

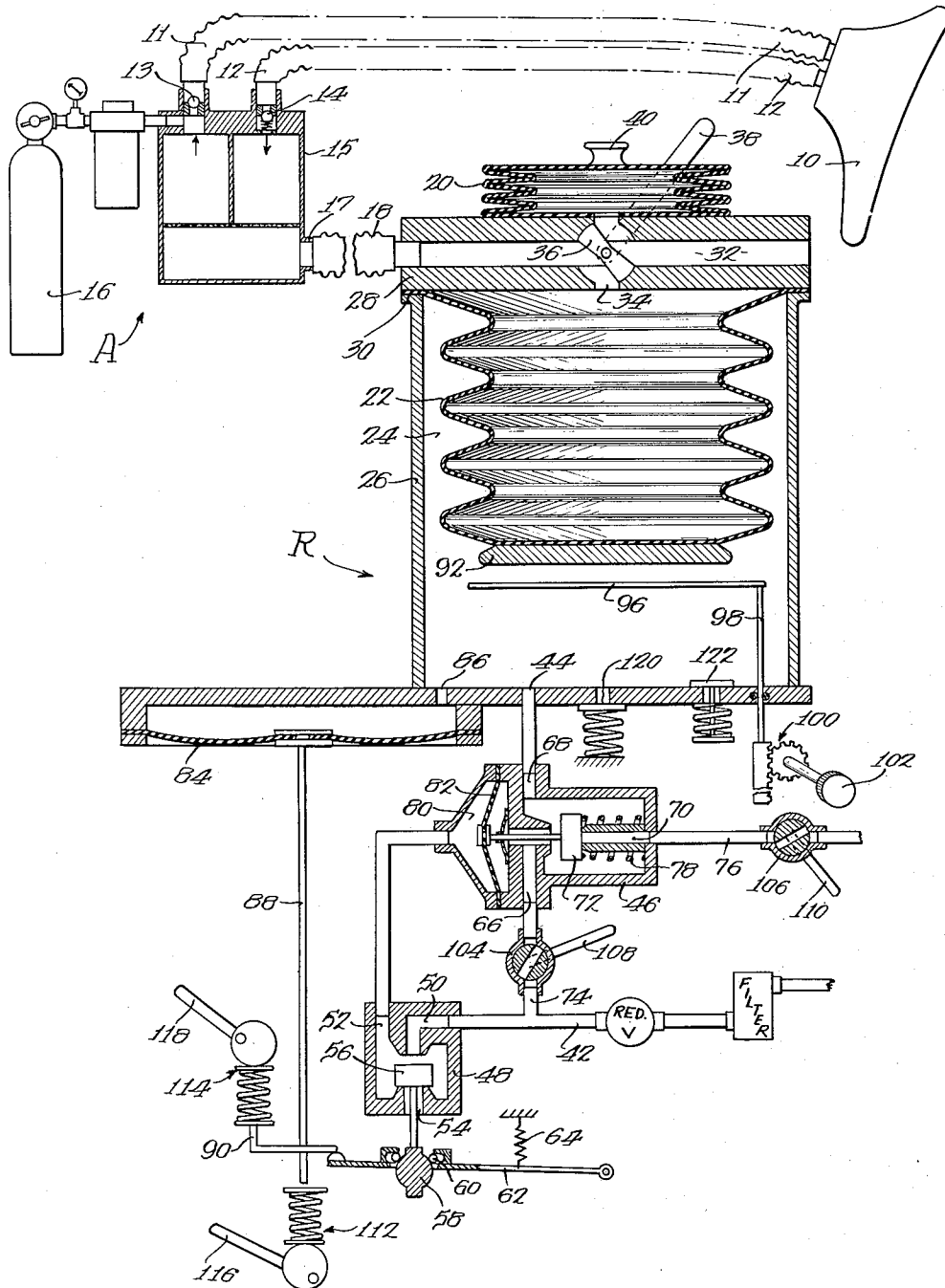
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RESPIRATOR

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RESPIRATOR

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The present invention relates to respirators; particularly to improved mechanical respiratory means for use for humans in the event of injury to or disability of the human respiratory system and/or during surgery.

Serious respiratory or cardiac conditions frequently occur during surgery, especially thoracic operations. Under such conditions, respiration must be assisted and/or controlled, and mechanical respirators intended for the general purpose are known. However, respirators previously proposed have been concerned principally or solely with the act of breathing and the relation of the act to surgical manipulations. Respiration, of course, serves to ventilate the blood by maintaining or supplying oxygen and removing carbon dioxide, but the physiological effects of breathing on the organisms of the body other than the lungs have generally been ignored heretofore in the art of mechanical respiration. In particular, normal breathing has pronounced effect on the heart and circulatory system, in that pressure in the region of the heart is substantially decreased during normal inspiration to assist in the venous return of blood and the diastolic filling of the heart. Research has proven that most efficient blood circulation is obtained when pressures in the lungs are alternately positive and negative. Yet, most mechanical respirators have operated principally on theories of intermittent positive pressures and positive differential pressure breathing, which may result in serious or disastrous consequences to thoracic organisms, particularly the heart.

Moreover, of the prior art respirators, most have produced a constant regular positive pressure rhythm forcing the patient to breathe in the rhythm of the machine. Generally, if the patient is respiring, the natural rhythm of respiration should be maintained, and assisted in those cases where weak. In special circumstances, controlled respiration is required, and in such cases complete control is necessary, not merely a constant regular rhythm.

One object of the present invention is the provision of improved mechanical respiratory means which automatically produces positive and negative pressures in the lungs of a patient.

A second object of the invention is the provision of improved respiratory means responsive to the breathing of the patient to assist existing respiration and to maintain as nearly as possible normal conditions in the thoracic region of the patient.

In combination with the two stated objects, the invention further provides improved respiratory means capable of substantially duplicating any respiratory condition and of exerting complete control over the patient's respiration when necessary.

Another and more specific object of the invention is to provide improved respiratory means of the character defined capable of independently controlling the duration, rate, volume, and pressure of both inspiration and expiration.

A further object of the invention is the provision of means of the character above defined capable of exerting

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minute control over a patient's respiration throughout the full range of the respiratory capabilities of the patient.

It is also an object of the invention to provide means as defined equally adapted for use with conventional anesthesia equipment and for direct application to the patient.

A still further object of the invention is to embody such means simply, economically and practically in a conveniently controlled automatic machine.

Additional objects include the provision of means of the character defined available for immediate use when required, but accommodating unassisted and uncontrolled respiration by the patient, and also accommodating manual assistance to or control of the patient's breathing by the anesthetist.

These and other objects and advantages of the invention will become apparent in the following detailed description of the theory, general make-up, functions and operation of my improved respiratory means. In the description, reference is made to the accompanying drawing schematically showing my respiratory means and its association with conventional anesthesia apparatus.

Referring to the drawing, the respiratory means of the invention is indicated generally at R and conventional anesthesia means associated therewith is indicated at A. The anesthesia apparatus comprises, principally, a mask 10, flexible inlet and outlet conduits or tubes 11 and 12 provided with check valves 13 and 14, respectively, and absorber or rebreather means 15 to which the mask is connected by the tubes. The rebreather means contains a suitable chemical, such as soda-lime, for removing carbon dioxide from the exhaled breath of the patient passing through the tube 12, so that the air may safely be recirculated back to the patient through the tube 11. To replenish or enrich the oxygen supply, a tank 16 containing oxygen communicates with the mask inlet tube 11. In accordance with conventional practice, one or more of the tanks 16 may be provided for the purpose of supplying the patient with oxygen and/or anesthetizing agents as required. The tanks 16 or the conduits leading therefrom are provided with the customary regulators, control valves and filters. The rebreather or absorber means 15 includes an outlet 17 to which an expansible breathing bag is customarily attached.

The respiratory means of the invention is connected to the anesthesia apparatus by a flexible tube 18 connected to the rebreather outlet 17 and establishing communication between the rebreather and the interior of one or the other of two breathing bags 20 and 22. As will become apparent as the description proceeds, the bag 20 takes the place of the customary breathing bag, and the bag 22 is the motivated instrumentality of the mechanical respiratory means of the invention.

The breathing bag 22 is disposed within a pressure chamber 24 preferably defined by a transparent cylinder 26. The cylinder may be closed at its lower end in any customary manner and at its upper end is closed by a cylindrical valve and port assembly 28. The bag 22 preferably comprises a cylindrical flexible bellows having a radial flange 30 at its upper end sealing between the cylinder 26 and the assembly 28. The bellows 20 may be of similar form and is sealed to the upper side of the assembly in an accessible position.

The valve and port assembly 28 as shown may comprise a cylindrical block including intersecting diametrical and axial bores 32 and 34, respectively, and a valve seat defined at the point of intersection of the bores. The axial bore 34 communicates at its opposite ends with the interior of the breathing bags 20 and 22, respectively. The bore 32 communicates at one end with the tube 18, and at its opposite end is vented to atmosphere. A valve member 36 is rotatably mounted within the valve seat

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recess of the block and comprises a cross bar seating against opposite ones of the lands between the bores 32 and 34. A handle 38 is connected to the valve exteriorly of the block to facilitate manual movement of the valve from one to the other of two effective positions. In one position, the position shown, the valve vents the bag 20 to atmosphere and establishes communication between the bag 22 and the rebreather 15 through the tube or conduit means 18. In its other position, the valve 36 vents the bag 22 to atmosphere and connects the bag 20 to the rebreather.

When the valve 36 is disposed in the latter position, the patient's breath will at least partially fill and empty the bag 20 during expiration and inspiration. The bag thus provides a visual indication of the patient's respiration. In the event that manual assistance to or control of respiration is desired or necessary, the anesthetist may use the bag 20 as a pump, manipulating the bag through a short distance in the rhythm of the patient's breathing to assist respiration and moving the bag through a greater stroke in a desired rhythm to take over and control the patient's respiration. To facilitate manipulation thereof, the bag preferably comprises a flexible bellows including a relatively rigid top provided with a handle or knob 40.

Being mounted in the manner described, the respirator bag 22 is disposed within a pressure-tight chamber 24 and mechanical respiration is effected according to the invention by variation of the fluid pressure in the chamber. Air is the preferred fluid medium and the pressure in the chamber is preferably varied between approximately atmospheric and a greater positive pressure. However, the device is equally operative at subatmospheric pressures, or at alternately positive and negative pressures. Thus, compressed air and/or vacuum may be used as the motivating medium. In the preferred embodiment, compressed air is supplied from a suitable source, such as a portable compressor, to an inlet conduit 42 suitably provided with a filter and pressure regulator. The inlet conduit communicates with the interior of the pressure chamber 24 through a port 44 provided in one wall thereof. Port 44 comprises a common inlet and outlet for the chamber and flow of air therethrough is controlled by valve means represented in the drawing as a pressure operated double acting valve 46 which is controlled by a second double acting valve 48.

The valve 48 may suitably include a normally open inlet port 50 with which the conduit 42 communicates, a continuously open port 52, a normally closed vent port 54, and a valve member 56 operative alternately to close the ports 50 and 54. The valve is of a snap-action type and is schematically shown as including a bulbous cam 58 on the valve stem which is engaged by a circular spring 60 carried by an actuating member 62 which is normally biased toward the valve by a spring 64, the circular spring 60 thus actuating the valve stem outwardly normally to close the vent port 54.

The flow controlling valve 46 includes a normally closed inlet 66, a continuously open port 68, a normally open outlet 70 and a valve member 72 operative alternately to close the inlet 66 and outlet 70. The inlet 66 is connected by a conduit 74 to the conduit 42. The port 68 communicates with the pressure chamber 24 through the port 44, and the outlet 70 communicates with a discharge or suction conduit 76. The valve member 72 is normally biased by a spring 78 to close the inlet 66 and includes a stem extending into a diaphragm chamber 80 and connected therein to a diaphragm 82. The chamber 80, to the side of the diaphragm opposite the valve, is connected to the continuously open port 52 of the valve 48.

In use, compressed air or oxygen supplied to the conduit 42 flows through the ports 50 and 52 of the valve 48 to the chamber 80 of the valve 46 wherein it acts upon the diaphragm 82 and moves the valve member 72 to open the inlet 66 and close the outlet 70 of the valve 46. Air under pressure then flows into the pressure chamber 24,

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and as pressure builds up on the exterior of the breathing bag 22, the bag is gradually compressed or contracted.

A control instrumentality comprising a flexible diaphragm 84 is associated with the pressure chamber 24 to sense the pressure therein, the diaphragm defining a secondary pressure chamber communicating with the chamber 24 through a continuously open port 86 in one wall of the pressure vessel. The diaphragm carries a stem 88 provided with a cross arm 90 disposed to engage the actuating lever 62 of the valve 48. As pressure builds up in the pressure chamber, the diaphragm 84 is moved outwardly to engage the arm 90 with the lever 62 and to force the lever 62 outwardly of the valve 48 until the spring 60 moves over-center with respect to the cam 58, thereupon snapping the valve 56 into position closing the inlet port 50 and opening the vent port 54.

When the port 54 is opened, the diaphragm chamber 80 of the valve 46 is vented to atmosphere and the spring 78 moves the valve member 72 to close the inlet 66 and open the outlet 70. Air under pressure in the pressure chamber 24 then exhausts through the ports 68 and 70 of the valve 46 and through the discharge conduit 76. As pressure within the chamber 24 is relieved, the bag 22 is released to accommodate expansion thereof. To effect positive mechanical expansion or distention of the bag, I provide the same with a heavy or weighted base plate 92 which automatically pulls the bag open as pressure decreases in the chamber 24. The weighted base plate 92 thus comprises mechanical means for distending the breathing bag and is exemplary of a variety of bag distending means that may be employed.

As pressure in the chamber 24 is decreased, the pressure on the diaphragm 84 is decreased equally, whereupon the spring 64, acting through lever 62, moves the diaphragm and its stem back toward normal position. When the pressure is lowered sufficiently, the spring 64 returns the lever 62 to normal position. As the spring 60 moves back over-center with respect to the cam 58, the valve 56 is snapped back into position closing the vent port 54 and opening the inlet 50, whereupon compressed air is again supplied to the system from the conduit 42 to repeat the described cycle of operation.

From the foregoing, it is to be appreciated that the breathing bag 22 is alternately contracted by means of compressed air and distended by the weighted base plate 92 upon relief of pressure. In the apparatus shown, the means defining the pressure chamber 24 and compressed air thus comprise bag contracting means, while the base plate 92, as responsive to relief of pressure in the chamber, comprises bag distending means. The breathing bag defines therein an air chamber that is effectively diminished and enlarged in size by the said contracting and distending means, so that the pressures therein are alternately positive and negative, respectively. When the bag 22 communicates with the patient's lungs through the valve assembly 28 and tube 18, the alternately negative and positive pressures in the bag assist or control the patient's respiration, and substantially duplicate the normal alternately positive and negative pressures in the lungs and the normal intermittent variable pressure conditions in the remainder of the thorax.

As is to be appreciated, the anesthetist may at any time switch the breathing bags 20 and 22 selectively into and out of the closed respiratory circuit to observe the actual respiration of the patient and mechanically assist or control respiration.

To facilitate complete regulation of the respiratory means described, I provide five control means effective to regulate the respirator for assisted or controlled respiration in the patient, the volume or depth of breathing, the rate of inspiration, the rate of expiration, the pressure of inspiration and the pressure of expiration. The volume control comprises a plate 96 movably mounted in the pressure chamber 24 beneath the base plate 92 of the bag 22 to limit distention, and likewise contrac-

tion, of the breathing bag. The plate is mounted on a rod 98 extending slidably through one wall of the pressure vessel and provided at its outer end with a rack engaged by a rotatable pinion, as indicated at 100, the pinion being provided with a handle or actuating knob 102 to accommodate adjustment of the plate 96 with respect to the breathing bag.

The second and third control means comprise independently adjustable flow restricting valves 104 and 106 disposed, respectively, in the inlet conduit 74 to the pressure chamber and the discharge conduit 76 leading from the pressure chamber. The valve 104 controls the rate of admittance of air to the pressure chamber and thereby controls the rate of contraction of the bag 22 and the rate of inspiration of the patient. The valve 106, since it controls the rate of discharge of air from the pressure chamber, controls the rate of distention of the bag and thus the rate of expiration of the patient. The valves are provided with handles 108 and 110, respectively, to facilitate manipulation thereof.

The fourth and fifth controls are independently adjustable means for controlling the movement in opposite directions of the valve controlling diaphragm 84. The two controls are indicated at 112 and 114, and each comprises a compression spring, plates at the opposite ends of the spring and an adjustable cam actuated by a handle 116 and 118, respectively. The spring of the means 112 controls downward movement of the diaphragm stem 88 to accommodate variation in the pressure at which the valves 48 and 46 are actuated, thus to control the degree of contraction of the bag 22 by air pressure, and thereby the end or maximum pressure of the patient's inspiration. The means 114 is associated with the cross arm 90 of the stem 88 to control upward movement thereof and thus control the pressure at which venting of air from the pressure chamber is discontinued and entrance of air is again accommodated. Accordingly, the means 114 controls the degree of distention of the breathing bag and the end or minimum pressure of the patient's expiration.

To safeguard the patient, overpressure and underpressure relief valves 120 and 122 are provided in one wall of the pressure vessel, which valves also serve to safeguard the vessel.

Having described the apparatus, the functions thereof are best understood in connection with a patient's requirement under thoracic surgery wherein the surgeon may demand certain respiratory conditions and/or control of lung movement. Before anesthesia, the respiratory means is set into action by supplying compressed air thereto. The patient's respiration may initially be adequate in which case the valve 36 is adjusted by the handle 38 so that the breathing bag 22 is vented to atmosphere and the manually operable breathing bag 20 communicates with the anesthesia apparatus through the tube 18. The mask 10 is fitted over the patient's nose and mouth whereupon a closed breathing circuit is established between the patient's lungs, the mask 10, the tubes 11 and 12, the rebreather 15, the tube 18 and the bag 20. As the patient breathes out and in, the bag 20 expands and contracts, respectively. Under these conditions, anesthetizing agents may be supplied to the patient in the customary manner.

Should the anesthetics produce sufficient depression that the respiratory centers do not function properly and respiration tends to weaken, the anesthetist may assist or control respiration manually by manipulation of the breathing bag 20.

In the event that respiration during surgery will require more or less continual assistance, the anesthetist, by observation of the bag 20, may adjust the controls 102, 108 and 110 in such manner that the bag 22, which is visible through the transparent cylinder 26, substantially duplicates the movements of the bag 20. Thus, mechanical movement of the breathing bag 22 is adjusted

substantially to duplicate the patient's own respiration. The breathing bag 22 may be continuously in operation once the supply of compressed air is started, even though the bag is vented to atmosphere. Thus, adjustment of the apparatus generally to approximate the rates and volume of the patient's inspiration and expiration is readily effected. If assisted respiration is dictated, the pressure controls are adjusted to relatively low values in the first instance, and the handle 38 of the valve 36 is then moved to place the bag 22 in the closed respiration circuit and to vent the bag 20 to atmosphere. As the patient breathes into and out of the bag 22, the patient dictates the movement of the bag due to the relatively low pressure influence of air in the chamber 24, and the apparatus almost immediately falls into step with the patient's existing respiration, even though that be highly irregular. The control handles 116 and 118 may then be set for appropriate maximum and minimum pressures in the apparatus.

During assisted respiration, positive pressure is created in the bag 22 during inspiration to increase the pressure in the upper airways of the patient, thus to overcome the work required to move the inspiratory air down into the alveoli. During expiration, a negative or subatmospheric pressure is created in the bag 22 to decrease the pressure in the upper air passages, thus to overcome the resistance to expiration. By this means, paradoxical respiration is prevented in cases where the pleural space is opened on one side. This eliminates the occurrence of the pendel-air that would normally pendulate back and forth from the lung on the intact side to the lung on the open side. In such instances, the apparatus of the invention serves to prevent increase in the dead air space in the lungs and to maintain oxygen tension and prevent increase in the carbon dioxide tension in the alveolar air. Yet, the patient may dictate entirely the volume and rate of inspiration and expiration.

Moreover, while respiration is assisted in the manner described, internal pressure variations in the thorax are optimal. In particular, strain on the heart is minimized as is interference with circulation.

If the patient becomes apnoeic, or respiration is exceedingly weak, the apparatus of the invention will automatically take over the breathing of the patient substantially in accordance with the rhythm originally dictated by the patient in accordance with the above.

On the other hand, if controlled respiration is dictated by surgical considerations or by the patient's general condition, it is only necessary to increase the air pressure, by suitable manipulation of the control handles 116 and 118, until the motivating pressures on the bag 22 overcome the pressures of the patient's respiration and force the patient to breathe as dictated by movement of the bag 22. Movement of the bag 22 in turn is dictated by the anesthetist by manipulation of the controls, the knob 102 controlling volume, the valve 104 the rate of inspiration, the valve 106 the rate of expiration, the control 112 the pressure of inspiration, and the control 114 the pressure of expiration. By independent adjustment of the five controls, substantially any normal rhythm of respiration may be duplicated by the anesthetist.

The extreme example is hyperventilation-apnea. Assume the surgeon wants the patient's lungs to be entirely still for a brief period. In the human system, this would be tantamount to holding one's breath. To effect the stated object, it is desirable to hyperventilate, i.e., to clear the blood of carbon dioxide and build up the supply of oxygen therein, to the extent possible in the period immediately prior to apnea, so that breathing may be stopped for the longest possible period.

In the apparatus of the invention, this is accomplished by increasing the volume and rate of inspiration and expiration thereby to breathe heavily for the patient. The volume is adjusted by the knob 102 and the rate of inspiration and expiration are increased by opening the

valves 104 and 106. After a period of hyperventilation, apnea is produced.

To produce apnea with the lungs expanded the valve 106 may be closed at any time after inspiration commences. That will not interfere with contraction of the bag or the patient's inspiration. However, as soon as the valve 46 is actuated in the manner previously described, air flow to the chamber is cut off and the bag is kept collapsed because air cannot escape from the chamber since the valve 106 is closed.

To still lung action when the lungs are contracted, the valve 104 may be closed during expiration. When the bag 22 is fully distended the valve 46 will change over to admit air but the device is stalled with the bag in that condition because valve 104 is closed.

Obviously, apnea may be produced at any intermediate stage of respiration by closing either of the valves 104 or 106 at the appropriate time in the inspiratory or expiratory stage, respectively.

From these examples, it is seen that variation in the openings of the valves 104 and 106 will accommodate any rate of inspiration or expiration. End pressure is dependent upon adjustment of the means 112 and 114. Volume is controlled by adjustment of the plate 96. Duration of course will be dependent upon the rate in relation to the end pressure and/or volume. By suitable adjustment of the five control means, any respiratory condition can be substantially duplicated. The apparatus is fully responsive to pressure variations to insure complete inspiration and expiration by the patient and to be regulated by the patient's rhythm of breathing in the case of assisted respiration. The apparatus produces positive and negative pressures in the patient's lungs to maintain optimal conditions in the thorax. Under controlled respiration, the pressures of the thorax are reversed from normal, i.e., are highest on forced inspiration and lowest on forced expiration, but the heart and other organisms rapidly adjust to the changed cycle and perform efficiently as long as the pressures are alternately positive and negative in the lungs.

Moreover, the apparatus of the invention particularly duplicates the normal human expiratory cycle in that the mechanical means that normally distends the breathing bag, i.e., the weight, upon venting of the pressure chamber produces within the bag (and thus within the patient's lungs) a decrease in pressure pursuant to an exponential function. In other words, at the start of the expiratory cycle, the weight produces a relatively sharp initial drop in pressure, followed by a gradual decrease in pressure and/or maintenance of the decreased pressure condition. In cooperation with the weight or mechanical distending means, the adjustable plate 96 is operative to vary the duration of the relatively sharp initial drop in pressure and the valve 106 is operative to vary the rate of the total drop in pressure. By virtue of the exponential pressure curve thus produced, the pressure within the chest of the patient, occasioned by the inspiratory cycle, is quite rapidly relieved, and is then maintained relieved for a relatively long period of time to facilitate venous return of blood to the heart, thereby insuring not only proper respiration, but proper circulation of blood through the patient's body during use of the respirator.

In view of the foregoing, it is to be appreciated that the respiratory means of the invention is capable of satisfying every condition that may be imposed upon a respirator, even in complicated thoracic surgery. The device is equally effective in cases of apnea and weakened respiratory action resulting from depression or pathology, such as poliomyelitis. In polio cases, the breathing bags 20 and 22 can be connected to the patient's lungs through appropriate valve means and by means of a pipe fitted into the patient's throat. This leaves the patient free of substantial encumbrances, permits access to the patient for routine check up and nursing care, and permits the patient

to lie normally in bed, rather than being confined to an iron lung, chest shell or like device.

While the apparatus as described is preferably operated only on compressed air, expiration can be effected, and control thereof enhanced, by connecting the discharge conduit 76 to a suction or vacuum pump. Control fluids other than air may be employed if desired.

From the description of the basic apparatus, it is to be appreciated that the respiratory means of the invention is economically constituted and that all of the objects and advantages of the invention may be economically and efficiently obtained.

While I have described what I regard to be satisfactory and effective apparatus for physical embodiment of the respiratory means of my invention, it is to be appreciated that variations, changes, rearrangements and modifications may be made therein without departing from the scope of the invention, as defined by the appended claims.

I claim:

1. In a respiratory means, in combination, breathing bag means, a weight carried by said breathing bag means for normally distending the same, means for contracting said breathing bag means, said contracting means and said weight alternately actuating said breathing bag means whereby alternating positive and negative pressures are created within said breathing bag means, said weight subsequent to contraction of the bag means causing a relatively rapid initial distention of said bag means for producing a relatively sharp initial drop in pressure in said bag means and for causing the pressure in said bag means to decrease pursuant to an exponential function.

2. In a respiratory means, in combination, breathing bag means, a weight carried by said breathing bag means for normally distending the same, means for contracting said breathing bag means, means for controlling said contracting means for alternately contracting said breathing bag means and permitting said weight to distend said breathing bag means whereby alternating positive and negative pressures are created within said breathing bag means, said weight subsequent to contraction of the bag means causing a relatively rapid initial distention of said bag means for producing a relatively sharp initial drop in pressure in said bag means, first independent adjustable control means for said contracting means for varying the rate of contraction of said breathing bag means, second independent adjustable control means for said contracting means for varying the degree of contraction and the maximum internal pressure of said breathing bag means, third independent adjustable control means for varying the rate of distention of said breathing bag means, and fourth independent adjustable control means for limiting the degree of distention of said breathing bag means, said third and fourth adjustable control means being adjustable to vary the duration of said sharp initial drop in pressure and the rate of pressure drop thereafter.

3. In a respiratory means, in combination, a pressure chamber, expansible breathing bag means in said chamber, a weight normally distending said breathing bag means, means for connecting said chamber exteriorly of said bag means to a fluid pressure source, said bag means being adapted to be contracted by fluid pressure and to be distended by said weight upon release of fluid pressure, and valve means for controlling communication between said chamber and a fluid pressure source for alternately establishing communication between the fluid pressure source and said chamber and releasing fluid pressure from said chamber, whereby said bag means is alternately contracted and expanded to create alternating positive and negative pressures therein.

4. In a respiratory means, in combination, a pressure chamber, expansible breathing bag means in said chamber, a weight normally distending said breathing bag means, means for connecting said chamber exteriorly of said bag means to a fluid pressure source, said bag means being adapted to be contracted by fluid pressure and

to be distended upon release of fluid pressure, valve means for controlling communication between said chamber and a fluid pressure source for alternately establishing communication between the fluid pressure source and said chamber and releasing fluid pressure from said chamber, whereby said bag means is alternately contracted and expanded to create alternating positive and negative pressures therein, said weight upon release of fluid pressure causing a rapid initial distention of said bag means to produce a sharp initial pressure drop in said bag means, inlet and outlet conduit means for said chamber for establishing communication between the fluid pressure source and said chamber and for accommodating release of fluid pressure from said chamber respectively, independently adjustable means for controlling each of said conduit means independently to vary respectively the rate of contraction of said bag means and the rate of distention of said bag means after said rapid initial distention, and adjustable means responsive to fluid pressure in said chamber and operatively associated with said valve means for controlling the maximum fluid pressure limit in said chamber to vary the degree of at least one of the movements of said bag means.

5. In a respiratory means, in combination, a pressure chamber, breathing bag means in said chamber, a weight normally distending said breathing bag means, means for connecting a fluid pressure source to said chamber exteriorly of said bag means for contracting said bag means, valve means for controlling said connecting means for alternately admitting and releasing fluid under pressure to and from said chamber, whereby said bag means is alternately contracted and expanded to create alternating positive and negative pressures therein, said weight upon release of fluid pressure causing a rapid initial distention of said bag means to produce a sharp initial pressure drop in said bag means, first adjustable means for controlling the rate of admittance of fluid to said chamber to vary the rate of contraction of said bag means, second adjustable means for controlling the rate of release of fluid from said chamber, means responsive solely to fluid pressure in said chamber operatively associated with said valve means for controlling fluid pressure in said chamber, third adjustable means operatively associated with said pressure responsive means for controlling the maximum pressure in said chamber to vary the degree of contraction of said bag means, and fourth adjustable means operatively associated with said bag means for limiting the degree of distention of said bag means, said second and fourth adjustable means being adjustable to vary the duration of said sharp initial drop in pressure and the rate of pressure drop thereafter.

6. In a respiratory means, in combination, a first breathing bag, means for mechanically distending and contracting said breathing bag alternately, whereby alternating positive and negative pressures are created in said bag, conduit means for establishing communication between the interior of said bag and a patient, a second manually operable breathing bag communicating with said conduit means, and valve means in said conduit means for selectively establishing communication between the patient and said first and second bags, said second bag when communicating with the patient indicating the respiration of the patient and accommodating manual assistance to and control of the patient's respiration, said first bag and said distending and contracting means being immediately responsive to communication with the patient to assist and control the patient's respiration by variation of the pressure and rate of distention and contraction of said bag means.

7. In a respiratory device having a pressure chamber, means for alternately admitting fluid under pressure to and releasing fluid from the chamber and a breathing bag

in the chamber to be alternately expanded and contracted, the improvement comprising a bellows type breathing bag, a weight carried by the bag for normally distending the same and a plate disposed in the path of movement of the weighted portion of the bag and adjustable relative thereto for limiting the degree of distention thereof.

8. In a respiratory device having a pressure chamber, means for alternately admitting fluid under pressure to and releasing the fluid from the chamber and a breathing bag in the chamber to be alternately expanded and contracted, the improvement comprising a bellows type breathing bag, a weight carried by the bag for normally distending the same, a plate disposed in the path of movement of the weighted portion of the bag and adjustable relative thereto for limiting the degree of distention thereof, and valve means for controlling the rate of release of fluid from the chamber.

9. In a respiratory device having a pressure chamber, a supply conduit for alternately admitting fluid under pressure to and releasing fluid from the chamber and a breathing bag in the chamber to be alternately expanded and contracted, the improvement comprising a large diaphragm responsive solely to the fluid pressure in the chamber, a control conduit communicating with the supply conduit, a highly sensitive first valve in said control conduit operatively associated with said diaphragm for actuation thereby, a second valve in the supply conduit for controlling admission and release of fluid to and from the chamber, and fluid operated means communicating with said control conduit and operatively associated with said second valve for actuating the same, said first valve controlling admission and release of fluid through said control conduit to and from said fluid operated means for effecting admission and release of fluid through the supply conduit to and from the chamber in response to movement of the diaphragm.

10. In a respiratory device having a pressure chamber, a supply conduit for alternately admitting fluid under pressure to and releasing fluid from the chamber and a breathing bag in the chamber to be alternately expanded and contracted, the improvement comprising a bellows type breathing bag, a weight carried by the bag for normally distending the same, a plate disposed in the path of movement of the weighted portion of the bag and adjustable relative thereto for limiting the degree of distention thereof, a large diaphragm responsive solely to the fluid pressure in the chamber, a control conduit communicating with the supply conduit, a highly sensitive first valve in said control conduit operatively associated with said diaphragm for actuation thereby, a second valve in the supply conduit for controlling admission and release of fluid to and from the chamber, fluid operated means communicating with said control conduit and operatively associated with said second valve for actuating the same, said first valve controlling admission and release of fluid through said control conduit to and from said fluid operated means for effecting admission and release of fluid through the supply conduit to and from the chamber in response to movement of the diaphragm, a third valve controlling the rate of admission of fluid to the chamber, and a fourth valve for controlling the rate of release of fluid from the chamber.

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