

May 2, 1967

A. M. RICHARDS

3,316,903

INHALATOR

Filed Sept. 26, 1963

3 Sheets-Sheet 1

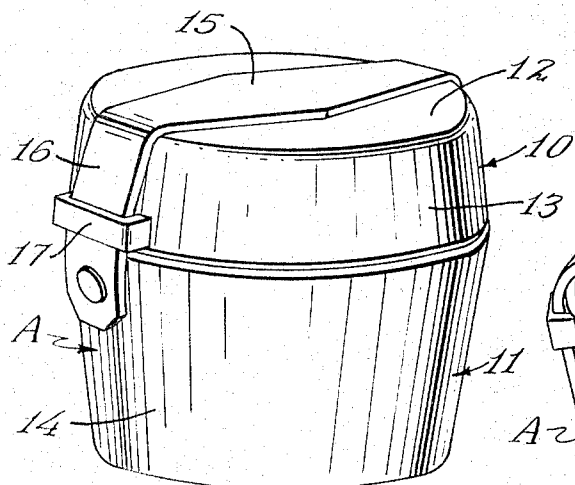


FIG. 1

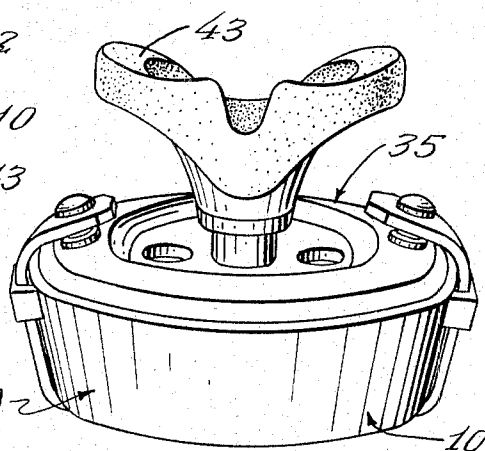


FIG. 2

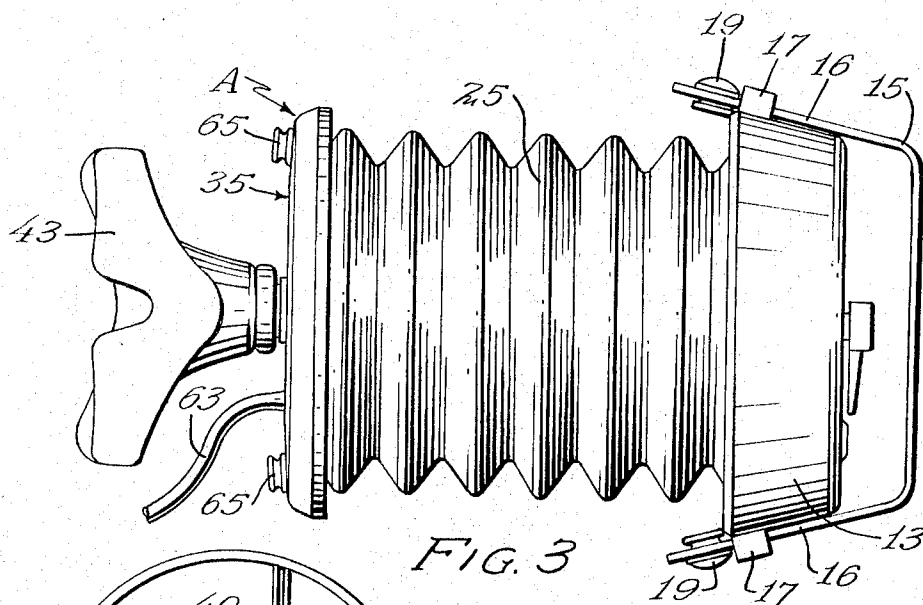


FIG. 3

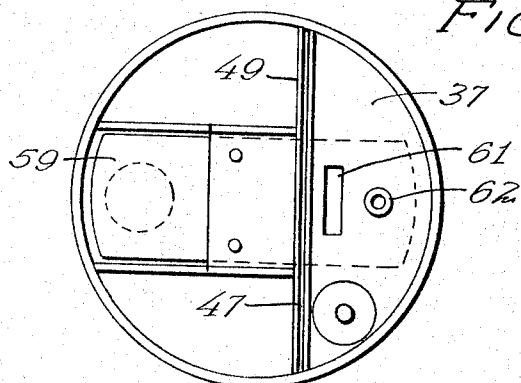


FIG. 8

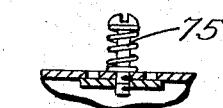


FIG. 9

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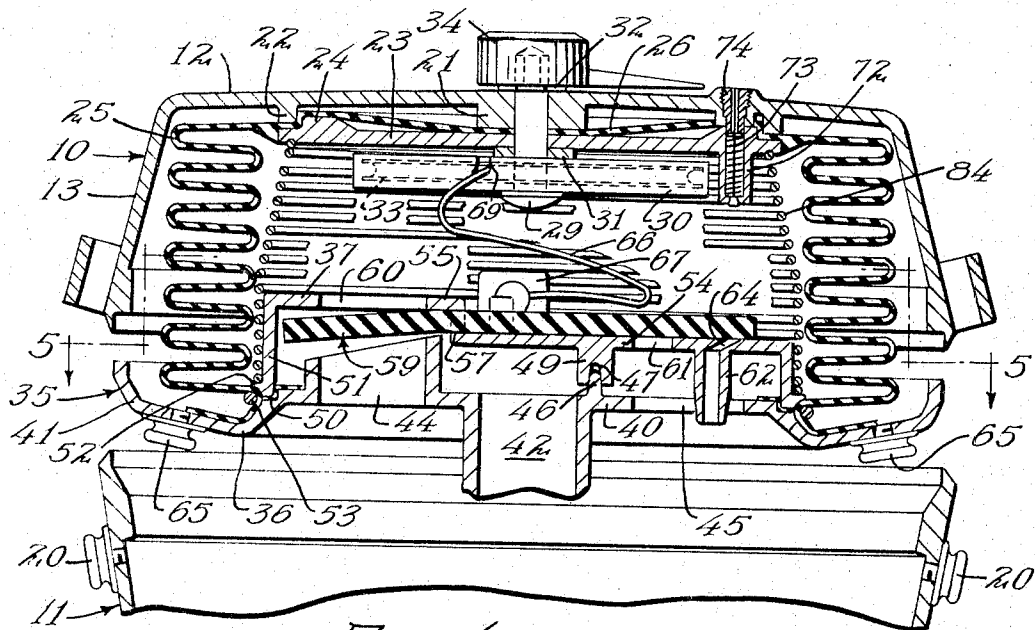


FIG. 4

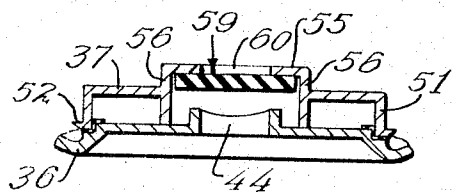


FIG. 7

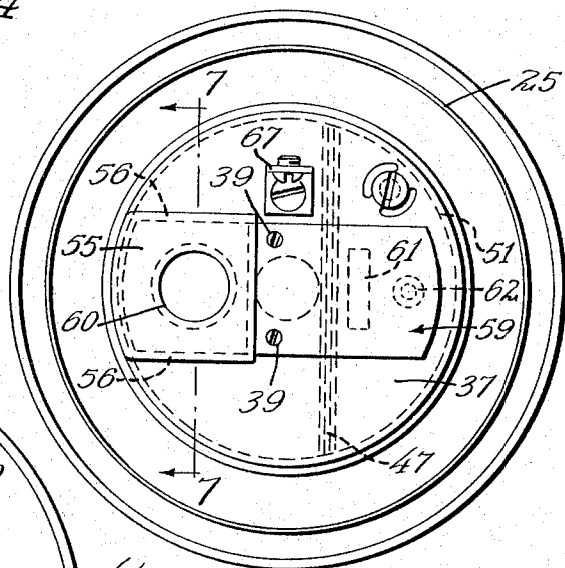


FIG. 5

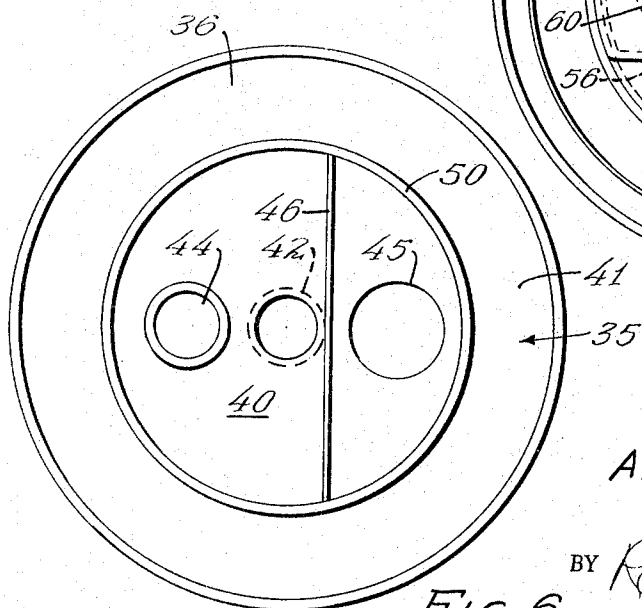


FIG. 6

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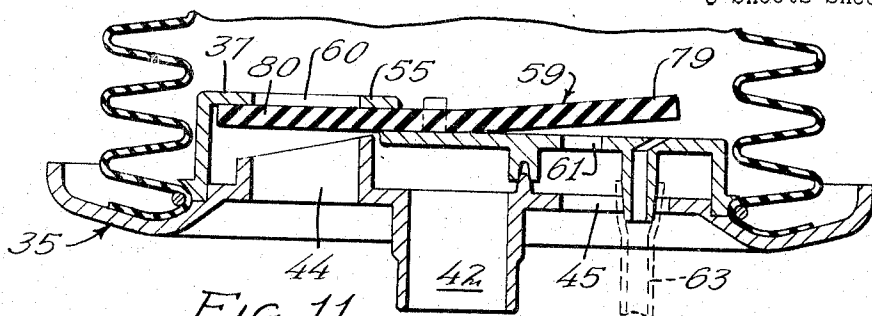


FIG. 11

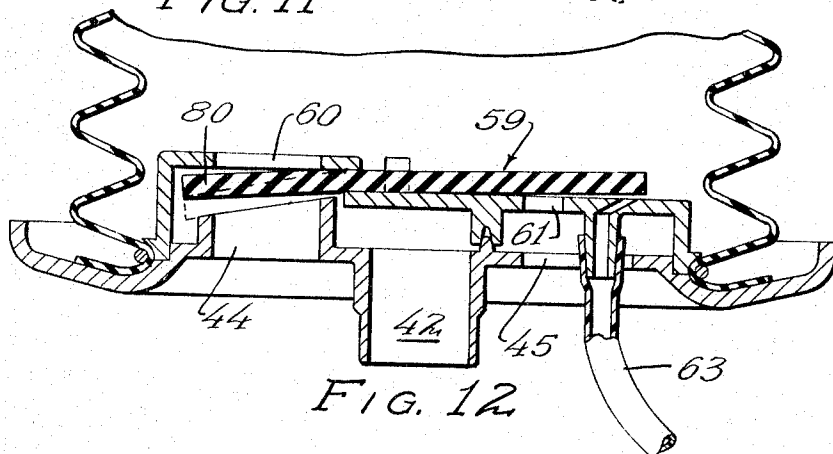


FIG. 12

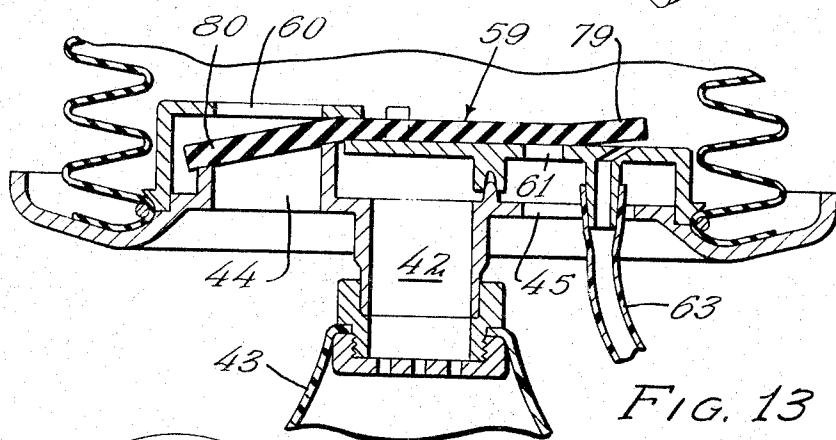


FIG. 13

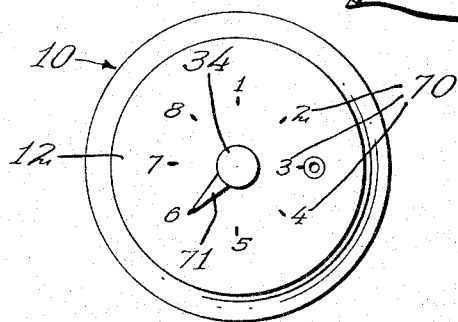


FIG. 10

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This invention relates to an improvement in an inhalator and deals particularly with a simple apparatus which is readily portable and which may be used for forcing air and other gases into the lungs of a patient.

Many types of portable devices have been used for use in emergencies to force air, oxygen, or medicated gases into the lungs of a patient. One of the problems which usually exists with devices of this type lies in the fact that they are not used at frequent intervals in many instances, and as a result any delicate parts such as valve mechanisms tend to stick or fail to operate properly merely through periods of disuse. Furthermore, most such devices require delicate parts which are expensive to produce and accordingly increase the cost of the original product. Obviously, expensive devices cannot be purchased and stored in readiness for use just on the chance that they might sometimes be important. It is a purpose of the present invention to provide an apparatus which might be produced at a sufficiently low cost so that considerably low investment is involved, thus making it more practical to purchase a sufficient quantity of the devices so that they are always readily available.

A feature of the present invention resides in the provision of a respiratory device, including a two-part outer housing, one part of which serves as a unitary part of the apparatus, and the other of which serves as an enclosure for the remainder of the device. As a result, the apparatus may be enclosed in such a way that the bellows and face mask forming a part of the apparatus are normally sealed from dust and dirt but in which the entire device is readily accessible by merely disengaging a pair of fastening means.

It is an object of the present invention to provide a device of the type described which is controlled by a single, simple and effective valve which preferably comprises merely an elongated strip of resilient material. This strip of material is anchored intermediate its ends so that one end of the strip serves as an inlet valve to permit air to enter the interior of the expandable and contractible bellows, while the other end thereof serves as a means of controlling the outlet from the bellows. The arrangement is such that when the bellows portion of the apparatus is expanding the outlet from the bellows is closed, the inlet is open, and the interior of the mask is open to atmosphere. When the bellows are being compressed, both the inlet and outlet are closed, and the air is forced from the interior of the bellows into the mask.

A further feature of the present invention resides in the provision of a compressed gas inlet into the interior of the bellows which is controlled by the valve previously described. The compressed gas inlet is located beneath one end of the flexible resilient valve so that pressure of the gas will force a portion of the valve into open position without actually opening the exterior air inlet. A positive pressure within the bellows holds both the bellows air inlet and bellows air outlet closed, directing the fluid under pressure into the interior of the mask.

A further object of the present invention lies in the provision of a device of the type described in which the movement of the bellows may be definitely limited so that only a predetermined amount of air will enter the bellows. This is accomplished by limiting the extent to which the bellows ends may be drawn apart. This

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arrangement is particularly useful in providing medication to a patient. By introducing a predetermined quantity of medicine usually in pressurized form to the interior of the bellows, and proper adjustment of the maximum spacing of the bellows ends, the proportion of medicine and air may be regulated.

An added feature of this invention lies in the fact that the apparatus is not rendered inoperative by vomitus or by the freezing of condensate in cold weather. The valves of most such devices are easily affected by vomitus which often accompanies resuscitation operations. The rather generous tolerances permitted by the design normally prevent the valve from ceasing to function under such conditions; and the valve does not readily freeze up in cold weather in the presence of condensate. Furthermore, the valve may be completely and easily disassembled for washing and sterilizing.

It is an important feature of the present invention that the valve arrangement is such that the bellows may be used as a reservoir and decompression chamber when a supply of compressed gas such as oxygen is connected thereto. The gas under pressure enters beneath the end of the valve overlying the air inlet, and acts to hold the air inlet open, permitting the gas to fill the bellows and leave through the air inlet as well as the bellows outlet, as long as the pressure within the bellows does not greatly exceed atmospheric pressure. If the patient inhales, a negative pressure is produced in the mask and valve chamber, the outlet valve is activated and tends to close, and the patient may inhale the oxygen or the other gas from the interior of the bellows. When exhaling, the outlet valve opens to atmosphere.

This feature is of decided importance, as devices of this type usually require the addition of a collapsible bag as a reservoir and decompression chamber for the oxygen somewhat like that used on an anesthesia machine where oxygen is to be breathed in under generally atmospheric pressure. At the same time, by applying a compressive force to the bellows, both the air inlet opening and air outlet opening may be closed to permit the application of the gas at a pressure dictated by the hand of the operator.

These and other objects and novel features of the present invention will be more clearly and fully set forth in the following specification and claims.

In the drawings forming a part of the specification; FIGURE 1 is a perspective view of the apparatus in closed position thereof when the device is not in use.

FIGURE 2 is a perspective view of one end of the container illustrated in FIGURE 1, showing the face mask which is normally enclosed within the other portion of the container.

FIGURE 3 is a side elevational view of the apparatus indicated in FIGURES 1 and 2.

FIGURE 4 is an enlarged sectional view through the apparatus with the removable portion of the enclosure partially removed.

FIGURE 5 is a sectional view through the apparatus, the position of the section being indicated by the line 5—5 of FIGURE 4.

FIGURE 6 is an end view of one end plate of the bellows.

FIGURE 7 is a sectional detail, the position of the section being indicated by the line 7—7 of FIGURE 5.

FIGURE 8 is a view somewhat similar to FIGURE 6, but omitting the end plate.

FIGURE 9 is a sectional detail showing a relief valve mechanism.

FIGURE 10 is a diagrammatic view showing the dial which may be used to control the separation between the bellows ends.

FIGURE 11 illustrates in section the position of the valve as the bellows are expanded.

FIGURE 12 is a view similar to FIGURE 11 where the bellows are neither expanded nor compressed.

FIGURE 13 is a view similar to FIGURES 11 and 12 in which the bellows are being compressed.

The respiratory device is indicated in general by the letter A, and preferably includes a first receptacle portion 10 and a second receptacle portion 11. The receptacle portion 10 comprises a disk-like bottom panel 12, and upwardly and outwardly inclined receptacle walls 13. The receptacle portion 11 is usually somewhat deeper than the portion 13 and includes a disklike bottom, not illustrated in the drawings, and peripheral upwardly tapering side walls 14. The two receptacles 10 and 11 are held in edge abutting relation by a flexible strap 15, the center portion of which overlies the bottom panel 12 of the receptacle section 10, and the ends 16 of which extend through flat loops 17 on opposite sides of the receptacle walls 13. Female snap portions 19 on the ends of the strap 15 are detachably engaged with oppositely disposed male snap portions 20 on opposite sides of the receptacle portion 11 as indicated in FIGURE 4 of the drawings, this figure omitting the strap in order to clarify the illustration. The end wall 12 of the receptacle portion 10 is provided with central inwardly extending boss 21 and a concentric inwardly extending flange 22. A clamping plate 23 is provided with an outwardly extending flange 24 designed to fit within the flange 22. A bellows 25 of flexible resilient yieldable material includes an end portion 26 which is clamped between the clamping plate 23 and the end plate 12, the bellows end being clamped between the flanges 22 and 24, and between the body of the plate and the boss 21. The parts are held assembled by a rotatable pivot bolt 29 which extends through a reel housing 30, a washer 31, the clamping plate 23, the bellows end 26, and the boss 21 to be held in place by a retaining nut or washer 32. A reel 33 is supported within the housing 30, and a knob 34 is mounted on the bolt 29 to rotate in unison therewith. The purpose of the knob will be described later more in detail.

The other end of the bellows 25 is connected to a bellows end member which is illustrated in general by the numeral 35. This end member 35 includes an end closure plate 36 and a cover plate 37 which are secured together in any desired manner such as by bolts 39. The end plate 36 includes a flat disk-like central portion 40 having a grooved flange 41 encircling the same. The hollow tubular boss 42 extends from the surface of the plate 40 most remote from the opposite end plate and designed to support the face mask 43. The plate 40 also includes a tubular outlet 44 and an inlet aperture 45 extending therethrough. As indicated in FIGURE 4, the inner end of the outlet 44 is on a plane which is inclined upwardly toward the center of the bellows. A partition wall 46 extends transversely across the closure plate 40 between the outlet 44 and the inlet 45, the partition wall 46 being frictionally engaged in a transverse groove 47 on a partition wall 49 on the under surface of the cover plate 37. Thus the space between the end plate 40 and the cover plate 37 is divided into two parts by the partition walls 46, 49.

The inner surface of the end plate 40 is provided with a circular groove 50 which is designed to accommodate the cylindrical outer wall 51 of the cover plate 37. The cylindrical wall 51 is provided with a peripheral tapered flange 52 designed to serve as a retaining flange for the bellows end. A clamping ring 53 encircles the end of the bellows and clamps the end of the bellows against the flange 52.

The major portion of the inner surface of the cover plate 37 comprises a flat plate 54. However, a generally rectangular area 55 of the cover plate is inwardly offset along parallel side walls 56 and an end wall which comprises an extension of the cylindrical wall 51. An

aperture 57 is provided in the edge of the offset portion 55 nearest the center of the cover plate, and an elongated resilient valve 59 extends through the aperture 57 to lie outwardly of the inwardly offset portion 55, and inwardly of the remainder of the end plate 37. The valve strip 59 is preferably formed of soft resilient material so that it may flex readily under relatively small differentials in pressure, and the valve closes the aperture 57. The valve may be held in place by the bolts 39 or other fastening means located so that either or both ends of the valve may flex.

The offset portion 55 is provided with an aperture 60 which is aligned with the sleeve 44 forming the outlet in the end plate 40, and is provided with an aperture 61 normally closed by the valve 59 and open to the intake opening 45. A sleeve or nipple 62 extends outwardly from the cover plate 37 for detachable connection with a flexible tube 63 which may be connected with a source of gas under pressure such as an oxygen tank. An inlet passage 64 extends through the cover plate 37 from the interior of the nipple 62, and extends obliquely toward the end of the flap valve end 79 and toward the wall of the bellows.

The outer surface of the ring shaped channel 41 is provided with a pair of male snap members 65 on to which the female snaps 19 of a strap 15 may be engaged when the unit is removed from the closure member 11. FIGURE 1 of the drawings shows the unit completely enclosed. FIGURE 2 of the drawings shows the ends of the straps secured to the end plate 35. FIGURE 2 of the drawings shows the manner in which the apparatus may be handled when the receptacle 11 is removed.

A flexible connector 66 is anchored to a bracket 67 on the cover plate 37 and extends through a slot 69 in the reel housing 30 to be secured to the reel 33. As indicated in FIGURE 10 of the drawings, the bottom 12 of the receptacle 10 is provided with a series of angularly spaced numbers or other indicia as indicated at 70 arranged about the axis of the knob 34. A pointer 71 attached to the knob indicates the position of the reel 33 within the housing 30. By winding more or less of the flexible connector 66 on the reel 33, the extent to which the ends of the bellows may be separated may be adjusted.

The clamping plate 23 is provided with an inwardly extending hollow boss 72 containing a normally closed valve mechanism 73 somewhat similar to that used on inflated items such as basketballs, footballs, or even pneumatic tires. A hollow cap 74 is provided on the end panel 12 of the closure 10 and aligned with the hollow boss 72. The purpose of this arrangement is to permit a medicine to be injected into the interior of the bellows from a pressurized capsule which dispenses a measured dose of the medicine. By manipulation of the knob 34, the quantity of air within the bellows may be proportioned relative to the dose of the medicine.

The apparatus is usually also equipped with a pressure relief valve such as is indicated at 75 in FIGURE 9 of the drawings. The purpose of this arrangement is to prevent the build up of a dangerous amount of pressure within the bellows, and to allow the escape of air from the interior of the bellows if the pressure within the same exceeds a desired maximum.

The operation of the apparatus can be most easily understood by referring to FIGURES 11, 12, and 13 of the drawings. The resuscitator is most commonly used by merely forcing air into the lungs of the patient through the mask 43. In doing this, the bellows are merely expanded and contracted at the desired rate, this action drawing air into the bellows and forcing this air into the mask. With reference to FIGURE 11 of the drawings, as the bellows is expanding, a partial vacuum is created within the bellows acting to raise the end 79 of the valve 59 and also seating the end 80 of the valve 59 to close the opening 60 in the offset portion 55. Air is permitted to enter through the aperture 45 in the end plate 35

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and through the aperture 61 in the cover plate 37. With the valve in the position shown in FIGURE 11, the interior of the tubular sleeve 42 which is connected to the mask 43 is in communication with the discharge passage 44 so that the patient may exhale through the mask to atmosphere.

FIGURE 12 of the drawing shows the position of the valve 59 when the bellows are being neither expanded nor compressed, it being possible for the patient to inhale or exhale to atmosphere if he desires, or for air to enter the bellows. When the bellows are compressed, and the pressure within the bellows exceeds that of the atmosphere, the end 80 of the valve 59 flexes down to engage the inclined upper end of the outlet tube 44, and as the valve 59 is almost as wide as the offset portion 55, the valve end 80 normally sweeps over the outlet 44 virtually immediately, and accordingly the compression of the bellows will force air through the tubular connection 42 with the mask 43.

FIGURE 12 illustrates the manner in which the bellows may act as a reservoir and decompression chamber for a gas such as oxygen. The oxygen, entering through the tube 63 from a source of supply, enters beneath the end 79 of the valve 59 flexing this valve end open. Oxygen may circulate through the bellows, and leave both through the air inlet 61 and bellows outlet 60, as long as the pressure within the bellows does not greatly exceed atmospheric pressure. Normally the filled bellows will be slightly above atmospheric pressure when expanded due to the weight of the upper end plate unless physically supported. The pressure maintained is not sufficient to close the air outlet 44. However, if the patient inhales, creating a negative pressure, the pressure differential on opposite sides of the valve end 80 increases causing the valve end 80 to close the outlet 44 and permitting the patient to inhale oxygen from the bellows. When the patient exhales, the valve 80 again opens the outlet 44 permitting exhalation to atmosphere.

When it is desired to force oxygen into the mask, a compressive force is exerted upon the bellows. This causes an increase in pressure in the bellows sufficient to force the valve end 80 to overlie the air outlet 44. The pressure also flexes the end 79 of the valve to close the air inlet 61. However, the force of the oxygen in the tube 63 causes the tip end of the valve end 79 to flex open in the manner shown in FIGURE 13. Thus the oxygen may be introduced through the valve chamber to the mask at a pressure determined by the operator.

As is believed obvious, the entire valve may be removed for cleaning and sterilizing by removing the end plate structure 35 and disconnecting the valve. It is important that the valve be made of relatively thick, soft resilient material, as the thin diaphragms sometimes used fail to function after a short period of use. In this connection it should be mentioned that while there is a decided advantage in using a single unitary strip for the valve, it could be cut in two each with one end clamped in place and still function.

Where the device is to be used with oxygen or the like, it may be desirable to employ a spring 84 which may be provided between the bellows ends to at least partially expand the bellows when the fastening means is released. This spring 84 is preferably not sufficiently strong to materially affect the normal operation of the bellows.

FIGURE 13 of the drawings in general shows the valve 59 in the position it assumes when the bellows are being compressed. However, this figure illustrates what takes place in the event oxygen or other compressed gas is introduced through the tube. When the pressure within the hose 63 exceeds that within the bellows, the end 80 of the valve will remain seated over the outlet port 44, and the valve will remain closed over the inlet opening 61. However, the tip extremity of the end 79 of the valve will flex upwardly enough to allow the compressed

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gas to enter the bellows, and will thereafter free to pass through the tube 42 and into the mask 43.

In accordance with the patent statutes, I have described the principles of construction and operation of my improvement in an "Inhalator," and while I have endeavored to set forth the best embodiment thereof, I desire to have it understood that changes may be made within the scope of the following claims without departing from the spirit of my invention.

I claim:

1. In a respiratory device of the type including a bellows and end members on the ends of said bellows by means of which said bellows may be expanded or contracted, one of said end members including an inlet passage, an outlet passage, and a mask passage, a face mask having its interior in communication with said mask passage, a bellows passage in opposed relation to said outlet passage and a valve for controlling the flow of fluid through said passages, said valve comprising an elongated strip of flexible material secured to said one end member intermediate its ends, one end of said strip extending over said inlet passage and operable to open said inlet passage when said bellows expands and close said inlet passage as said bellows contract, the other end of said strip being movable from one position closing said outlet passage when said bellows contract to a position closing said bellows passage when said bellows expand, said mask passage being in communication with said outlet passage when said strip is in the last named position.

2. The structure of claim 1 and including a compressed gas inlet communicating with the interior of said bellows and terminating beneath the end of said strip overlying said inlet passage.

3. A respiratory device including a bellows and end members closing the ends of said bellows and by means of which said bellows may be expanded and contracted, one of said end members including an air chamber, an outlet passage communicating with said air chamber, a mask passage communicating with said air chamber, and a bellows passage in opposed relation to said outlet passage connecting said air chamber and said bellows interior, said one end member including an inlet passage therethrough, a resilient elongated flap valve secured intermediate its ends to said one end member between said inlet passage and said outlet passage, one end of said valve overlying said inlet to permit air to enter said bellows but to prevent the escape of air therefrom, the other end of said valve extending into said air chamber and being movable from one extreme position closing said outlet to a second extreme position closing said bellows passage, said mask passage being in communication with said bellows passage when said outlet passage is closed by said valve, and being in communication with said outlet passage when said bellows passage is closed.

4. The structure of claim 3 and including a compressed gas inlet extending through said one end member and terminating beneath the end of the valve which overlies said air inlet opening, whereby said compressed gas inlet may be open when said inlet and outlet passages are closed by said valve.

5. A respiratory device including a bellows and end members closing the ends of said bellows and by means of which said bellows may be expanded and contracted, one of said end members comprising a pair of spaced walls peripherally connected together, a partition wall extending between said spaced walls to divide the space therebetween into two sections, both of said walls having air inlet openings leading through one of said sections, partition walls extending in generally parallel relation at right angles to said first named partition wall defining an air chamber in the other of said sections, a mask passage and an outlet passage extending through the outer of said spaced walls and communicating with said air chamber, a bellows opening in the inner of said walls

and in generally opposed relation to said outlet passage, a valve member comprising an elongated strip of flexible resilient material secured to the inner of said spaced walls and the other end extending into said air chamber between said outlet passage and said bellows opening, said one end of said valve flexing inwardly as said bellows is expanded to open said inlet opening and the other end of said valve flexing inwardly to close said bellows opening leaving said mask passage in communication with said outlet passage, said one end of said valve closing said inlet opening and the other end of said valve closing said outlet passage when said bellows is compressed and providing communication from said bellows through said bellows opening to said mask passage.

6. The structure of claim 5 and including a compressed gas inlet extending through said spaced walls and terminating adjacent said one end of said valve and normally closed by said valve.

7. A respiratory device including a bellows and end members attached to and closing the ends thereof, a face mask secured to one of said end members and communicating with the interior of said bellows, and adjustable means limiting the separation of said end members, said adjustable means including a flexible connector connecting said end members, and means externally of one of said end members for adjusting the length of said connector.

8. A respiratory device including a bellows, a pair of end members closing the ends of said bellows, a face mask secured to one said end members and communicating with the interior of said bellows, and a covering receptacle enclosing said one end member and said face mask and extending in end abutting relation to the other of said end members, and detachable means connecting said receptacle in edge abutting relation to said other end member.

9. The structure of claim 8 and in which said detachable means includes a strap extending across the other of said member and along diametrically opposite sides thereof, means on the sides of said other end member for holding said strap, and detachable means on the ends of said strap and on said receptacle for connecting said strap and said receptacle.

10. The structure of claim 9 and in which said means on said other end member for holding said strap comprise loops through which said strap slidably extend, and in which said detachable means on the ends of said strap retain the ends of said strap from passing completely through said loops.

11. The structure of claim 9 and including auxiliary detachable connecting means on said one end member

for engagement with the detachable means on the ends of said strap when said receptacle is removed.

12. A respiratory device of the type including a bellows, and end members on the ends of said bellows by means of which said bellows may be expanded or contracted, one of said members including an air inlet passage and a compressed gas inlet passage, a flexible resilient inlet valve secured to said one end member and having a free end, said valve overlying said air inlet and having its end extremity overlying said compressed gas inlet, said bellows, when not subjected to compression, forming a gas reservoir and decompression chamber, one of said end members including an outlet passage and a face mask passage, a face mask communicating with said face mask passage, an outlet valve controlling said outlet passage, said face mask passage being so located that a reduction in pressure in said face mask passage creates a tendency for said outlet valve to close said outlet valve, whereby inhalation by a patient wearing said face mask tends to close said outlet valve to atmosphere and to permit inhalation of gas from said bellows.

13. The construction of claim 12 and in which said inlet valve may close said air inlet while still keeping said compressed gas inlet open when said bellows is compressed to increase the internal pressure therein.

14. The structure of claim 12 and in which said compressed gas may fill said bellows and pass to atmosphere through said air inlet when the pressure within said bellows does not materially exceed atmospheric pressure.

15. The structure of claim 12 and including means for normally urging said bellows toward expanded position.

16. A respiratory device including a bellows and end members attached to and closing the ends thereof, a face mask secured to one of said end members and communicating with the interior of said bellows adjustable means limiting the separation of said end members, said adjustable means including a flexible connector anchored to one said end member and a reel on the other said member on which said connector is wound, and means adjusting the position of said reel.

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