

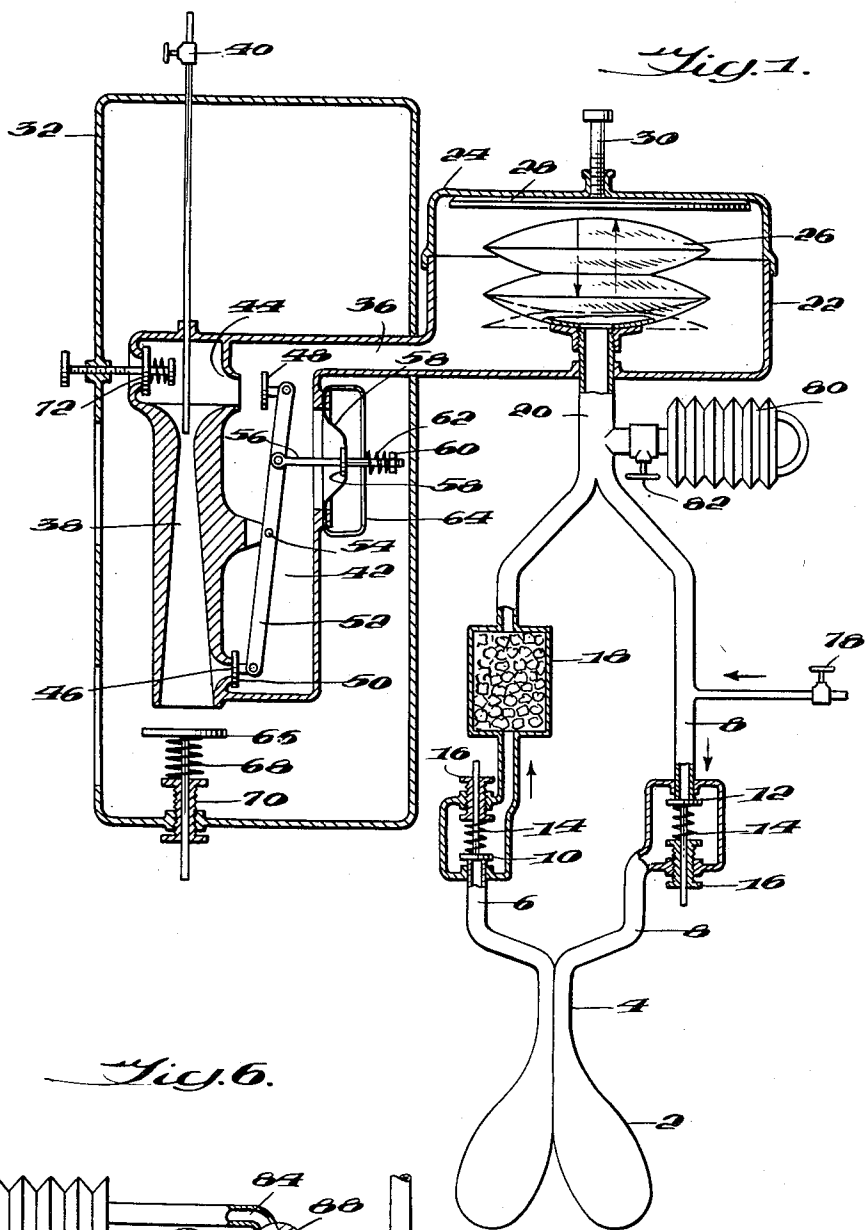
Oct. 16, 1956

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APPARATUS FOR ARTIFICIAL RESPIRATION, IN
PARTICULAR FOR PURPOSES OF ANESTHESIA

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2 Sheets-Sheet 1



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Fig. 2.

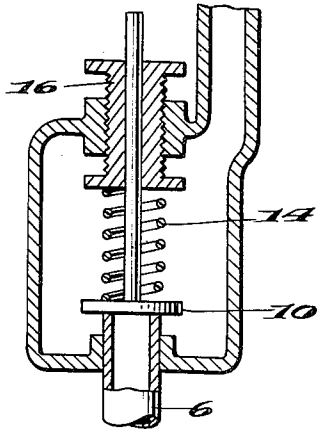


Fig. 3.

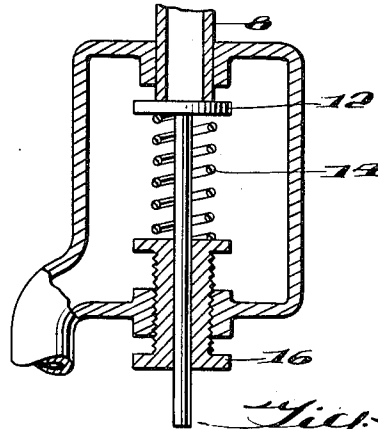


Fig. 4.

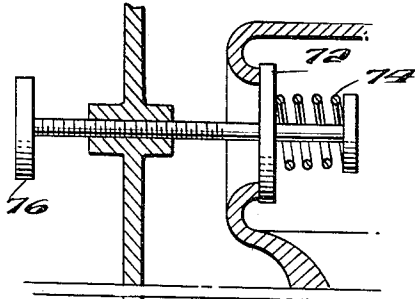


Fig. 5.

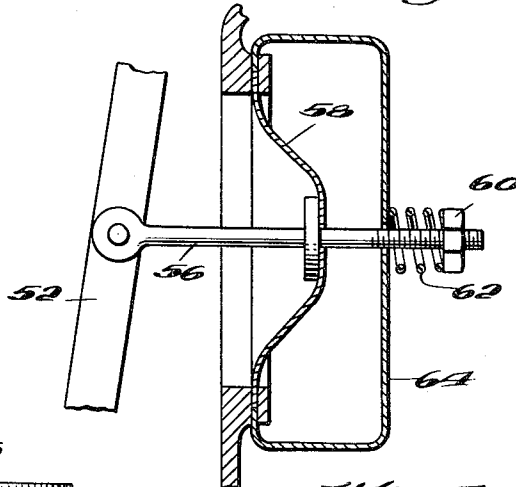
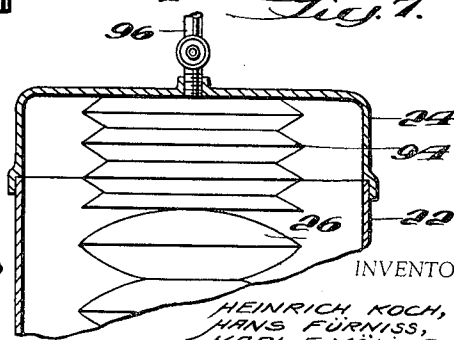
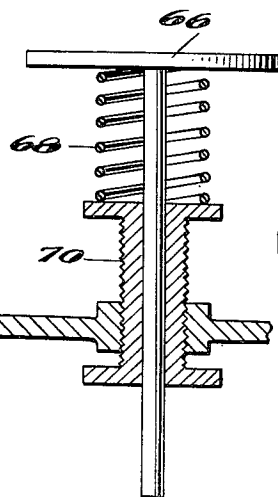


Fig. 7.



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APPARATUS FOR ARTIFICIAL RESPIRATION, IN PARTICULAR FOR PURPOSES OF ANESTHESIA**Heinrich Koch, Hans Fürniss, and Karl F. Möllering, Lubeck, Germany, assignors to Firma Dragerwerk, Heinr. & Bernh. Drager, Lubeck, Germany****Application April 15, 1954, Serial No. 423,482****7 Claims. (Cl. 128—188)**

The invention relates to apparatus for producing artificial respiration, and more especially to such apparatus designed for anesthesia.

Known devices for this purpose have various disadvantages. In some, the exhaling step is entirely dependent on the natural collapsing action of the lungs. This action, both as to the volume of air exhaled and as to the time required for exhalation, then is wholly dependent on the patient's condition at the time, and cannot be controlled by the operator.

In some such systems, also it is necessary, in order to maintain adequate respiration, to use a substantial minimum pressure when filling the lungs to insure a sufficient contraction of the lungs during exhalation to produce a proper exchange of gas between the lungs and the bag. This pressure may be too great for the patient's safety. On the other hand, if the lungs contract too far during exhalation, excessive breathing may occur because the lungs are refilled to the same pressure. Such devices, therefore, do not allow proper control of the breathing, because the lungs expand only between the maximum pressure and the pressure created by the contraction of the lung at the transition between inhaling and exhaling, so that the average breathing pressure of the lung is higher than normal. In lung surgery, for example, it is undesirable for the lungs to fill completely when the thorax is opened.

Other respiratory devices, in which the rate of exchange is determined by the displacement and the rate of operation of the pump, and is fixed for any given pump, have the disadvantage that in lungs of different sizes different pressures will be created, the smaller the lung the greater the pressure. In order to make such a device of general utility, it is necessary either to provide means for varying the stroke of the pump which supplies the pressure or to have several interchangeable pumps of different output. Another disadvantage of such devices is that the maximum pressure is not adjustable from the very beginning of the operation. Also, if the respiratory passages become temporarily blocked, because of the presence of mucus or some surgical action, the piston will build up a considerable pressure head in the system which may be dangerously high. Such systems may be provided with pressure relief valves to permit the escape of gas under such circumstances, but this gas is then lost and must be replaced in the system when normal operation is restored. Also, during the suction stroke of the pump, especially after the escape of gas from the system, subatmospheric pressures may be created in the lungs which are so low as to cause seepage of blood through the lining into the lung, thereby causing damage to the lung. If a safety valve is used to avoid such excessively low pressure, the air drawn in will dilute the gas in the system so that the desired proportions of the different gases will no longer exist, especially when an anesthetic gas is being used.

The primary object of the present invention is to avoid the disadvantages of the known systems.

Another object of the invention is to provide a respiratory system in which the pressure can be maintained within a desired range without adding gas to or allowing it to escape from the system.

A further object of the invention is to provide a system

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in which sub-atmospheric pressures can be created without the use of a piston pump.

An additional object of the invention is to provide a system in which the range of pressures can easily be varied as desired.

Further objects and advantages of the invention will appear more fully from the following description, especially when taken in conjunction with the accompanying drawings which form a part thereof.

In the drawings:

Fig. 1 shows in section a system embodying the invention;

Figs. 2 to 5 are details of parts of Fig. 1; and

Figs. 6 and 7 are views of modifications of parts of Fig. 1.

In the system, the lungs 2 are connected to a fitting 4 in any conventional manner; as by an intertracheal catheter. From this fitting run branch pipes 6, 8, containing one-way valves 10, 12 for exhalation and inhalation respectively. These valves (see Figs. 2 and 3) are pressed on their seats by springs 14. The pressure of the springs can be adjusted by turning stems 16 threaded in the walls of the valves. Pipe 6 also contains a carbon dioxide absorbing cartridge 18.

Both pipes connect to a common fitting 20 fixed in the wall 22 of a chamber having a removable cover 24 which can be held in place in any suitable manner. A respirator bag 26 is removably threaded on fitting 20. Inside cover 24 is a plate 28 forming a piston whose position can be adjusted by turning its stem 30 which is threaded in the cover. Bag 26 may be formed of any suitable flexible but impervious and non-stretchable material, such as cloth impregnated with rubber. It is preferably of bellows construction.

Enclosed in a casing 32 provided with openings such as 34 (Fig. 4) is a pump mechanism which is connected with chamber 22 by a pipe 36. The pump includes a venturi section 38, into which air under pressure is fed from any suitable source, such as a cylinder of compressed gas, by a valved pipe 40, which feeds into the throat of the venturi. The pipe 36 connects with a space 42 which communicates through openings 44 and 46 with the low-pressure and high pressure sides of the venturi, respectively. Openings 44, 46 are controlled by valves 48, 50, respectively, mounted on opposite ends of a lever 52 pivoted at 54. This lever is connected by a rod 56 connected to a diaphragm 58 in the wall of space 42. The resiliency of this diaphragm may be adjusted by turning a nut 60 (Fig. 5) threaded on the end of rod 56 and engaging a spring 62 which rests against a fixed frame 64.

The outlet of the venturi is closed by a check valve 66 (see Fig. 4) acted on by a spring 68 whose tension is adjustable by a stem 70 threaded in the wall 32. The low pressure side is provided with an intake check valve 72 acted on by a spring 74 adjustable by a stem 76.

A valved line 78 is connected to pipe 8, or to some other point, so that oxygen, anesthetic gas, or the like can be introduced into the system.

This arrangement operates as follows:

With the parts in the position shown in Fig. 1, valve 66 is open as is valve 48. Air flowing through the venturi will create a suction at the intake side of the venturi, which will gradually reduce the pressure in space 42 and thereby in chamber 22, causing bag 26 to expand and draw air from the lungs. The suction will depend on the setting of valve 66, being less as the tension of spring 68 is increased, since less air will then flow through the venturi. Thus the rate of expansion of bag 26 can be regulated by stem 70.

Eventually, the pressure in space 42 will become low enough to draw in diaphragm 58 in the direction of

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the arrow (Fig. 1). This diaphragm may be of a snap action type. The pressure at which it is moved can be varied by adjusting nut 60. When the diaphragm moves inward, it shifts lever 52, closing valve 43 and opening valve 50, thus admitting air from the pressure side of the venturi to spaces 42 and 22, and gradually collapsing bag 26 so as to force air into the lungs. During this operation, the amount of air flowing through the venturi will depend on the pressure on valve 72, and the rate at which the pressure builds up can therefore be controlled by stem 76. The greater the tension of spring 74, the slower the pressure builds up.

When a certain pressure is reached in space 42, diaphragm 58 is pushed outward, and the parts return to the position shown in Fig. 1.

When the respirator bag expands, it draws air from the lungs through pipe 6, valve 10 and absorber 18 so as to remove the carbon dioxide. The rate of this exhalation can be controlled by valve 66. When the bag contracts, it forces air into the lungs through pipe 8 and valve 12. The rate of this inhalation can be controlled by valve 72.

The use of a pneumatic pump, of the type shown, makes it possible to control very simply, by nut 60, the pressures produced in chamber 22 and therefore in the respiratory system. Also, such a pump switches automatically and immediately from the suction to the pressure phase, and vice versa, as soon as the high and low pressure limits are reached. Thus it is impossible for excessively high or low pressures to be produced in chamber 22.

Respirator bag 26 is removable, so that bags of different sizes can be used for different patients. It is also possible to limit the expansion of bag 26 by moving plate 28 downward within chamber 22.

It may be desirable to connect a second respirator bag 80 to the fitting 6 through a valve 82. This may be filled with the anesthetic gas mixture. This makes it possible to vary the inflation of the lungs as desired. For example, opening valve 82 and collapsing bag 80 (by hand, for example) will inflate the lungs further. Expanding of bag 80 will have the opposite effect.

In Fig. 6, the second respirator bag 80 is connected to fitting 20 by two pipes 84, 86 which can be selectively opened by a three-way valve 88. Pipe 86 contains two adjustable check valves 90, 92 acting in opposite directions.

With such an arrangement, if valve 92, which opens into bag 80, is set to open at a very slight excess over the desired maximum pressure, and if valve 88 is set so as to connect pipe 86 with fitting 20, the lung of the patient can be filled only up to this pressure even if the pressure in chamber 22 becomes excessive. Likewise, if valve 90, which opens out of bag 80, is set slightly below the desired minimum, the pressure in the system cannot drop below this minimum since additional gas will enter the system from bag 80. After each such operation, the next phase of the respiratory cycle restores the balance with bag 80.

In Fig. 7, the cover 24 carries on its lower face an inflatable bag 94 which can be supplied with gas under pressure or with a liquid through valved pipe 96. By varying the inflation of bag 94, the amount to which bag 26 can be inflated can be regulated.

While we have described herein some embodiments of our invention, we wish it to be understood that we do not intend to limit ourselves thereby except within the scope of the claims hereto or hereinafter appended.

We claim:

1. Artificial respiration apparatus comprising a respirator bag, a closed system for connecting said bag to the lungs of a patient, means forming a chamber enclosing said bag, and means to produce super-atmospheric and subatmospheric pressures in said chamber, said pres-

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sure producing means including an injector pump, and check valves at the high and low pressure sides of said pump.

2. Apparatus as claimed in claim 1, having adjustable means for limiting expansion of said bag.

3. Artificial respiration apparatus comprising a respirator bag, a closed system for connecting said bag to the lungs of a patient, means forming a chamber enclosing said bag, and means to produce super-atmospheric and sub-atmospheric pressures in said chamber, said apparatus having adjustable means for limiting the expansion of said bag comprising a piston-like member adjustably mounted in said chamber for movement towards and from the bag.

4. Artificial respiration apparatus comprising a respirator bag, a closed system for connecting said bag to the lungs of a patient, means forming a chamber enclosing said bag, and means to produce super-atmospheric and sub-atmospheric pressures in said chamber, said apparatus having adjustable means for limiting the expansion of said bag comprising an inflatable member mounted in said container opposite the bag.

5. Artificial respiration apparatus comprising a respirator bag, a closed system for connecting said bag to the lungs of a patient, means forming a chamber enclosing said bag, and means to produce super-atmospheric and sub-atmospheric pressures in said chamber, said pressure producing means including an injector pump having a venturi passage and means to supply air under pressure to the throat of the venturi passage, and means responsive to the pressure in said chamber for connecting the chamber to the throat of the venturi passage when the pressure in the chamber reaches a predetermined maximum and to the mouth of the venturi passage when the pressure in the chamber reaches a predetermined minimum, an inwardly opening check valve connected with the throat of the venturi passage and an outwardly opening check valve connected with the mouth of the venturi passage.

6. Artificial respiration apparatus comprising a respirator bag, a closed system for connecting said bag to the lungs of a patient, means forming a chamber enclosing said bag, and means to produce super-atmospheric and sub-atmospheric pressures in said chamber, said pressure producing means including an injector pump having a venturi passage and means to supply air under pressure to the throat of the venturi passage, openings from said chamber to the throat and mouth of the venturi passage, a pivoted lever having valves thereon for selectively closing said openings, and a diaphragm in the wall of said chamber so connected to said lever as to move said valves to connect the chamber to the throat of the venturi passage when the pressure in the chamber reaches a predetermined maximum and to the mouth of the venturi passage when the pressure in the chamber reaches a predetermined minimum, an inwardly opening check valve connected with the throat of the venturi passage and an outwardly opening check valve connected with the mouth of the venturi passage.

7. Artificial respiration apparatus comprising a respirator bag, a closed system for connecting said bag to the lungs of a patient, means forming a chamber enclosing said bag, and means to produce super-atmospheric and sub-atmospheric pressures in said chamber, said apparatus having a member within the chamber, means mounting the member for movement towards and from the bag, and means to adjust the position of the member so as to limit expansion of the bag.

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