May 29, 1962 A. S. J. LEE 3,036,584

NON-REBREATHING VALVE FOR GAS ADMINISTRATION

Filed July 18, 1961

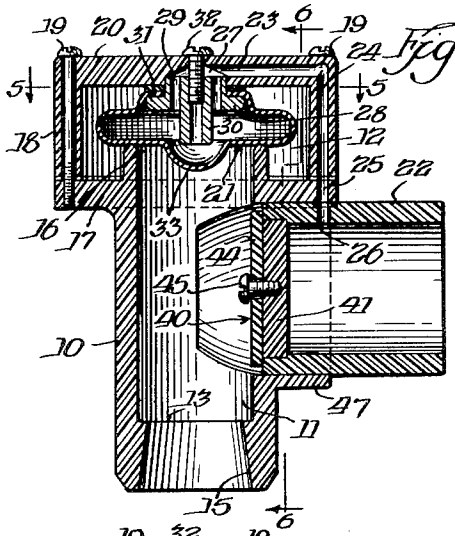


Fig. 1.

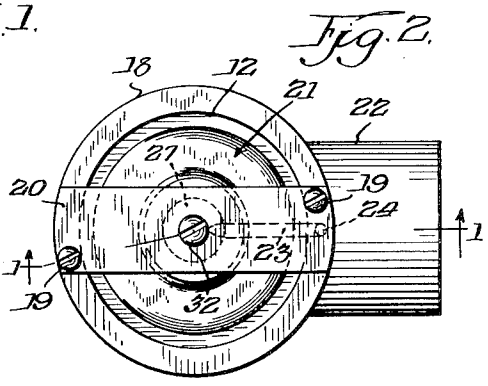


Fig. 2.

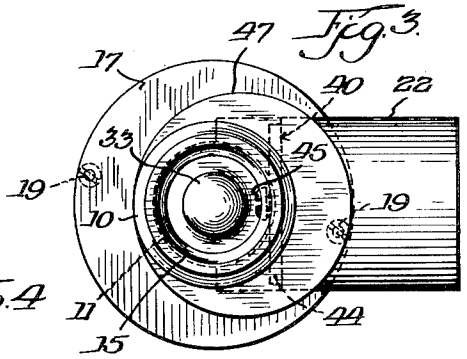


Fig. 3.

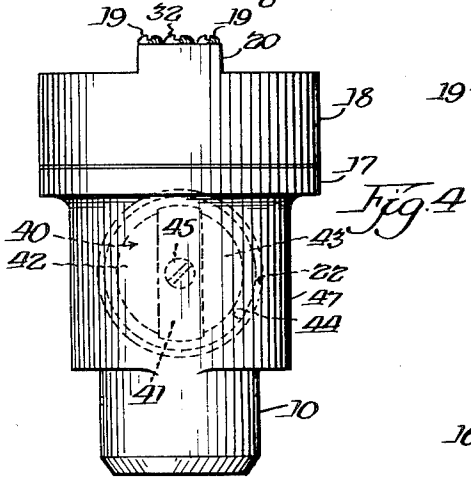


Fig. 4

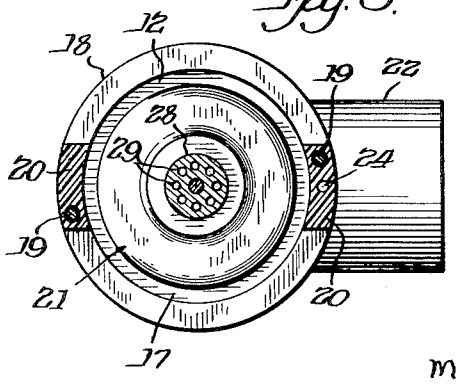


Fig. 5.

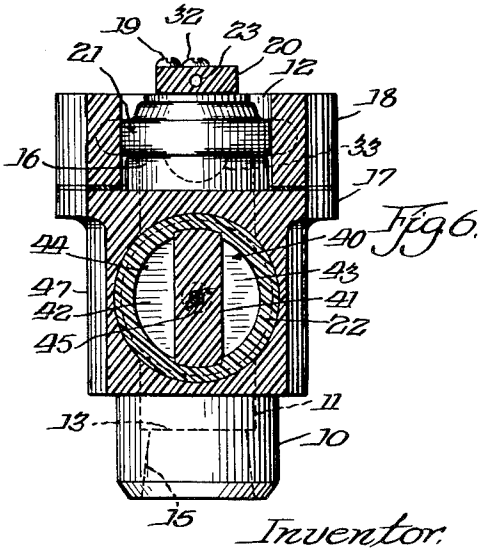


Fig. 6.

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NON-REBREATHING VALVE FOR GAS ADMINISTRATION

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This invention relates to a valve arrangement for use in apparatus employed in the therapeutic administration of free oxygen containing gases. It is more specifically concerned with a valve mechanism for use in a breathing machine in which a patient does his own breathing.

In the so-called non-rebreathing systems of therapeutical oxygen administration, the patient can breathe naturally by normal respiration or can be assisted in his breathing by a pressure applied by a breathing machine which assists in the inspiration of free oxygen containing gases by the patient in synchronism with his own efforts to breathe. Resuscitation systems are also provided which are utilized in artificial respiration and in which the patient plays no active role in the breathing cycle. In this case the oxygen containing gas is pumped into the patient alternately with periods of relaxation during which the patient is allowed to exhale.

In all of these systems the patient generally inhales the free oxygen containing gases from a light, flexible, thin-walled container which is generally fabricated from an elastomeric material. This container acts as a reservoir for the oxygen at atmospheric pressure. The oxygen supply is constantly fed from the flexible container into a feed conduit which is equipped with a valve system to allow the patient to inhale oxygen containing gas from the bag and exhale into the atmosphere with a minimum of gas flow resistance under the various respiration systems described above. In accordance with this invention a non-rebreathing valve having a simple construction is provided for use in therapeutic oxygen administration systems.

FIGURE 1 is a cross sectional side elevation view taken approximately along line 1—1 of FIGURE 2 of one embodiment of this invention.

FIGURE 2 is a top plan view of the valve illustrated in FIGURE 1.

FIGURE 3 is a bottom plan view.

FIGURE 4 is a side elevation view.

FIGURE 5 is a horizontal cross sectional view approximately along line 5—5 of FIGURE 1.

FIGURE 6 is a cross sectional view approximately along line 6—6 of FIGURE 1.

Referring to the drawings, the specific embodiment of this invention shown in one and one half times full scale comprises a valve body 10 consisting of a first tubular chamber 11 and a second tubular chamber 12 superposed thereon. Chamber 11 which has a substantially constant internal diameter is provided with a breathing port 13 adapted to receive an endotracheal tube, not shown. To insure a fluid-tight seal a tapered seat 15 is provided which cooperates with the mating end of the endotracheal tube. The other end of chamber 11 forms an exhaust valve port 16. The marginal edges of chamber 11 adjacent valve port 16 are preferably rounded to form a valve seat. Upper chamber 12 is formed by means of circular flange 17 which is integral with the side wall of lower chamber 11. An annular ring 18 is secured to flange 17 by means of threaded fasteners 19 to form the wall portion of chamber 12.

Spanning the open end of chamber 12 through which the patient exhales into the atmosphere and integral therewith is support member 20 which performs two functions: (1) it serves as a supporting means for chambered convoluted bellows 21 and (2) it provides a passageway area

for interconnecting the interior of convoluted bellows 21 with inlet conduit 22 which communicates with lower chamber 11 through the side wall thereof. In support member 20 is provided a lateral passageway 23. Passageway 23 interconnects at one end with passageway 24 which is provided in side wall 18 of chamber 12. The other end of passageway 24 registers with orifices 25 and 26 provided respectively in flange 17 and the side wall of inlet conduit 22. The other end of passageway 23 in support member 20 terminates in an outwardly flaring port 27 which is directed downwardly and opens into upper chamber 12.

Chambered convoluted bellows 21 is secured to support member 20 by means of button fastener 28. A plurality of apertures 29 are spaced around stem element 30 of fastener 28. Apertures 29 register with port 27 to permit communication between the interior of convoluted bellows 21 and inlet conduit 22. Shoulder portion 31 of button fastener 28 engages with the top section of convoluted bellows 21 and holds it in fluid tight relationship against the inner side of support member 20. Button fastener 28 is held in position by means of a suitable threaded fastener 32 which enters through a hole provided in support member 20 and engages with an internally threaded bore in stem 30. In the illustrative embodiment shown in the drawings, chambered convoluted bellows 21 has a discoid configuration having a protuberant bottom segment 33 which registers with outlet port 16 in lower chamber 11. Stem 30 depends downwardly in alignment with bottom segment 33 and serves as a check means for preventing the complete collapse of convoluted bellows 21 upon exhalation and serves to improve the sensitvity of convoluted bellows 21. In the event that the gas supply fails, the patient may inhale to create a subatmospheric condition within the bellows 21 so that the bellows collapses, thus providing free communication between the patient and the open end of chamber 12 in a manner hereafter apparent.

In order to prevent the reversal of gas flow from lower chamber 11 into inlet conduit 22 a check valve 40 is provided. In the illustrative embodiment this check valve comprises a support bar member 41 which diametrically traverses the end of inlet conduit 22 communicating with lower chamber 11. The width of support bar 41 is substantially less than the internal diameter of conduit 22 thereby providing inlet ports 42 and 43 on either side of bracket 41. Enclosing the terminal end of inlet conduit 22 which communicates with the interior of lower chamber 11 is a thin flexible flap member 44 which has a circular configuration conforming with inlet conduit 22 and has a diameter slightly larger than the inside diameter of inlet conduit 22. The flap member is fabricated from sheet material such as rubber which is sufficiently flexible to permit the flap member to be flexed by the small pressure differentials occurring during the respiration cycle. Flexible flap 44 is secured to bracket 43 by means of threaded fastener 45. The peripheral edge of flexible flap 44 engages with the end of inlet conduit 22 to provide a fluid tight seal which will permit gas flow through inlet conduit 22 into lower chamber 11 but will prevent the reversal of the flow of gases from lower chamber 11 back into inlet conduit 22 during the respiration cycle. The other end of inlet conduit 22 is adapted to engage an oxygen supply tube, not shown, which interconnects the non-rebreathing valve mechanism of this invention with the oxygen supply apparatus. The oxygen supply tube is connected to either the thin walled container or directly to a respirator, depending upon the type of breathing machine in connection with which the instant invention is being employed. To permit inlet conduit 22 to be rigidly attached to chamber 11 a thickened side wall portion 47 is provided.

In use in a breathing machine in which the patient breathes naturally, the free oxygen containing gas is withdrawn from the oxygen supply through inlet conduit 22. The chambered convoluted bellows 21 in the quiescent condition normally closes valve port 16. A negligible amount of super-atmospheric pressure exists in inlet tube 22. Because of the communication between the interior of the chambered convoluted bellows 21 and inlet conduit 22 this negligible amount of superatmospheric pressure also occurs in chambered convoluted bellows 21. When the valve of the present invention is connected to a source of breathing gas, the pressure existing in the inlet conduit 22 and the convoluted bellows 21 is sufficient to retain the bellows seated so that valve port 16 is closed. When the patient exhales, however, a sufficient pressure is created which unseats convoluted bellows 21 from valve port 16 which permits the exhalation gases to be exhausted into the atmosphere through the open top of upper chamber 12. The exhalation gases are prevented from flowing into inlet conduit 22 by means of check valve 40.

If the flexible container element of the breathing machine to which the valve is connected were to become empty there would be no oxygen for the patient to breathe. When the patient attempts to inhale, a sub-atmospheric pressure would be produced in inlet conduit 22 and therefore within the interior chamber of convoluted bellows 21. This sub-atmospheric pressure on the interior of convoluted bellows 21 would result in convoluted bellows 21 being collapsed and displaced from valve port 16 because convoluted bellows 21 has a greater effective area exposed to the atmosphere than the area of valve port 16 thus allowing the patient to breathe in from the atmosphere. The bellows 21 remains collapsed until the supply of oxygen-containing gas is restored and the pressure within the conduit 22 returned to super-atmospheric level. This is an important safety feature.

Under conditions where the normal respiration of a patient is supplemented by forcing free oxygen containing gases into the lungs of the patient, an even higher super-atmospheric pressure occurs in inlet conduit 22 which is communicated to the chamber of convoluted bellows 21 by means of the connected passageways 23 and 24. Because the effective area of chambered convoluted bellows 21 which is exposed to the super-atmospheric pressure is greater than the effective area of valve port 16, convoluted bellows 21 is tightly seated against valve port 16. Accordingly, the free oxygen containing gas is forced through lower chamber 11 into the patient. When the flow of gas is intermittently terminated during the relaxation period of the breathing cycle, the pressure in inlet conduit 22 returns to atmospheric. The pressure in the chamber of convoluted bellows 21 being the same as the pressure in inlet conduit 22 the convoluted bellows becomes free to move and upon exhalation by the patient the convoluted bellows is displaced and the exhalation gases vented through the open top of upper chamber 12.

In constructing the non-rebreathing valve of this invention it is apparent that various modifications can be made by those skilled in the art to which this invention pertains without departing from the scope of the invention as defined by the appended claims. Although the diaphragm employed in the illustrative embodiment comprises a chambered convoluted bellows fabricated from an elastomeric sheeting such as rubber, it is apparent that other chambered convoluted bellows can be used such as a metallic bellows, a piston ararngement wherein a sliding piston functions as the valve closing means, and others. The check valve assembly is also subject to modifications in construction and other expedients can be employed for affixing the flap element of the check valve in position without unduly restricting the cross sectional area of the inlet conduit. In addition other arrangements of the several elements of the breathing valve of this invention can be made without affecting the efficiency of operation of the non-rebreathing valve of this invention.

Conventional materials of construction can be utilized in manufacturing the various elements of this invention. For sanitary reasons it is important to employ materials of construction which can withstand the rigorous cleaning procedures necessary to produce antiseptic conditions required by therapeutic use of the valve. It is also important in using the valve in therapeutic use to employ pressure control devices to provide protection against the existence of superatmospheric pressures in the inlet conduit 22 during the breathing cycle when the patient exhales. The orifice 26 is positioned in proximate spaced relation to the valve 40 to afford extremely rapid reduction of pressure within the bellows 21 in the event of failure of the gas supply. For this reason also, the volume of the conduit 22 and the connecting conduit to the gas source is preferably of limited extent. As the patient inhales, the pressure within the chamber 11 is reduced and a suction is exerted on the bottom surface of the bellows 21 which tends to maintain the bellows in seated position. In the event of gas supply failure, however, the check valve 40 opens and a sub-atmospheric condition is created within the bellows. This sub-atmospheric pressure is exerted over a greater area of the bellows than that defined by the port 16. As a result, the bellows collapses to permit access of ambient air to the patient through the exhalation port.

This application is a continuation-in-part of applicant's co-pending application Serial No. 752,664, entitled "Non-Rebreathing Valve for Gas Administration" filed August 1, 1958.

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom, as modifications will be obvious to those skilled in the art.

What is claimed is:

1. A non-rebreathing valve for gas administration which comprises an open-ended first tubular chamber of substantially constant diameter, one end of said chamber comprising a valve port, the other end of said chamber being adaptable as a cylindrical breathing port, a cylindrical gas inlet conduit communicating with said chamber through the sidewall thereof, check valve means comprising a first narrow support bar diametrically traversing the end of said conduit communicating with said chamber and a thin flexible closure disk having a diameter larger than the inside diameter but less than the outside diameter of said conduit fastened to said support bar enclosing the end of said conduit to prevent fluid flow from said chamber to said conduit, said chamber having an integral circular flange laterally depending from the sidewall thereof, a tubular section mounted on the marginal edge of said flange forming a second tubular chamber surrounding said valve port and longitudinally aligned with said first chamber, a second narrow support bar traversing the open end of said chamber, a flexible, chambered convoluted bellows dependently mounted on said second support bar and closing said valve port comprising an elastomeric discoidal bag having a protuberant bottom segment registering with said valve port, the cross-sectional area of said convoluted bellows being less than the cross-sectional area of said second chamber in a plane perpendicular to the longitudinal axis of said valve port and having an effective area exposed to the interior of the second chamber greater than the area of said exhaust valve port, a passageway formed in said second support bar and the wall of said tubular section interconnecting the chamber of said convoluted bellows with said inlet conduit down stream of said check valve means, and exhalation outlet means provided in said second chamber.

2. A valve for administering gas to mammals comprising a chamber having an inlet port and an outlet port, an inlet conduit in fluid communication with said inlet

port, said inlet conduit being adapted to be disposed in fluid communication with a gas source, a check valve for affording unidirectional flow of gas from said inlet conduit to said chamber, a breathing port having a seat, an exhalation valve engaging said seat and normally closing said outlet port, said exhalation valve comprising a chambered convoluted flexible bellows in free fluid communication with said inlet conduit and having a surface in free fluid communication with said chamber, said bellows having at least one folded convolution extending outwardly beyond the periphery of said seat a sufficient distance so that the exterior surface in communication with

atmospheric pressure is of greater area than said first named surface, whereby said bellows closes said outlet port when the pressure in said chamber is less than the pressure in said bellows, opens said outlet port when the pressure in said chamber exceeds the pressure in said bellows and opens said outlet port when the pressure in said bellows and opens said outlet port when the pressure in said inlet conduit and within said bellows drops below a predetermined value below atmospheric thus affording free passage of atmospheric air into said chamber through said outlet port.

No references cited.