

[54] **RESUSCITATOR**

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 1969, abandoned.

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[51] Int. Cl. **A62b 7/02**

[58] Field of Search... **128/140, 142.3, 193, 194, 188,**
128/145.8, 145.5, 145.6, 145.7, 146, 146.3;
137/604

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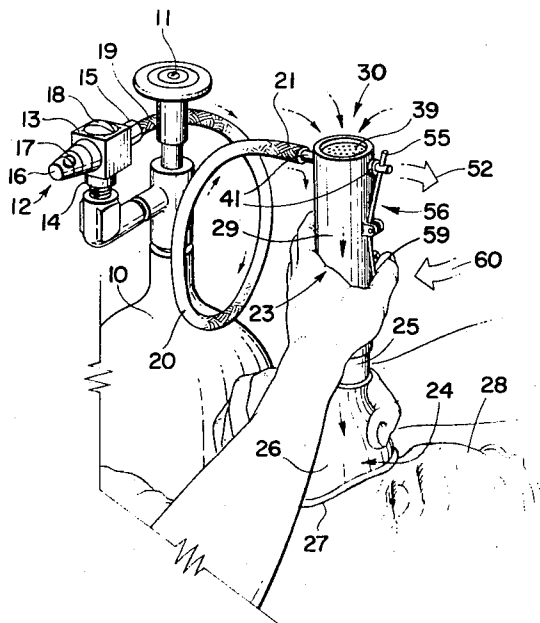
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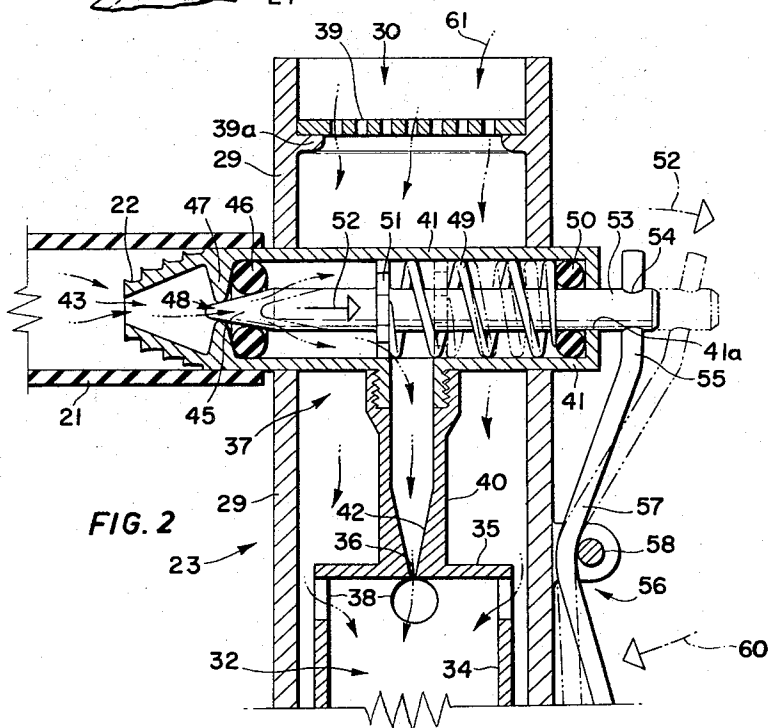
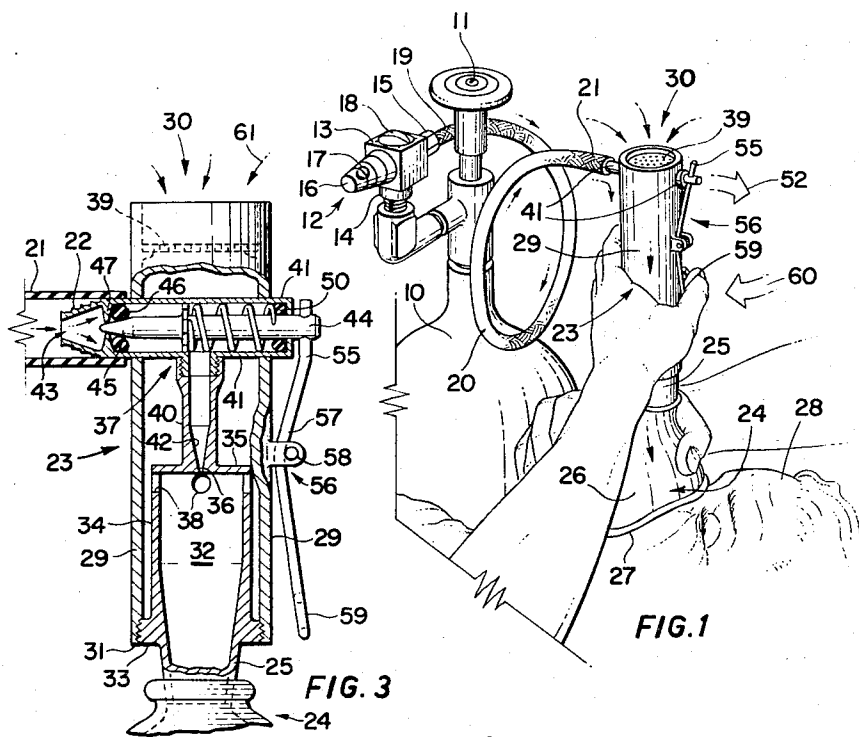
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ABSTRACT

A resuscitation apparatus for use with a face mask or the like and a supply of oxygen having a body portion with an air inlet open to atmosphere and an outlet opening for connection to the mask, a mixing chamber positioned within the body portion connected with the outlet opening of the body portion, at least one air delivery port connecting with the mixing chamber, at least one oxygen inlet port in the mixing chamber arranged and oriented adjacent to the air delivery port to procure induction of air into the chamber by venturi action responsive to the flow of oxygen through the oxygen inlet passage, conduit means connected with the oxygen inlet port and connected to a source of oxygen, and manually operated valve means in the oxygen inlet passage for controlling the flow of oxygen from the conduit means to the oxygen inlet port in the chamber. In this way, the mask is always directly open to atmosphere through the air inlet port regardless of oxygen delivery. Delivery of oxygen inducts additional air which is mixed and supplied to the mask under slight pressure. Excess pressure escapes to atmosphere through the air inlet port.

10 Claims, 8 Drawing Figures





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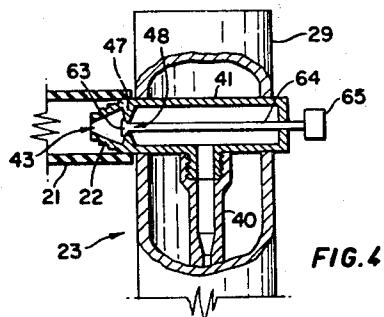


FIG. 4

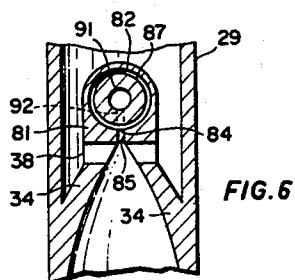


FIG. 6

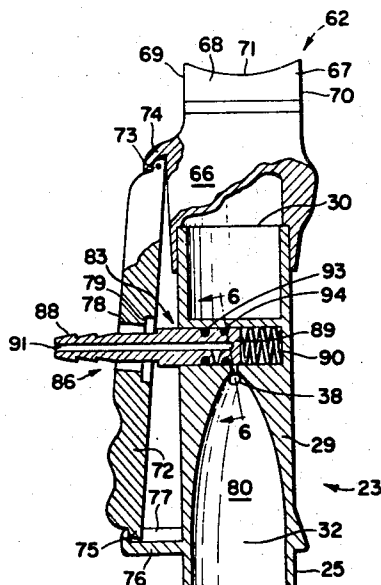


FIG. 5

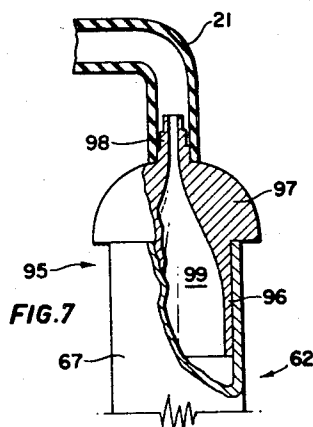


FIG. 7

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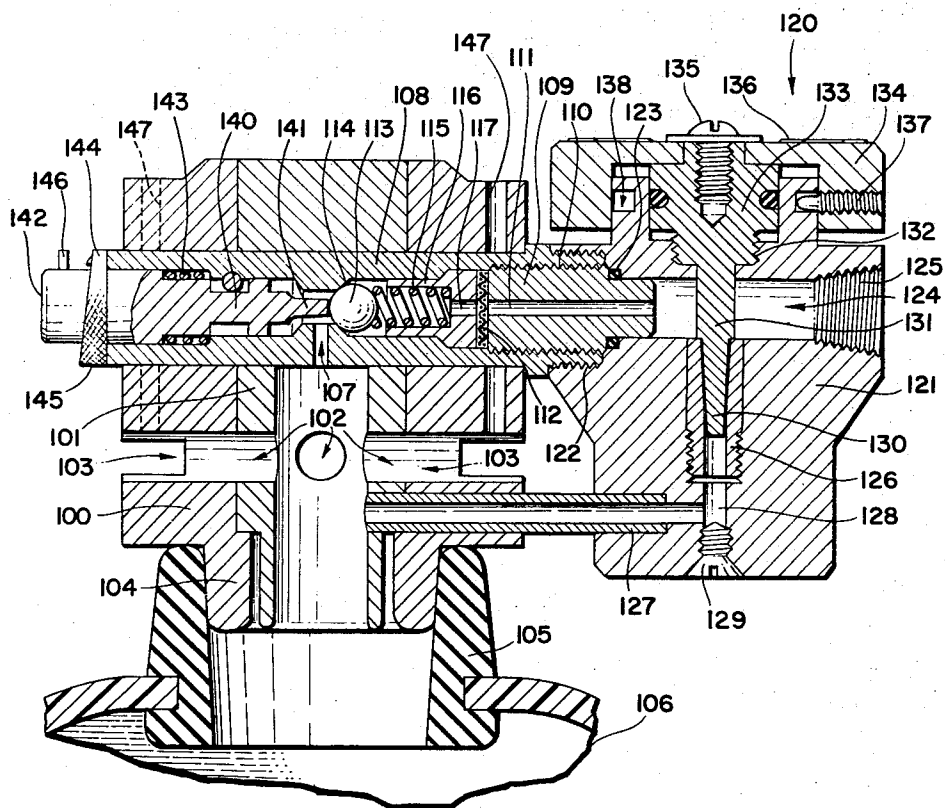


FIG. 8

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RESUSCITATOR

This application is a continuation-in-part of U.S. application Ser. No. 839,326, filed July 17, 1969, now abandoned.

BACKGROUND OF THE INVENTION

A given amount by the weight of oxygen per unit of time is required by each person when breathing if he is to survive. If a person is unconscious, it is necessary to add oxygen to the inhaled air to give him more than the required weight of oxygen within a given time. The use of known resuscitation apparatus requires the assistance of a skilled operator as an unconscious person must be forced to inhale the oxygen air mixture rhythmically as if the patient were breathing by himself until the patient regains consciousness and his own voluntary effort begins.

Various embodiments of apparatus for resuscitation are known for use in cases of emergencies, for example, for emergency cases in hospitals, at accidents, or fires by members of rescue squads, fire departments, police departments or the like. Such apparatus for resuscitation usually have a cylindrical oxygen container of considerable size and volume associated with it and comprise a regulating mechanism and a means for obtaining a mixture of oxygen and atmospheric air for the patient. Such known apparatus have relatively complicated construction and can therefore only be operated by trained personnel. A conventional oxygen cylinder has an operating pressure of up to 150 atmospheres. Oxygen at this pressure cannot be used for resuscitation so a flowmeter or pressure reducing device known in the art is attached to the container to provide gas at, or about, atmospheric pressure at its outlet. A needle valve on the flowmeter can be simply manipulated by any unskilled person to give an outlet of oxygen at any desired pressure from the flowmeter. With most of the known resuscitators such a flowmeter is not used and the operator has difficulty in controlling the pressure introduced into the lungs of the patient and this uncontrollable pressure often causes damage to the lung tissues of the patient.

Two resuscitators presently available on the market are a demand valve resuscitator, and a manual bag with a directional valve. The demand valve resuscitator is connected by an air line to an anatomical mask which is placed on the patient's mouth and nose to administer oxygen to the patient. The demand valve resuscitator has complex equipment therein to provide the oxygen automatically in predetermined quantities to the patient at a predetermined positive pressure. The resuscitator is automatically turned on when there is a negative pressure in the patient's lungs. This demand valve resuscitator cannot be used with a victim of cardiac arrest because it is desirable to apply cardiac massage to the victim to keep his heart working until it begins beating again by itself. The pressure applied in external massage causes a negative pressure in the lungs and turns the resuscitator on, forcing more air into the lungs which could injure the patient. The demand valve resuscitator must be operated by skilled personnel to prevent injury to the patient. Also this equipment is complex and there is a great possibility of breakdown in the operational parts when in use.

The manual bag resuscitator has a directional valve connected to a mask which is placed on the nose and

mouth of the patient. An oxygen line is connected to the inlet end of the bag and the bag is manually compressed by an operator to administer oxygen into the lungs of the patient. A good seal must be maintained between the mask and the face of the patient to prevent the air mixture from escaping out the side of the mask. The pressure at which the oxygen is forced into the lungs of the patient cannot be controlled by the operator and the continuous manual compression of the bag is exhausting to the operator. The directional valve merely permits the oxygen to leave the outlet opening of the bag and prevents the exhaled air from returning to the bag. The volume and pressure of the oxygen entering the lungs of the patient is uncontrollable with the manual bag and often causes damage to the lung tissues in the patient. Also, if any regurgitated matter enters the bag, the operator must stop and change it as there is no method of cleaning the bag. If a new bag is not available, then mouth to mouth resuscitation must be applied.

BRIEF SUMMARY OF THE INVENTION

An apparatus according to this invention overcomes the above disadvantages and provides an apparatus for resuscitation connected directly to a face mask. The apparatus incorporates a mixing chamber in communication with atmospheric air, and oxygen under pressure flowing into the chamber draws air into the chamber by a venturi principle and thus increases the concentration of oxygen in the mixture of oxygen and air that flows into the lungs of the patient without dangerously increasing the pressure. The pressure of the oxygen is controlled by a valve thereby permitting an unskilled operator to use the apparatus on a patient, and permitting use of an intermittent positive pressure technique on the patient by means of which the oxygen enriched air is rhythmically introduced into the lungs of the patient at a desired rate of breathing until voluntary effort begins on the part of the patient himself. Preferably, in order to regulate the volume and pressure of enriched air in the lungs of the patient, the oxygen is supplied through a flowmeter of known design, and for an adult, the flowmeter is usually set at 30 centimeters of water pressure and then the operator can adjust this rate in either direction if the lungs of the patient are not being completely filled or are being filled too much. The valve in the apparatus has a fingertip control at the oxygen inlet positioned in such a manner that the operator is able to hold the apparatus and the mask securely on the patient's face while operating the control valve. A proper seal can always be maintained between the mask and the face of the patient and proper ventilation of the patient is obtained. Since the mixing chamber is always open to atmosphere, dangerous pressure build-ups are prevented, notwithstanding that the lungs of the patient may already be filled.

It is an object of this invention to provide a resuscitator apparatus for mixing two gases under different pressures in which the supply of the gas under greater pressure is directly controlled by an operator and the supply of the other gas is controlled by the flow of the gas under greater pressure.

It is another object of this invention to provide a resuscitator apparatus in which the flow of oxygen is directly controlled by an operator and the supply of air is controlled by the flow of oxygen.

It is still another object of this invention to provide a resuscitator apparatus of simple construction, light in weight, and readily portable being suitable for use in the field or the hospital.

It is yet another object of this invention to provide a resuscitator apparatus which can easily be cleaned and sanitized after being used.

It is yet another object of this invention to provide a resuscitator apparatus which can be used on a patient receiving external cardiac massage.

It is yet another object of this invention to provide a resuscitator apparatus which can be used for mouth to mouth resuscitation on a patient with a communicable disease.

Other advantages and fuller understanding of the invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a perspective view of an apparatus for resuscitation according to the invention;

FIG. 2 is an enlarged partial longitudinal cross-section view of the apparatus for resuscitation shown in FIG. 1 illustrating the invention being incorporated therein;

FIG. 3 is a view similar to FIG. 2, wherein a fragmentary cross-section view of the whole apparatus is shown;

FIG. 4 is a partial longitudinal cross-section view of an alternative embodiment of a valve means for the resuscitation apparatus;

FIG. 5 is a partial longitudinal cross-section view of another alternative embodiment of the resuscitation apparatus;

FIG. 6 is a section view along the line 6—6 of the FIG. 5;

FIG. 7 is a partial longitudinal cross-section view of a mouthpiece insertion member to be used in conjunction with the mouthpiece of the resuscitation apparatus; and

FIG. 8 is a sectional side elevational view of a further embodiment of the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

As shown in FIG. 1, a cylinder containing oxygen 10, has an outlet valve 11 with a flowmeter 12 connected thereon. The flowmeter 12 has a main body 13 with an inlet opening 14 and outlet opening 15 and a hollow chamber 16 diametrically opposite from the outlet opening 15. The chamber 16 has a calibrated flow scale thereon and a ball 17 therein. A needle valve 18 controls the pressure at the flowmeter inlet opening 14 from the cylinder 10. When the needle valve 18 is opened, oxygen flows into the flowmeter 12 and a back pressure of oxygen is formed in the chamber 16 which moves the ball 17 up and down in the chamber 16 to indicate the pressure at the outlet opening 15. The outlet opening 15 has a nipple construction and an end 19 of a plastic hose 20 or the like which preferably can withstand 50 pounds per square inch pressure therein, is connected thereon. The other end 21 of the hose 20 is connected to a nipple 22 at the oxygen inlet valve of a resuscitation apparatus 23 that is attached to an anatomical mask 24 by a universal connecting means

25. The mask 24 includes a frusto-conical portion 26 provided with a face engaging portion 27 preferably of a resilient material and the continuous edge of which is adapted to engage the face of a patient 28 and to encircle his nose and mouth.

The apparatus 23 comprises a tubular body portion 29 having an upper air inlet opening 30 and a lower outlet opening 31. A hollow mixing chamber 32 preferably cylindrical in shape is positioned within the body portion 29 and has its lower edge 33 aligned with the outlet opening 31 of the body portion 29. Preferably the chamber 32 is screwed into the body portion 29 as shown in FIG. 3. The lower edge 33 of the chamber 32 is connected to the universal connecting means 25 at the outlet opening 31 of the body portion 29. Preferably the chamber 32 has side walls 34 spaced away from the walls of the body portion 29 and connected at the upper end by a top member 35 at the intermediate portion of the body portion 29. The chamber 32 could also be frusto-conical in shape with the side walls 34 extending upwards and inwards from the lower edge 33 to the top member 35. A restricted orifice 36 through the top member 35 of the chamber 32 is connected to the oxygen inlet nipple 22 by a T-shaped hollow member 37 with a valve means to be described hereinafter therein. Oxygen is introduced into the chamber 32 through the orifice 36.

A plurality of laterally extending air inlet openings 38 pass through the walls 34 adjacent the top member 35. Preferably the openings 38 are four in number and positioned 90° apart all in the same plane. However, it is possible to have only one opening 38 if desired. The upper edge of each opening 38 is preferably in the same plane as the outlet end of the orifice 36 to provide a venturi passageway for reasons which will be described later. The walls 34 are positioned away from the body portion 29 to permit atmospheric air to enter the chamber 32. A perforated member 39 is secured to a ridge 39a on the inside wall of the body portion 29 and prevents any foreign matter from falling into the tubular body portion 29 and clogging up the holes 38.

The T-shaped member 37 comprises a hollow stem portion 40 connected to the top member 35 of the chamber 32 at one end and releasably secured to a hollow bar portion 41 by threaded means at the other end. The bar portion 41 has a length greater than the diameter of the body portion 29 and is preferably positioned perpendicular to the stem portion 40. The hollow stem portion 40 has inner walls 42 which diverge inwardly and downwardly towards the orifice 36 to provide a restricted orifice 36 as required. The bar portion 41 has the oxygen inlet nipple 22 with the valve means on one end with an opening 43 therethrough and an opening 41a in the other end with a smaller diameter than the inside diameter of the bar portion 41.

A pin 44 is passed through the opening 41a and positioned within the bar portion 41 and has a length as long as the length of the hollow bar portion 41. The pin 44 has an engaging surface 45 at the end adjacent the nipple 22 which is shaped to make sealing engagement with a rubber O-ring 46 abutting against a ridge 47 in the hollow bar portion 41. This structure forms the valve means at the oxygen inlet nipple 22. The ridge 47 leaves an opening 48 through which the oxygen passes into the bar portion 41 when the engaging surface 45 is

away from the O-ring 46. Other valve means of known designs can be used here also. The engaging surface 45 of the pin 44 is urged into sealing engagement with the rubber O-ring 46 by means of a spring means 49 which is made of a non-corrosive material and one end rests against an O-ring 50 positioned at one end of the hollow bar portion 41 and the other end rests against an axially positioned solid means 51 secured to the pin 44 which compresses the spring 49 when the pin is drawn in the direction shown by an arrow 52, in FIG. 2. An end 53 of the pin 44 opposite to the engaging surface 45 extends out of the opening 41a in one end of the bar portion 41 and has a transverse hole 54 through which is passed an end 55 of a fingertip lever 56.

The lever 56 has its intermediate portion 57 attached to a pin 58 which is connected to the tubular body portion 29 by securing means extending therefrom. A free end 59 of the lever 56 extends downwards from the intermediate portion 57 towards the outlet opening 33 and is positioned away from the outer wall of the tubular body portion 29 to permit the end 59 to be moved towards the body portion 29. When the free end 59 is moved towards the body portion 29 to a position shown in dotted lines in FIG. 2 by a force applied in a direction shown by an arrow 60 in FIGS. 1 and 2, the pin 44 is drawn in the direction shown by the arrow 52 and oxygen is permitted to enter into the T-shaped member 37 and the spring 49 is compressed as shown in dotted lines in FIG. 2. When the force on the free end 59 of the lever 56 is relaxed, the spring forces the engaging surface 45 of the pin 44 to make a sealing engagement with the rubber O-ring 46 again and stop the flow of oxygen into the T-shaped member 37.

An arrow 61 indicates the flow of atmospheric air into resuscitation apparatus 23.

It should be noted that the operator uses the intermittent positive pressure method until voluntary effort of the patient begins itself. Physical signs on the patient indicate whether the patient is voluntarily breathing or not to the operator. These are, watching the chest rise as the lungs are filled up, the color of the skin, and once the lungs are filled, the operator will feel the pressure backing up out the air inlet opening 30 on the apparatus 23. When the lungs are filled with air, the lungs are stretched to almost their maximum elasticity and this is known as the compliance of the lungs. Once the compliance of the lungs is exceeded, there is a possibility of rupture of the lungs and also of damaging other organs in the vicinity of the lungs. By the practice of the present invention, however, since the mixing chamber is always open to atmosphere, dangerous pressure build-ups are prevented, notwithstanding that the lungs of the patient may already be filled.

In operation, when a resuscitator is to be used on the patient, he is usually placed in the supine position, i.e., laying on his back, and the anatomical mask 24 is placed on the face over the nose and mouth and a seal is attained between the surface of the mask 27 and the skin of the patient 28. The valve 11 of the cylinder is turned on to permit oxygen to flow into the inlet opening 14 of the flowmeter 12. The needle valve 18 is turned on to permit oxygen to flow out of the outlet opening 15 into the hose 20 and into the oxygen inlet nipple 22 of the resuscitation apparatus 23. The oxygen flowing into the oxygen inlet nipple 22 will have a max-

imum pressure set by the needle valve 18 of the flowmeter 12.

Inside the apparatus 23, as shown in solid lines in FIGS. 2 and 3, the engaging surface 45 of the pin 44 is resiliently held against the O-ring 46 and acts as a valve to prevent any oxygen from entering the opening 48 until the operator moves the free end 59 of the control lever 56 in a direction shown by the arrow 60 to the position shown in dotted lines in FIG. 2 where the engaging surface 45 is drawn away from the O-ring 46. Oxygen is then permitted to flow through the opening 48 and through the T-shaped member 37 to the restricted orifice 36 in the top member 35 of the chamber 32.

Atmospheric air is drawn into the chamber 32 through the openings 38 as the oxygen enters the chamber 32 through the orifice 36 under pressure. The atmospheric air at the openings 38 is at a sub-ambient pressure in relation to the pressure of the oxygen entering the chamber 32, and by the Venturi principle, the air at atmospheric pressure is drawn into the chamber 32 through the openings 38 to be mixed with the oxygen therein. This increases the concentration of oxygen in the air mixture which flows into the lungs of the patient. The pressure of the air mixture flowing into the lungs of the patient will be no greater than the pressure of the oxygen entering by the orifice 36. Thus when the lungs are filled, no further oxygen is forced into the lungs until the patient exhales the air in the lungs and the pressure in the lungs drops. The excess oxygen being introduced into the chamber 32 and exhaled air escape through the air openings 38 in the chamber 32 to the atmosphere.

With the lever 56 in the position shown in dotted lines, the spring 49 is compressed, as shown in dotted lines in FIG. 2, between the solid member 51 and the O-ring 50 and the oxygen is allowed to flow through the hollow bar portion 41 and the stem portion 40 to the orifice 36. The pressure of the oxygen flowing through the orifice 36 is the same as the pressure shown on the flowmeter 12. The operator keeps his finger on the free end 59 of the lever 56 and oxygen enters into the chamber 32 through the orifice 36. Once the finger is released from the lever 56, the spring 49 acts against the solid member 51 and moves the pin 44 to re-engage the engaging surface 45 of the pin 44 re-engages the O-ring 46 and terminates the flow of the oxygen into the T-shaped member 37 and into the chamber 32.

The pressure of the oxygen enriched air mixture in the chamber 32 will never be more than equal to the pressure of the oxygen entering by the orifice 36 as once the pressure of the air mixture is equal to the pressure of the oxygen entering the chamber 32, no atmospheric air is drawn through the openings 38 into the chamber 32. Also any additional oxygen entering the chamber 32 with the pressures equal, flows out the openings 38. The oxygen enriched air mixture in the chamber 32 passes through the face mask 24 and into the air passageway of the patient and into the lungs of the patient only after the patient has exhaled.

If the patient is not breathing voluntarily, the intermittent positive pressure technique is used and the operator depresses the free end 59 of the lever 56 for approximately 3 to 4 seconds permitting oxygen to flow into the chamber 32 and the oxygen enriched air mix-

ture to flow into the lungs. No damage is done to the tissues of the lung, as the pressure in the lungs, air passageway, face mask 24 or chamber 32 cannot be greater than the pressure of the oxygen entering the chamber 32 through the orifice 36. Any additional oxygen entering the chamber 32 escapes through the openings 38 to the atmosphere through the air inlet opening 30 of the tubular body portion 29.

If the patient is breathing voluntarily, the operator need only keep the free end 59 of the lever 56 depressed continuously as the patient will exhale voluntarily when compliance of the lungs is reached. When the patient is exhaling, the oxygen entering the chamber 32 escapes out the openings 38, as does the exhaled air. When the patient inhales, oxygen enriched air mixture is again formed in the chamber 32 and flows into the lungs of the patient.

Once the needle valve 18 of the flowmeter 12 is set so that there is compliance of the lungs of the patient, the operator need only concern himself with keeping a tight seal between the face of the patient and the mask 24 and operating the lever 56 to permit oxygen to flow into the chamber 32 through the orifice 36.

It is also possible to have a resuscitation apparatus 23 with another embodiment of the valve means which controls the flow of oxygen into the conduit portion 41 from the nipple side of the valve seat 47 and uses the pressure of the oxygen in the hose 21 to close the opening 48. As shown in FIG. 4, a frusto-conical shaped closure member 63 is placed on the nipple side of the valve seat 47 with its apex fitting into the opening 48. The member 63 is attached to one end of a pin 64 having a diameter less than the opening 48 which extends through the conduit portion 41 with a button 65 attached on the other end of the pin 64. The pressure of the oxygen entering the opening 43 in the nipple 22 forces the member 63 against the seat 47 and prevents the oxygen from flowing into the conduit portion 41.

In operation, when the operator wishes oxygen to be introduced into the mixing chamber 32, the button 65 is moved towards the adjacent end of the conduit portion 41 forcing the frusto-conical member 63 at the other end of the pin 64 away from the valve seat 47 to permit oxygen to flow through the opening 48. Oxygen enters the mixing chamber 32 as long as the operator holds the button 65 in this position. When the operator releases the pressure on the button 65, the pressure of the oxygen in the hose 21 acts on the member 63 to force the member 63 against the valve seat 47 and prevent any oxygen from flowing into the conduit portion 41 through the opening 48.

To permit the operator to apply mouth to mouth resuscitation to a patient the mouthpiece 62 is placed on the air inlet opening 30 of the tubular body portion 29. One type of mouthpiece which can be used is shown in FIGS. 5 and 7 with the mouthpiece 62 having a hollow lower attachment portion 66 which fits on the air inlet opening 30 of the tubular body portion 29. A hollow upper portion 67 is shaped to fit easily over the mouth of an operator with spaced apart parallel side walls 68 (only one is shown) joined at the ends by curved end walls 69 and 70. The side walls 68 have an upper surface 71 which preferably is concave-shaped.

To permit the resuscitation apparatus 23 to be made from thermoplastic material or the like, the tubular

body portion 29 and the mixing chamber 32 are integrally moulded together as shown in FIGS. 5 and 6. A handle 72 is moulded separately from the tubular body portion 29 and then is attached to the tubular body portion 29. The handle 72 has its upper end 73 positioned in an extension 74 secured to the attachment lower portion 66 of the mouthpiece 62 and its other end 75 positioned in an extension 76 with a channel 77 therein secured to the tubular body portion 29 to permit the end 75 of the handle 72 to be moved away from the tubular body portion 29 a predetermined distance for reasons which will be explained later. In an intermediate portion of the handle 72 is an elongated opening 78 therethrough having an engaging shoulder 79 formed at one end of the opening 78.

The tubular body portion 29 of the resuscitation apparatus 23 has the air inlet passage 30 at one end open to the atmosphere and the outlet opening 31 at the other end. The mixing chamber 32 is integrally moulded with the tubular body portion 29 and has an upper portion 80 which is preferably frusto-conical in shape with a pair of opposed venturi air inlet passages 38 communicating with the interior of the tubular body portion 29 to permit atmospheric air to enter the mixing chamber 32. The side walls 34 of the mixing chamber 32 diverge upwards and inwards at the upper portion 80 from the walls of the tubular body portion 29 and are joined by a body member 81. The body member 81 has a tubular valve chamber 82 therein of a predetermined regular cross-section throughout its length with a valve receiving opening 83 in the wall of the tubular body portion 29. At an intermediate position along the length of the tubular chamber 82 is an outlet port 84 communicating with the tubular chamber 82 and an inlet passage 85 to the mixing chamber 32. The end opposite the outlet port 84 of the inlet passage 85 is arranged and oriented in relation to the air inlet passages 38 to procure induction of air into the mixing chamber 32 by venturi action responsive to the flow of oxygen through the inlet passage 85.

A valve member 86 having a substantially cylindrical body portion 87 is dimensioned to fit within the interior of the chamber 82 and has a nipple portion 88 at one end which extends out the valve receiving opening 83 of the tubular chamber 82 and through the elongated opening 78 in the handle 72 with the outer surface of the nipple portion engaging the shoulder 79 of the handle 72. On the other end of the valve member 86, is a sealing portion 89 which will be described in more detail hereinafter. A resilient spring means 90 is positioned within the tubular chamber 82 between the closed end of the tubular chamber 82 and the free end of the sealing portion 89 and the spring means 90 is compressed in an operating position. An oxygen passageway 91 preferably L-shaped, extends through the valve member 86 with the longer leg being aligned with the central axis of the valve member 86 and a shorter leg, preferably being perpendicular to the central axis and positioned in the sealing portion 89 of the valve member 86 with a first oxygen discharge port 92 therefrom. The first oxygen discharge port 82 is not in register with the inlet passage 85 in a normal position as shown in FIG. 5. On either side of the first oxygen discharge port 92 are a first and second O-ring 93 and 94 respectively axially positioned on said sealing por-

tion 89 of the valve member 86 to form a tight seal between the inner walls of the valve chamber 82 and the sealing portion 89 of the valve member 86.

In operation, the operator connects the hose 21, shown in FIG. 4 on the nipple portion 88 of the valve member 86 to bring oxygen from a supply source such as shown in FIG. 1. The oxygen flows through the oxygen passageway 91 and out the first oxygen discharge port 92. In the normal position, the first oxygen discharge port 92 is not in register with the inlet passage 85 and no oxygen flows out between the first and second O-rings 93 and 94 to the atmosphere. The sealing portion 89 of the valve member 86 permits the oxygen to flow into the inlet passage 85 only in the operating position.

The operator grasps the handle 72 and the tubular body portion 29 in the palm of his hand and moves the movable end 75 of the handle 72 towards the tubular body portion 29 to the operating position. The elongated opening 78 and shoulder 79 of the handle 72 engages the valve member 86 and moves the valve member 86 in the same direction compressing the spring means 90 and placing the first oxygen discharge port 92 in register with the inlet passage 85 permitting the oxygen to flow into the mixing chamber 32. By venturi action, atmospheric air is drawn through the air inlet passages 38 to provide an oxygen enriched air mixture in the mixing chamber 32. When the operator releases the pressure on the handle 72, the compressed spring means 90 acts on the adjacent end of the valve member 86 to move the oxygen discharge port 92 out of register with the oxygen inlet passage 85 and back to the normal position. The handle 72 is also moved away from the tubular body portion 29 until the movable end 75 hits the end of the channel 77 of the extension 76 on the tubular body portion 29. Preferably, the nipple portion 88 is also in engagement with the shoulder 79 and sides of the elongated opening 78 in the normal position.

The resuscitation apparatus 23 can also be used by the operator with an apparatus for cleaning foreign matter out of the lungs of a patient. The resuscitation apparatus 23 with the venturi action in the mixing chamber 32 creates a sub-ambient pressure at the air inlet opening 30 drawing air into the air inlet opening 30 when the valve means is operated. This sub-ambient pressure can also be used to draw foreign matter from the lungs of a patient such as mucus into a mucus container (not shown) by connecting a first hose 21 between the container and the air inlet opening 30 of the resuscitation apparatus 23 which creates a sub-ambient pressure in the container. One end of a second hose (not shown) is inserted in the lungs of the patient (not shown) and the other end is connected to the container. When the sub-ambient pressure is created in the container, a sub-ambient pressure is created at the free end of the second hose (not shown) in the lungs of the patient which draws the foreign matter into the hose and up into the mucus bottle.

As shown in FIG. 7, a hollow mouthpiece insert member 95 is used in association with the mouthpiece 62 to give a tight seal therebetween to create the sub-ambient pressure in the hose 21 connected to the insert member 95. The insert member 95 has a lower portion 96 which is inserted into the hollow upper portion 67 of

the mouthpiece 62 and an upper skirt portion 97 which covers the upper surfaces 71 of the mouthpiece 62. A nipple 98 is secured to the upper portion 97 to permit the hose 21 to be attached thereto. An air passageway 99 through the insert member 95 permits the sub-ambient pressure to be created in the hose 21.

According to a further embodiment of the invention as illustrated in FIG. 8, the entire apparatus may be substantially reduced in scale and complexity. In this further embodiment, a body portion 100 may be provided of plastic material or the like having a central tubular sleeve member 101 fitting in a suitable tubular opening extending through the body member 100. The tubular sleeve member 101 constitutes the mixing chamber according to the invention, and is provided with air inlet ports 102, connected by means of air inlet conduits 103 to atmosphere. The lower end of body member 100 is provided with a downwardly extending spigot 104 shaped and adapted to fit within an upstanding collar member 105 of a face mask 106, the details of which have been omitted for the sake of clarity. Thus, the interior of the face mask 106 is always in direct communication through the ports 102 and conduits 103 with atmosphere, thereby preventing any undesirable build-up of pressure therein.

In order to admit oxygen under pressure into the interior of tube 101, there is provided an oxygen discharge nozzle 107, located at the upper closed end of the tube 101. The nozzle 107 is formed in an oxygen delivery housing 108, which is preferably arranged in the form of a cylindrical metallic member extending transversely from side to side through the upper portion of the body 100. The oxygen delivery housing 108 is counter-bored from each end, and at one end is provided with a male threaded junction pipe 109 exteriorly threaded, and fitting within corresponding female threads 110 within one counter-bored end of the housing 108. The junction member 109 is provided with interior drilling or oxygen conduit 111 through which oxygen may be admitted under pressure to the interior of the housing 108. A filter disc member 112 is mounted within the same counter-bored end of the housing 108 for filtering the incoming oxygen. In order to control emission of oxygen from the nozzle 107, valve means are provided in the form of the relatively hard rubber ball valve member 113, seating on a valve seat 114 machined on the interior of the housing 108. Ball valve 113 is held in position by means of a spring 115, which is itself retained in position by means of a sleeve member 116 fitting snugly within the interior of housing 108, and held in position by means of the filter disc 112 and the threaded junction member 109. The sleeve member 116 is provided with a conduit 117 for admission of oxygen from the conduit 111.

In its simplest concept, oxygen at a reduced pressure, i.e., coming from a standard form of flowmeter attached in the oxygen supply line (not shown) may be delivered directly to the junction member 109, and enter the conduit 111. Means for delivery of such oxygen are not specifically shown, but are, in any event, matters which are well known to persons skilled in the art. If necessary, they could be essentially the same as the oxygen delivery means shown in connection with the embodiment of FIG. 1.

However, in this preferred embodiment of the invention it is considered desirable to provide an oxygen by-pass means whereby oxygen can be selectively delivered either to the conduit 111, and hence to the ball valve 113, or alternatively, the oxygen can by-pass the conduit 111 and ball valve 113 altogether and flow continuously into the lower end of the tubular member 101. Such an oxygen by-pass means comprises the by-pass control valve shown by the general reference arrow 120. By-pass control valve 120 will be seen to comprise an outer body 121, having a interior threaded counter-bore 122 at one end, adapted to engage corresponding exterior threads on the exterior of the oxygen delivery housing member 108. Preferably, a good seal is maintained, by means of the rubber O-ring 123. Body member 121 is preferably provided with an interior oxygen conduit 124 extending completely transversely of the body 121, and at its free end the conduit 124 is provided with interior tapered threads 125 for connection with any standard form of oxygen delivery system omitted here for the sake of clarity. In order to effectively by-pass the flow of oxygen from the conduit 124, a by-pass conduit sleeve member 126 extends vertically downwardly within body 121 normal to the axis of conduit 124, and a second by-pass conduit 127 extends transversely from the lower end of body 121. Obviously, the construction of body 121 may vary, but in this case, interior drillings 128 are arranged within body 121 to communicate between conduits 126 and 127, and a plug 129 is inserted into the lower end of drilling 128 to seal it against escape of oxygen therefrom. The free end of conduit 127 passes through body portion 100 and tubular member 101 and is available to admit oxygen continuously into the interior of tubular member 101, below the air entry ports 102. In order to control flow of oxygen into and out of conduit 126 a needle valve member 130 is provided on a stem 131, which in turn is adapted to be drawn upwardly and downwardly by threaded means 132 on the boss member 133. Preferably, the boss member 133 is provided with an exterior generally cylindrical knurled hand wheel 134, the two members being fastened together by means of the screw 135. An indicator disc 136 is mounted on the upper surface of hand wheel 134, having any suitable visual calibrations marked thereon so as to indicate various positions of the needle valve 130, corresponding to different flow rates of oxygen.

A stop member 137 running in an oversized groove 138, limits upward and downward movement of the hand wheel 134.

In order to control the operation of the ball valve 113 so as to permit an operator to supply intermittent deliveries of oxygen through the nozzle 107, an operating plunger 140 is provided in the outer end of the housing member 108, having a contact rod 141 adapted to contact the ball valve 113 and push it off the seat 114 against the pressure of spring 115, thereby admitting oxygen to the nozzle 107. Operation of the plunger 140 is effected by manual pressure from the hand of an operator applied to the outer end of the button 142, pressing against the return spring 143, and also pressing against the pressure of the spring 115.

In certain cases, it may be desirable to accurately control and limit the inward extent of movement of the

button 142. In particular, it is sometimes desirable, especially when using such a device for the resuscitation of children, that any possibility of applying an excess oxygen pressure to the lungs of the child be avoided. For this purpose, a knurled ring 144 is rotatably mounted on the outer end of the housing 108, being rotatable about the button 142. The outwardly directed surface 145 of the ring 144 is arranged at an angle so as to provide a camming action, and a pin follower member 146 is mounted in a suitable place in the button 142, so that the button will abut against the surface 145 of the ring 144. Obviously, rotation of the ring 144 will cause the pin 146 to be stopped at different positions, thereby limiting the inward extent of travel of the button 142.

In some cases, the operator, especially if he or she is inexperienced, may accidentally cover up one or other of the air passageways 103, thereby preventing the admission of air into the interior of the tubular member 101. In order to prevent any undesirable result, additional air passageways indicated at 147 are provided vertically downwardly through the sides of the body 100, thereby permitting air to pass vertically downwardly therethrough and into the air passageways 103.

In operation, assuming a resuscitation effect is required, then after the device has been connected to a suitable of high pressure oxygen, the operator simply places the mask 106 over the mouth of the patient and presses the button 142. Oxygen then passes around ball 113 through nozzle 107 under pressure and downwardly through the tubular member 101. As it passes downwardly, it will induct air through the air passageways 103 and the openings 102, by venturi action and will become mixed therewith and enter the mask 106. If the patient is able to breathe such flow will continue. If the patient is not actually breathing on his own, then there will be a slight build-up of pressure inside the mask 106, applying a slight resuscitation action to the lungs of the patient, after which any excess pressure will, of course, flow directly out of the air openings 103. As soon as the operator notices the patient's lungs have become inflated, he will release the button 142, thereby releasing the pressure on the patient's lungs, and the lungs will naturally tend to recover their normal size and exhale. Continued intermittent pressure on the button 142 will continue to produce intermittent resuscitation action as long as is desired.

As soon as the patient is breathing on his own, then the intermittent resuscitation action can be discontinued, and continual small quantities of oxygen can be supplied simply by opening the by-pass valve 130 so that there is a continual flow of oxygen through the conduit 127 into the tubular member 101 and into the mask 106.

The foregoing is a description of a preferred embodiment of the invention only. The invention is not to be taken as limited to any features described but comprehends all such variations as come within the spirit and scope of the claims.

What I claim is:

1. A resuscitation apparatus for use with a face mask or the like and a supply of compressed oxygen and comprising:
 - a body portion;

air inlet opening means in said body portion open to atmosphere;

a mixing chamber located within said body portion having an outlet opening, adapted to be connected to a face mask or the like;

air inlet passage means in said mixing chamber communicating between the interior thereof and atmosphere through said air inlet opening means in said body portion for inflow and outflow of atmospheric air;

at least one oxygen inlet passage in said mixing chamber;

said oxygen inlet passage including a nozzle arranged and oriented adjacent to said air inlet passage means to procure induction of air into said chamber by venturi action responsive to the flow of oxygen through said oxygen inlet passage;

conduit means connected with said oxygen inlet passage through said body portion and connectible with a source of compressed oxygen;

manually operable valve means in connection with said oxygen inlet passage and said nozzle for controlling the flow of oxygen from said conduit means to said nozzle;

said mixing chamber having cylindrical side walls extending upwards from said outlet opening of said body portion and a top wall joining said side walls at one end; said oxygen inlet passage having a central axis and adapted to pass through said top wall; and said air inlet passage adapted to pass through said side walls being in a plane perpendicular to the central axis of said oxygen inlet passage.

2. An apparatus as claimed in claim 1, wherein said chamber comprises frusto-conical side walls extending upwards and inwards from said outlet opening and a top wall joining said side walls at one end; said oxygen inlet passage having a central axis and adapted to pass through said top wall; and said air inlet passage adapted to pass through said side walls being in a plane perpendicular to the central axis of said oxygen inlet passage.

3. An apparatus as claimed in claim 1, including spring means associated with said valve means and adapted to hold said valve means in a closed position.

4. An apparatus claimed in claim 1, including a shaft means connected to said valve means having a free end

extending out of the wall of said body portion; manually engageable means on the free end of said shaft means and adapted to be operable by the fingers of the operator for manually actuating said valve means.

5. An apparatus as claimed in claim 1, including a control handle associated with said valve means, said body portion and control handle being so dimensioned as to be grasped as a unit in the palm of the hand of an operator.

6. An apparatus as claimed in claim 1, including an oxygen container having a supply of compressed oxygen; a flowmeter associated with said container for measuring and reducing the pressure of the oxygen from said container; control means on said flowmeter for adjusting the pressure of the oxygen emerging from said container; and tubular means connected between the outlet end of said flowmeter and said conduit means.

7. An apparatus as claimed in claim 1, including means for coupling said conduit means to the supply of oxygen with an adjustable pressure control means associated therewith, whereby the pressure of the oxygen entering said oxygen inlet passage is predetermined.

8. Apparatus as claimed in claim 1 including tubular opening means extending transversely of said body portion, said conduit means being located in one end of said tubular opening means, said valve means being connected therewith as aforesaid, and including valve operating means extending from the other end of said tubular opening means for manual operation thereof.

9. Apparatus as claimed in claim 1 including additional air passageway means formed in said body parallel to the central axis thereof and communicating at one end with said air inlet passage means, and at the other end thereof to atmosphere at one end of said body whereby to avoid blockage of said air passage means by the hand of an operator.

10. Apparatus as claimed in claim 1 including oxygen bypass means connecting between said conduit means and said mixing chamber for direct delivery of oxygen thereto in bypass relation to said inlet passage means and nozzle, and flow regulator means for regulating flow through said bypass means.

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