantially atmospheric pressure check valve in said atmospheric by-pass conduit which is moved to open position by at least substantially atmospheric pressure in said atmospheric by-pass conduit and to closed position by negative pressure therein, means for controlling the effective size of the passage of the negative pressure by-pass, means for controlling the effective size of the passage of the atmospheric pressure by-pass and means for controlling the effective size of the transfer conduit, whereby the amount of time necessary to build up sufficient negative pressure in said transfer conduit to operate said second pneumatically operated switch and the amount of time necessary to build up sufficient atmospheric or positive pressure to operate said second pneumatically operated switch may be controlled so that said second pneumatically operated switch controls said electrically operated means only when said first pneumatically operated switch fails to function for a predetermined period of time.

8. Apparatus for producing artificial respiration comprising a substantially air-tight respirator casing to receive and enclose at least part of the user's chest but with his head exposed to the atmosphere, a negative pressure conduit communicating with the casing, suction means connected to the negative pressure conduit for creating negative pressure within the casing to assist the user's inhalation, an atmospheric pressure conduit providing communication between the interior of the casing and the atmosphere, a valve in the atmospheric conduit movable to open and closed positions and which, when in open position, admits at least atmospheric pressure to the casing to assist the user's exhalation, a first pressure responsive control means, a passage interconnecting the user with the first pressure responsive control means, one end of said passage adapted to be so connected to the user as to expose the first pressure responsive control to negative pressure by the initiation of an inhalation by the user, said first pressure control means being operative to close the valve upon the initiation of each period of inhalation by the user and to open the valve upon the termination of each period of inhalation, a second pressure responsive control means, a transfer conduit interconnecting the atmospheric conduit with the second pressure responsive control means, for exposing the second pressure responsive control means to predetermined variations of the pressure in the atmospheric conduit, and adjustable valves in the transfer conduit for regulating the flow of gas existing in said transfer conduit at said predetermined variations of pressure through said transfer conduit at a predetermined rate so as to expose the second pressure responsive control means thereto at predetermined intervals, the rate of said predetermined intervals being slower

13

than the rate of the periods of initiation of inhalation and exhalation by the user, said second pressure responsive control means being responsive to said predetermined variations of pressure in the atmospheric conduit and operative to close and open the valve at predetermined intervals upon the first pressure responsive control means becoming inoperative because of the inability of the user to initiate the period of inhalation.

9. Apparatus for producing artificial respiration comprising a substantially air-tight respirator casing to receive and enclose at least part of the user's chest but with his head exposed to the atmosphere, a negative pressure conduit communicating with the casing, suction means connected to the negative pressure conduit for creating negative pressure within the casing to assist the user's inhalation, an atmospheric conduit having communication between the interior of the casing and the atmosphere or a source of positive pressure, a valve in the atmospheric conduit movable to open and closed position and which, when in open position, admits at least substantially atmospheric or positive pressure to the casing to assist the user's exhalation, and pressure responsive control means including a diaphragm and a diaphragm operated switch, electrical means for opening and closing the valve and a circuit electrically interconnecting the switch with said electrical means, the switch when closed being operative to close the circuit to energize said electrical means and to open the valve, and the switch when open being operative to open the circuit to de-energize the electrical means and to close the valve, means for pneumatically interconnecting the user with the diaphragm and constructed and arranged so as to expose the diaphragm to variations of the pressure in the user's lungs, said diaphragm being movable in response to said variations in pressure to open the switch upon the initiation of each period of inhalation by the user.

10. Apparatus for producing artificial respiration comprising a respirator casing to receive and enclose at least part of the user's chest and adapted to give the user access to the atmosphere for breathing purposes, means for creating a negative pressure, a source of positive or atmospheric pressure, a conduit system affording communication between the interior of said casing, said means for creating negative pressure and said source of pressure, valve means in said conduit system adapted to be operated to alternately afford operative communication between the interior of said casing and said means for creating negative pressure and said source of pressure, means for controlling the operation of said valve means through a time cycle comprising two alternating time periods, during one of which periods said valve means is actuated to provide operative communication between the interior of said casing and said means for creating negative pressure to produce within said casing a negative pressure whereby inhalation is induced in the user, and during the other of said time periods, said valve means is actuated to provide operative communication between the interior of said casing and said source of pressure to produce substantially atmospheric or positive pressure within the interior of said casing, whereby exhalation occurs, said control means comprising means for actuating said valve means to initiate said negative pressure period of said cycle in response to initiation by the user of each inhalation and to actuate said valve means to terminate said negative pressure period and initiate the other pressure period of said cycle after termination of said inhalation.

11. The apparatus of claim 10 including a second means for controlling the operation of said valve means through a cycle similar to said first mentioned cycle when the first valve control means fails to function for a predetermined time, said second valve control means comprising means responsive to variations in pressure within the interior of said casing for actuating said valve means through said similar cycle when said first valve

14

control means fails to function for a predetermined time.

12. Apparatus for producing artificial respiration comprising a substantially air-tight respirator casing to receive and enclose at least part of the user's chest but adapted to give the user access to the atmosphere for breathing purposes, means for transmitting negative pressure to the interior of said casing to induce inhalation in the user, means for transmitting positive or atmospheric pressure to the interior of said casing whereby exhalation occurs without any effort on the part of the user, valve means associated with said pressure transmitting means and adapted to be operated to alternately provide for the transmission of said negative pressure and said positive or atmospheric pressure to said interior, pneumatic means, responsive to initiation by the user of each inhalation when said pneumatic means is operably connected with the user, for operating said valve means through a time cycle comprising two alternating periods, during one of which periods said valve means is actuated to provide for said transmission of negative pressure to said casing, whereby completion of said inhalation is induced and during the other of said periods said valve means is actuated to provide for the transmission of said positive or atmospheric pressure to said casing, whereby exhalation occurs with no effort on the part of the user.

13. Apparatus for producing artificial respiration comprising a substantially air-tight respirator casing to receive and enclose at least part of the user's chest but adapted to give the user access to the atmosphere for breathing purposes, means for transmitting negative pressure to the interior of said casing to induce inhalation in the user, means for transmitting positive or atmospheric pressure to the interior of said casing whereby exhalation occurs without effort on the part of the user, valve means associated with said pressure transmitting means and adapted to be operated to alternately provide for the transmission of said negative pressure and said positive or atmospheric pressure to said interior, first means for controlling the operation of said valve means through a time cycle comprising two alternating periods, during one of which periods said valve means is actuated to provide for the transmission of negative pressure to the interior of said casing to induce inhalation in the user and during the other of said periods said valve means is actuated to provide for the transmission of positive or atmospheric pressure to said interior, whereby exhalation occurs, said means for controlling the operation of said valve means including a chamber, means responsive to pressure variations in said chamber for operating said valve means, means, responsive to the initial expansion of the user's lungs upon initiation by the user of an inhalation, for creating negative pressure in said chamber, said valve operating means being responsive to said creation of negative pressure in said chamber to actuate said valve means to initiate a negative pressure period of said cycle and induce the completion of said inhalation without further effort on the part of the user, second means for automatically controlling the operation of said valve means through a cycle similar to the first mentioned cycle when said first valve control means fails to function for a predetermined period of time, said second valve control means including a second chamber, means, responsive to variations of pressure in said second chamber when said first valve control means fails to function for a predetermined period of time, for automatically operating said valve means through said similar time cycle, and means responsive to pressure variations within the interior of said casing for varying the pressure in said second chamber to automatically and cyclically actuate said second valve operating means through said similar cycle when said first valve control means fails to function for a predetermined period of time, said means for varying the pressure in said second chamber including conduit means providing for the flow of gases into and out of said second chamber, said last mentioned conduit

15

means having means for restricting the operable size thereof and hence the rate of flow of gas therethrough.

14. Apparatus for producing artificial respiration comprising a substantially air-tight respirator casing to receive and enclose at least part of the user's chest but adapted to give the user access to the atmosphere for breathing purposes, means for transmitting negative pressure to the interior of said casing to induce inhalation in the user, means for transmitting positive or atmospheric pressure to the interior of said casing to induce exhalation in the user, valve means associated with said pressure transmitting means and adapted to be operated to alternately provide for the transmission of said negative pressure and said positive or atmospheric pressure to said interior, means for controlling the operation of said valve means through a time cycle comprising two alternating periods, during one of which periods said valve means is actuated to provide for the transmission of negative pressure to the interior of said casing and to induce inhalation in the user and during the other of said periods said valve means is actuated to provide for the transmission of positive or atmospheric pressure to the interior of said casing whereby exhalation occurs without any effort on the part of the user, said valve control means comprising a chamber, means responsive to pressure variations in said chamber for operating said valve means, means responsive to the initiation of inhalation by the user for varying the pressure in said chamber to actuate said valve operating means and said valve means through said inhalation period whereby the completion of said inhalation is induced without further effort on the part of the user when said respirator casing is operably connected with said user and means responsive to the termination of said inhalation to actuate said valve operating means and said valve means to initiate said exhalation period whereby exhalation occurs without any effort on the part of the user.

15. A valve apparatus for cyclically producing alternating pressures of different magnitudes in apparatus for treating users comprising, delivery conduit means, means for transmitting pressure of one magnitude to said delivery conduit means, means for transmitting pressure of a different magnitude to said delivery conduit means, valve means associated with said pressure transmitting means and adapted to be operated to alternately provide for the transmission of said pressure of one magnitude and said pressure of a different magnitude to said delivery conduit means, pneumatic means, responsive to initiation by the user of each inhalation when said pneumatic means is operably connected to the user, for operating said valve means through a time cycle comprising two alternating periods, during one of which periods said valve means is actuated to provide for the transmission of said pressure of one magnitude to said delivery conduit means and during the other of said periods said valve means is actuated to provide for transmission of said pressure of a different magnitude to said delivery conduit means, second pneumatic means for automatically actuating said valve means through a cycle similar to said first mentioned cycle when said first pneumatic means fails to function for a predetermined time.

16. A valve apparatus for cyclically producing alternating pressures of different magnitudes in apparatus for treating users comprising delivery conduit means, a first port for communication with a first source of pressure of one magnitude, a second port for communication with a second source of pressure of a different magnitude, a conduit system for affording operative communication between said first port and said delivery conduit means and between said second port and said delivery conduit means, valve means to alternately provide for the transmission of a pressure of one magnitude from said first port through said conduit system to said delivery conduit means, whereby inhalation is automatically induced in said user when said delivery conduit means is operably connected with

16

the user and for the transmission of a pressure of a different magnitude from said second port through said conduit system to said delivery conduit means, whereby exhalation occurs with no effort on the part of the user, pressure sensitive means for actuating said valve means, said pressure sensitive means being remote from the flow path of gas flowing between said delivery conduit means and the port from which the pressure of greater magnitude is transmitted while said pressure of greater magnitude is being transmitted to said delivery conduit means, means for transmitting negative pressure created by initiation of an inhalation by the user to said pressure sensitive means when said pressure sensitive means is operatively connected to said user, said pressure sensitive means being responsive to said transmission of said negative pressure thereto to actuate said valve means to provide for said transmission of pressure of one magnitude from said first port to said delivery conduit means to automatically induce the completion of said inhalation without further effort on the part of the user, said pressure sensitive means also being responsive to the completion of said inhalation to automatically actuate said valve means to provide for said transmission of a pressure of a different magnitude from said second port to said delivery conduit means, whereby exhalation occurs with no effort on the part of the user.

17. The apparatus of claim 16 including second pressure sensitive means, responsive to variations of pressure in said delivery conduit means, for automatically actuating said valve means through a time cycle comprising two alternating periods when said first pressure sensitive means fails to function for a predetermined time, during one of which periods said valve means is actuated to provide for the transmission of a pressure of one magnitude from said first port to said delivery conduit means and during the other of said periods said valve means is actuated to provide for the transmission of a pressure of a different magnitude from said second port to said delivery conduit means.

18. Apparatus for cyclically producing alternating pressures of different magnitudes in apparatus for treating users comprising delivery conduit means, a first port for communication with a first source of pressure of one magnitude, a second port for communication with a second source of pressure of a different magnitude, a conduit system affording operative communication between said first port and said delivery conduit means and between said second port and said delivery conduit means, valve means to alternately provide for the transmission of pressure of one magnitude from said first port through said conduit system to said delivery conduit means, whereby inhalation is induced in the user when he is operably connected with said delivery conduit means, and for the transmission of pressure of a different magnitude from said second port through said conduit system to said delivery conduit means, whereby exhalation occurs without effort on the part of the user, a control chamber remote from the flow path of gas flowing between said delivery conduit means and the port from which the pressure of greater magnitude is transmitted to said delivery conduit means while said pressure of greater magnitude is being transmitted to said delivery conduit means, means responsive to pressure variations in said chamber for operating said valve means, means for transmitting negative pressure created by an initiation of inhalation by the user to said chamber when said chamber is operatively connected to the user, said valve operating means being responsive to said transmission of negative pressure to said chamber to actuate said valve means to provide for said transmission of pressure of one magnitude from said first port to said delivery conduit means to thereby automatically induce the completion of said inhalation without further effort on the part of the user when said delivery conduit means is operably connected with said user.

19. Apparatus for cyclically producing alternating pres-

17
 sures of different magnitudes in apparatus for treating users comprising delivery conduit means, means for transmitting pressure of one magnitude to said delivery conduit means, means for transmitting pressure of a different magnitude to said delivery conduit means, valve means associated with said pressure transmitting means and adapted to be operated to alternately provide for the transmission of said pressure of one magnitude and said pressure of a different magnitude to said delivery conduit means, a chamber, means responsive to pressure variations in said chamber for operating said valve means, means responsive to the initiation of an inhalation by the user to vary the pressure in said chamber when said chamber is operably connected to the user, said valve operating means being responsive to said variation in pressure in said chamber caused by said initiation of inhalation by the user to actuate said valve means to provide for the transmission of said pressure of one magnitude to said delivery conduit means whereby the completion of said inhalation is automatically induced without further effort on the part of the user, and means responsive to termination of said inhalation for thereafter automatically actuating said valve means to provide for the transmission of said pressure of a different magnitude to said delivery conduit means, whereby exhalation occurs without effort on the part of the user and means for automatically operating said valve means through a time cycle comprising two alternating periods when a predetermined time has elapsed without the initiation of an inhalation by the user, during one of such periods such valve means is actuated to provide for the transmission of said pressure of one magnitude to said delivery conduit means and during the other of said periods said valve means is actuated to provide for the transmission of said pressure of a different magnitude to said delivery conduit means, said last mentioned means for automatically operating said valve means comprising a second control chamber, means for actuating said valve means through said last mentioned cycle in response to pressure variations in said second chamber, means for varying the pressure in said second chamber in response to pressure variations in said delivery conduit means, said last mentioned means including transfer conduit means for permitting the flow of gas into and out of said second chamber said transfer conduit means having means for restricting the operable size thereof and hence the rate of flow therethrough to a rate which is substantially less than the rate of flow through said valve means.

20. A valve apparatus for cyclically producing alternating negative and positive or atmospheric pressures in apparatus for treating users comprising, delivery conduit means, a source of positive or atmospheric pressure, a source of negative pressure less than the pressure of the surrounding atmosphere, a conduit system affording communication between said negative and positive or atmospheric sources of pressure and said delivery conduit means, valve means in said conduit system to alternately afford operative communication between said delivery conduit means and said positive or atmospheric pressure source and between said delivery conduit means and said negative pressure source, whereby said pressures are alternately delivered to said delivery conduit means, pneumatic means responsive to initiation of each inhalation by the user for operating said valve means without further effort on the part of the user through a time cycle comprising two alternating periods, during one of which periods said valve means is actuated to provide operative communication between said delivery conduit means and said source of positive or atmospheric pressure and during the other of said periods said valve means is actuated to provide operative communication between said delivery conduit means and said source of negative pressure.

21. The apparatus of claim 20 including second pneumatic means for automatically actuating said valve means through a cycle similar to said first mentioned cycle when said first pneumatic means fails to function for a predetermined time.

22. The apparatus of claim 14 wherein said means for actuating said valve means to terminate said inhalation period and initiate said exhalation period comprises transfer conduit means for communicating between said chamber and a source of gas, said transfer conduit means having means for restricting the operable size thereof and hence the rate of gas flow therethrough.

23. The apparatus of claim 14 wherein said means for actuating said valve means to terminate said inhalation period and initiate said exhalation period is responsive to the resistance of the user's lungs to flow of gas thereinto.

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