Nov. 14, 1967 R. G. BARTLETT, JR 3,352,304

MASK-TO-MASK RESUSCITATION SYSTEMS

Filed Nov. 30, 1964 2 Sheets-Sheet 1

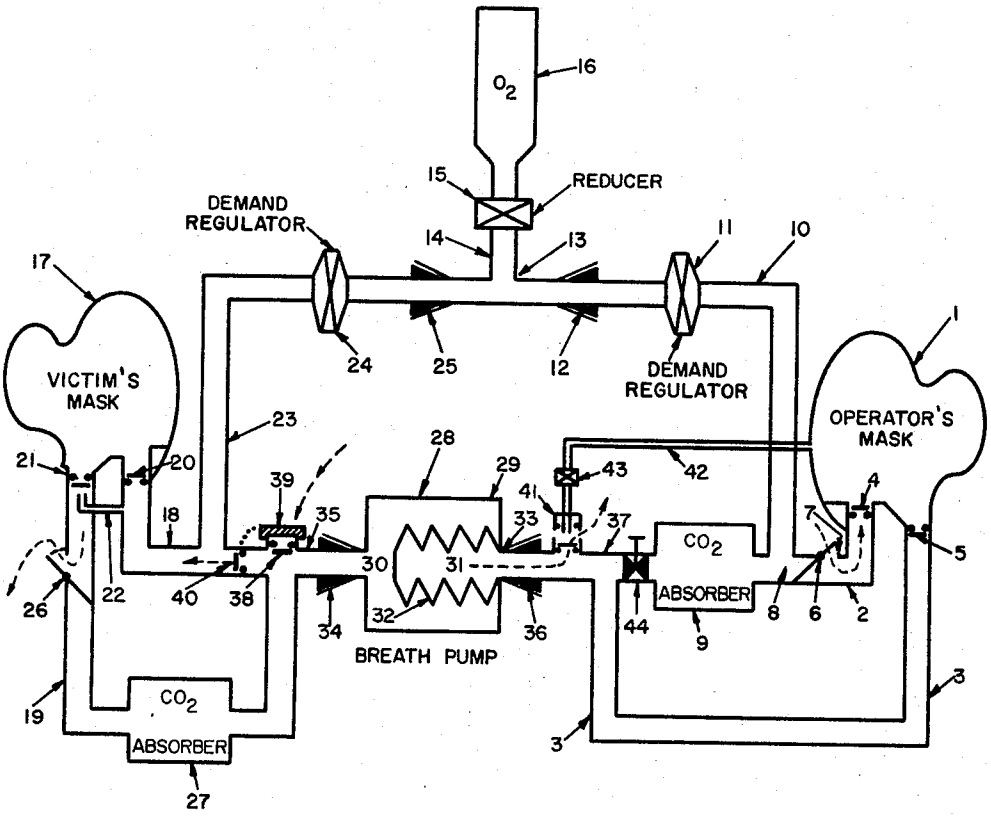


FIG. 1

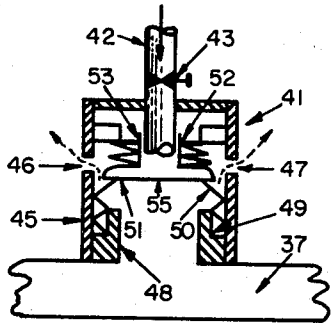


FIG. 2

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MASK-TO-MASK RESUSCITATION SYSTEMS

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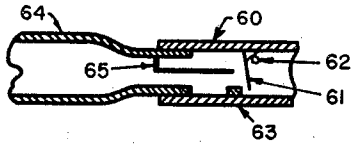


FIG. 3

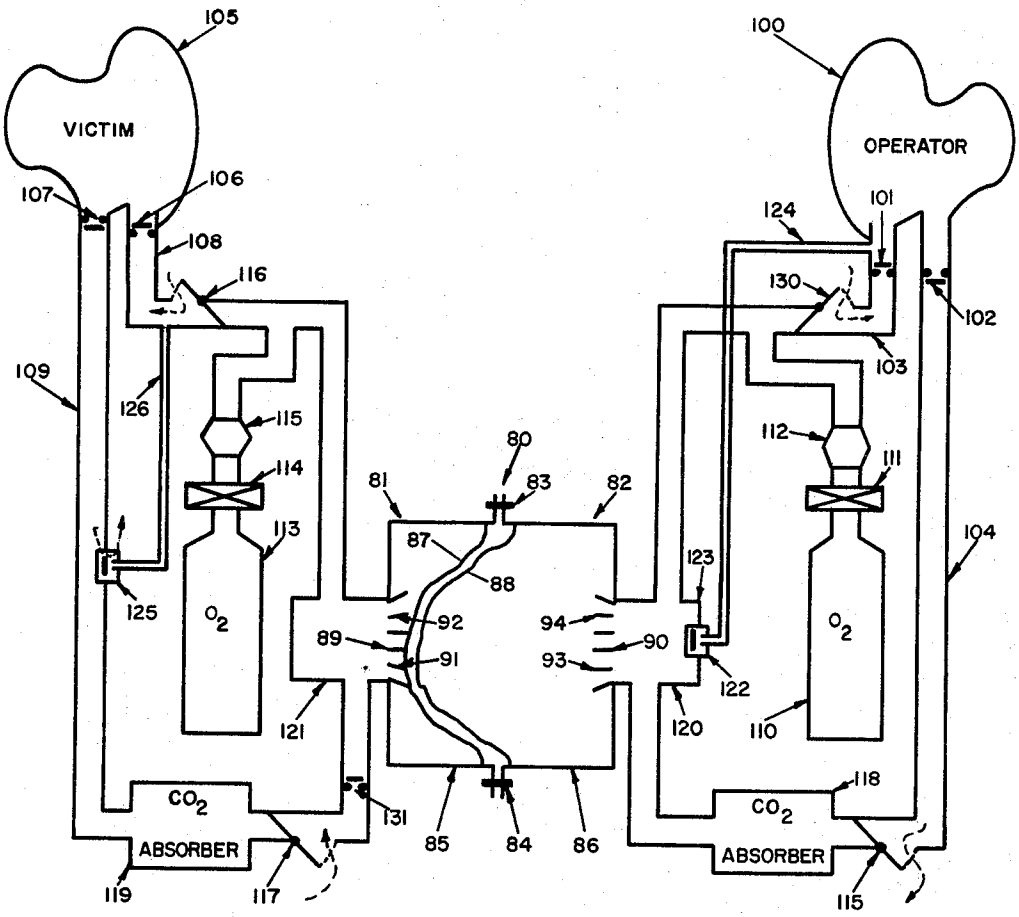


FIG. 4

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MASK-TO-MASK RESUSCITATION SYSTEMS

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30 Claims. (Cl. 128—145.8)

ABSTRACT OF THE DISCLOSURE

This invention is directed to a resuscitation arrangement wherein the rescuer and the victim are provided with facemasks and each party may breathe air or oxygen in either an open or closed circuit. Additionally, either party may perform the rescue effort and force air or oxygen into the other's respiratory system. In the actual apparatus, the rebreathing device also serves as a breath pump interconnecting both systems.

The present invention relates generally to apparatus for aiding individuals experiencing respiratory difficulties because of an insufficiency of oxygen in their breathing environment or because of a temperary interruption of their breathing mechanism brought about by, for example, a paralytic or gas attack and, more particularly, to a resuscitation system which can readily be interconnected in a variety of different ventilating and operational modes.

In the so-called "mouth-to-mouth" resuscitation method, the rescuer's expired breath, as is well known, is discharged directly into the victim's lungs in an effort to restore these organs to their normal operation. In a variation of this technique, a facemask is fitted over the victum's face, and the rescuer utilizes the remote and disconnected end of the oxygen supply line for this mask as a mouthpiece or couples this line to the exhaust line of his own mask.

In applicant's copending application, Ser. No. 389,039, filed Aug. 12, 1964, now Patent No. 3,327,704, there is disclosed a versatile resuscitation system utilizing a mask-to-mask method which can be arranged to permit, for example, the rescuer to breathe pure oxygen and ventilate the victim with his discharge, with the victim's expirations reclaimed for further use by the rescuer. Alternatively, the system can be connected so as to have the rescuer breathe air from the local environment and still continue his resuscitation effort. Also, the system can be transformed into a rebreather escape device with oxygen which can operate in an open or closed circuit mode. Each of these modes can be selected by the operator or rescuer and put into practice by merely making or breaking selected connections.

In the systems disclosed in the above-identified application, the rescuer's discharge passes directly into the respiratory system of the victim, and the latter's exhalation, after treatment in a carbon dioxide adsorber, is rebreathed by the rescuer when the system is connected in a closed-loop configuration for minimizing the oxygen drain from the oxygen storage supply. Thus, there is always the possibility of mutual contamination. In order to avoid this, the present invention includes a breath pump or rebreather which permits the victim to be ventilated by the rescuer but provides complete isolation between the respiratory systems of the two parties.

In this system the operator and the victim may both breathe oxygen in a rebreathing mode to minimize oxygen consumption, or the victim can be ventilated with oxygen while the operator breathes air, or both parties can be on air. Each of the above different modes of ventilation can be readily selected by the operator and put in practice by simple mechanical adjustments to the system.

Also, by making certain minor disconnections to the system, the apparatus can be transformed into a rebreather or inhalation escape device for either party. Additionallly, the apparatus can be conveniently switched between an open-end circuit mode to purge, for example, the respiratory system of the operator or the victim when this is necessary at high altitudes or to eliminate, for example, carbon monoxide from the body.

It is accordingly a primary object of the present invention to provide a flexible system for emergency pulmonary resuscitation wherein the rescuer and the victim can be ventilated with either oxygen or air in a mask-to-mask rescue method with complete isolation between their respiratory systems.

Another object of the present invention is to provide respiratory apparatus wherein, at the rescuer's option, various alternative ventilation modes can be selected for reviving the victim.

Another object of the present invention is to provide a respiratory system wherein rescuer and victim are intercoupled in a facemask-to-facemask circuit with isolation therebetween for preventing mutual contamination.

Another object of the present invention is to provide an emergency resuscitation system utilizing a pair of facemasks which can be intercoupled in an open or closed circuit mode with complete isolation between the individuals.

Another object of the present invention is to provide a facemask-to-facemask resuscitation system which can be transformed into a rebreather or inhalation escape device for either party by simple adjustments.

Briefly and in somewhat general terms, the above objects of invention are realized in one preferred embodiment of the invention by providing the rescuer or operator with a facemask equipped with check valves which allow either air or oxygen to flow into his facemask area and his exhalations to pass out therefrom and by providing the victim with a similar facemask but one designed for pressure breathing. In this latter type of mask, as is well known, the discharge valve is pressure-compensated so that it remains closed while the air or oxygen is being forced into the victim's respiratory system, opening only in response to the victim's passive exhalations.

The input line of the operator's mask and the input line of the victim's mask are each coupled by means of demand valves and a common pressure reducer to an oxygen storage supply. Thus, each of the individuals can be independently supplied with oxygen on a demand basis.

The operator's discharge line is coupled to one side of a breath pump, the other side end of which is coupled through a check valve to both the victim's inlet and exhaust lines. To conserve oxygen and prolong the lifetime of the oxygen supply, carbon dioxide absorbers are included in the operator's and victim's rebreathing loops. Because the operator and victim are intercoupled only through the breath pump, their respiratory systems are isolated and protected against mutual contamination.

Also included in the system at strategic locations are several quick, self-sealing disconnectors, and by decoupling the system at these points the apparatus can be transformed readily from a resuscitation device to a rebreather or inhalation escape device for either party.

In an alternative embodiment of the present invention, the element common to both the rescuer's and victim's breathing circuit is a back-to-back rebreathing device which can be subdivided to allow either party to operate in a rebreathing mode to conserve their own oxygen supply. When assembled as a unitary device, it performs as a breathing pump to permit the rescuer to ventilate the victim while isolating their respiratory systems.

Other objects, advantages and novel features of the invention will become apparent from the following de-

tailed description of the invention when considered in conjunction with the accompanying drawings wherein:

FIG. 1 illustrates one modification of the present invention when arranged to provide closed loop rebreathing circuits for both the operator and the victim;

FIG. 2 shows the details of a pressure-compensated exhalation valve of the type required in the system of FIG. 1;

FIG. 3 shows a simple, self-sealing disconnector which can be utilized at various sites in the system; and

FIG. 4 is an alternative system which can be subdivided to provide two complete and independent breathing systems for the operator and victim.

Referring now to FIG. 1 of the drawings which schematically illustrates the various components interconnected in a mask-to-mask resuscitation mode with oxygen rebreathing loops for the victim and rescuer, it will be seen that the system includes a first facemask **1**, the operator's mask, provided with flexible inlet and exhaust lines **2** and **3**, respectively, which lead into and communicate with the facemask area. Positioned within inlet line **2** is a conventional, normally closed, check valve **4** which is arranged to move to an open position during the inhalation effort of the operator when the pressure level within his facemask area drops below that within the lower portion of this line. Positioned, likewise, within exhaust line **3** is a normally closed, check valve **5**, which is arranged to open during the expirational portion of his breathing cycle when the pressure level within the facemask area exceeds that within the lower portion of this line. Valves **4** and **5**, it will thus be appreciated, operate in a sequential manner during the operator's breathing cycle to permit him to inhale oxygen, an oxygen-air mixture or air and to discharge his exhalations from the facemask area.

Valve **5** in the usual mask vents the individual's exhalations into the atmosphere. In the present system, as will be seen hereinafter, these exhalations are utilized to drive a breath pump to revitalize the victim by either forcing oxygen or air into his respiratory system.

Inlet line **2** in this modification, which is a flexible air passageway where it extends beyond the facemask, has mounted in a sidewall portion thereof a manually operated, flap valve **6** which, in one of its positions, vents this line at point **7** while blocking it at a downstream point **8**. When rotated to its other position, it closes vent **7** and does not interfere with the free passage of gas through line **2**.

Mounted in line **2** so as to treat any gas mixture flowing therethrough is a carbon dioxide absorber **9** for permitting the operator to rebreathe this gas either alone or admixed with oxygen from the oxygen storage supply. Line **2** has a branch line **10** coupled thereto, and this line which contains a conventional demand valve **11** is coupled at its remote end by a quick disconnector **12** of the self-sealing type to a T-section **13**, whose vertical branch line **14** contains a pressure reducer **15** and an oxygen storage member **16**.

The victim's facemask **17**, like the operator's facemask, includes a flexible inlet line **18** and a flexible discharge line **19**. Positioned within line **18** is a conventional, normally closed, check valve **20** similar to the one present in the operator's inlet line **2**. However, this facemask is equipped with a conventional exhalation valve **21** of the pressure-compensated type. To illustrate the nature of this valve, the circuit includes a small pressure-balancing passageway **22** interconnecting the inlet line **18** and discharge line **19**. This line, it will be appreciated, applies a counterbalancing pressure to the confronting lower side of valve **21**, thereby maintaining it closed when air or oxygen is forced into the victim's facemask area during the resuscitation attempt. Without this provision, this gas transfer process would be ineffective with the victim connected in an open circuit breathing mode, since valve **20** would open and bypass his respiratory system. Valve **21**, it will thus be seen, is opened only by the victim's passive exhalations.

Valves **20** and **21** in facemask **17** consequently open during mutually exclusive periods corresponding to the times during which air or oxygen is being forced into the victim's facemask area and the times during which his expirational action is being carried out by himself or the operator.

Inlet line **18** of the victim's facemask, like inlet line **2** associated with the operator's mask, has a branch line **23** coupled thereto, and this line contains a conventional demand valve **24**. The remote end of this line is coupled to one branch of the T-section **13** by a quick disconnector **25** of the self-sealing type. Positioned within discharge line **19** is a manually operated flap valve **26** of the type employed in the rescuer's inlet line. This component, in one of its positions, opens line **19** to the atmosphere on the mask side while simultaneously closing it on the downstream side. In its other position, it is flush with the inner wall of line **19**, closing the vent to the atmosphere and allowing the uninterrupted passage of gas through this line.

A carbon dioxide absorber **27** is also incorporated in discharge line **19** for treating the victim's discharge when he is being resuscitated with oxygen or when he is breathing oxygen in a closed circuit mode.

In order to permit the rescuer's exhalations to be utilized in the resuscitation attempt and still isolate the respiratory systems of the victim and the rescuer, the present invention, as illuded to hereinbefore, utilizes as the common element of both breathing circuits a breath pump **28**, which has a housing **29** opened at opposite ends **30** and **31** and a flexible bellows **32** accommodated therein. Bellows **32**, which is preformed to return to a midposition after it has been distended by air forced therein, is sealed at its rim portion **33** to the open side **31** of housing **29**. At side **30**, this pump is connected by a quick disconnector **34** of the self-sealing type to a flexible line **35** which is in communication with branch line **23** and inlet and exhaust lines **18** and **19** of the victim's facemask. At its other side **31**, the breath pump is also connected by a quick disconnector **36** and a line **37** to branch line **10** and inlet and exhaust lines **2** and **3** of the rescuer's mask.

Wall mounted in line **35** is an air inlet check valve **38** which can be blocked by closure cap **39**. This valve is placed in an operable condition only when it is desired to attempt resuscitation of the victim with air or when the victim is capable of breathing air. Line **35** also contains a normally closed, check valve **40** located between branch line **23** leading to the oxygen supply and exhaust line **19**.

Associated with line **37** on the operator's side of breath pump **28** is a wall mounted, pressure-compensated valve **41** which has a sensing line **42** affiliated therewith that leads into the facemask area of the rescuer's mask **1**. This sensing line is provided with an occlusion vent **43** which in one position blocks this line and in another position renders it patent. Valve **41**, whose construction is best shown in FIG. 2, it would be pointed out, opens only when the operator is inspiring air or oxygen in an open circuit mode.

Also included in line **37** at a point between exhaust line **3** and carbon dioxide absorber **9** is an airway occlusion cock **44**. When closed, this cock insures that the operator's inhalation is from the operator's storage supply **16** and not from bellows **32** acting as a rebreathing element as is required in an open circuit use.

Referring now to FIG. 2, which schematically illustrates the details of pressure-compensated valve **41**, it will be seen that this valve includes an outer sleeve **45** that is secured to or otherwise mounted on air passageway **37**. This sleeve, which is apertured at **46** and **47**, accommodates a ring **48** that has a cutout portion **49** formed in its inner rim for retaining one end of a flexible, annular bellows **50**. Sealing the other end of this bellows is a hollow, T-shaped closure member **51** that

has a sleeve 52 projecting from its top wall surface which slidably embraces the open end of pressure sensing line 42. Closure member 51 is spring biased by a helical spring 53, which also acts to maintain bellows 50 under a given amount of compression. It will be appreciated that member 51 stays in the position shown when, for example, the operator exhales with line 42 open since equal forces act on both sides of its bottom wall 55.

When closure member 51 is in the position shown, valve 41 is closed. For this valve to open, this member, it will be appreciated, must be upwardly displaced to a point slightly beyond the expanded limit of bellows 50. However, the condition of sensing line 42 determines whether or not this can happen. If this line is closed by occlusion vent 43, for example, valve 41 cannot be opened since any upward displacement of member 51 builds up the pressure within the lower part of this line, and this pressure counterbalances the force tending to further lift this member.

The operation of valve 41 is as follows: When occlusion vent 43 is closed, that is, when the lower portion of sensing line 42 is blocked and the operator, for example, expires, the buildup of pressure within line 37 and the lower portion of sleeve 45 in communication therewith moves closure member 51 upward towards the open end of sensing line 42. This movement, as mentioned above, increases the pressure within the lower portion of line 42, and further upward displacement of member 51 is prevented. Since member 51 has not traveled a distance sufficient to become disengaged from bellows 52 because of the accompanying expansion of this bellows, valve 41 remains closed.

When occlusion vent 43 is opened, however, and line 42 made patent, valve 41 still remains closed during the operator's exhalations since equal forces are directed against opposite sides of bottom wall 55 during this portion of his breathing cycle. However, any buildup of pressure within the line 37 can now open valve 41. Such a buildup can occur, for example, when bellows 52 collapses with flap valve 6 or occlusion cock 44 closed. Then, closure member 51 moves off of bellows 50 and an air passageway exists from line 37 to the atmosphere through vents 46 and 47. It would be pointed out that vent 43 is opened only when the operator is breathing in an open circuit mode with air or oxygen and it is desired to vent his discharge to the atmosphere.

When the system is interconnected in the manner shown with valves 6 and 26 closed, cock 44 opened and occlusion vent 43 closed, the rescuer breathes oxygen and the victim is resuscitated with oxygen. More particularly, the rescuer's breathing requirements are first satisfied from the air mixture available within bellows 32 and then from fresh oxygen drawn from storage supply 16 on a demand basis. His discharge when it takes place passes out through valve 5 into line 3 and thence into bellows 32, distending this element from its preformed midposition. When bellows 32 is expanded, it will be recognized, the air mixture within housing 28 and line 35 is forced through check valve 40, line 18, valve 20, into the victim's facemask area for activating or stimulating his respiratory system. Valve 41, of course, remains closed during this revitalization attempt because of the closed condition of sensing line 42 which allows the pressure buildup to occur and prevents closure members 51 from moving off of bellows 50 and establishing an air passageway to the atmosphere.

When the operator inspires, bellows 31 collapses. The air mixture previously accumulated within this storage space is now available for rebreathing and, consequently, it is treated in carbon dioxide absorber 9 prior to its use by the operator. The operator in this breathing mode thus has a closed rebreathing loop for minimizing the amount of fresh oxygen required from storage supply 16. If bellows 32 does not follow the operator's breathing cycle, that is, if it is partially emptied when the operator commences to inspire, then, oxygen is demanded from the storage supply.

When the operator exhales and the gas mixture within housing 29 and lines 18 and 35 is forced into the victim's respiratory system, the construction of breath pump 28 provides physical isolation between the rescuer's and operator's respiratory systems. Hence, there is no possibility of mutual contamination.

When the operator inhales and bellows 32 collapses or when this element otherwise recoils to its preformed midposition, a negative pressure is created in lines 35 and 19, valve 21 opens, and the passive exhalation of the victim is aided.

It would be pointed out that the setting of demand valve 24 in the victim's oxygen supply line is low enough so that the recoil of bellows 32 opens this valve after the victim's lungs have been emptied. If the recoil action of the bellows is insufficient to open this valve, then the operator's next inhalation effort will, by empting his bellows, demand oxygen for the victim through valves 20 and 21.

When the elastic recoil of the victim's chest occurs, his discharge is sent through valve 21, line 19 and carbon dioxide absorber 27 into housing 29 for subsequent redelivery to him during the operator's next expiration effort. Once the victim commences to breathe normally, his further breathing requirements are satisfied from the mixture within the breathing pump and from oxygen introduced into line 23 by demand valve 24.

When valve 6 is moved to the position shown to vent line 2 at point 7, the operator, instead of breathing oxygen, inhales air through this vent from the surrounding environment and his discharge continues to activate breath pump 28 in the manner described above, both to force oxygen or air-oxygen mixture into the victim's lungs and assist his expirations. When valve 6 is open, cock 44 is closed and vent 43 open. This allows the operator's discharge, after it has activated pump 28, to pass out of the system. More particularly, when bellows 32 returns to its midposition because of its preformed design, this movement builds up the pressure in line 37, and closure member 53, now unimpeded by the action of vent 40, moves to an open position to vent the system.

In order to permit the operator in the system of FIG. 1 to still breathe oxygen but in an open circuit mode with no rebreathing, as may be required, for example, to purge nitrogen or some toxic gas from his lungs, valve 6 need only be moved to its closed condition, cock 44 closed and vent 43 opened to make line 42 patent. When these conditions exist, of course, sensing line 42 is effective, and the operator's discharge, after activating bellows 32, passes out of the system when bellows 32 recoils to its preformed condition and opens valve 41. Valve 41, here again, does not open during the operator's exhalations because of the balanced pressures on opposite sides of bottom wall 55 of closure member 51.

The victim, it will be appreciated, can be ventilated with air by removing the cap 39 from air inlet valve 38 and moving valve 26 in discharge line 19 to its venting condition. When these adjustments are made, air from the local environment is sucked through valve 38 into the interior of breath pump 28 during the contraction of bellows 32 and then delivered to the victim's facemask area when this element is next expanded by the operator's subsequent exhalation. The victim's discharge in this setup is vented to the atmosphere at valve 26.

The apparatus of FIG. 1 can be readily transformed into a rebreather escape device for the operator by merely breaking the system at disconnectors 25 and 34, provided these disconnectors are of the self-sealing type which automatically close the line when the male element of the connector is detached therefrom. Connectors of the type suitable for this purpose are described in the above copending application. In FIG. 3, there is shown one type of connector where line 60 has mounted therein a closure member 61 which is spring biased at 62 against a stop 63

to seal this end of the line. When line **64** is inserted into line **60**, a prong **65** projecting beyond line **64** displaces member **61** upwardly, thereby opening the line to the free passage of gas therethrough. When line **64** is withdrawn, line **60** is again blocked by flap **61** returning to its closed condition. Also, when the male connectors are removed from the system of FIG. 1, a simple closure plate can be employed to cover the open end of the female line.

When the apparatus of FIG. 1 is so disconnected, the operator, at his election, can breathe oxygen in a closed system, oxygen in an open system or air in an open system, depending upon the adjustments made hereinbefore involving the condition of flap valve **6**, cock **44** and sensing line **42**.

By the same token, the apparatus of FIG. 1 can also be transformed into a rebreathing escape device for the victim by merely breaking the system at disconnectors **12** and **36** and closing the otherwise opened end of the lines terminating in the female elements of these connectors. In this setup, the victim can breathe oxygen in a closed circuit mode with breath pump **28** acting as a rebreathing accumulator, or oxygen in an open circuit mode by setting valve **26** to a venting condition, or air in an open circiut mode by additionally rendering air inlet valve **39** operable.

Instead of providing a separate demand valve for the victim and operator, the system can be somewhat simplified by replacing these valves with a single valve located in the vertical line **14** of T-section **13**.

In FIGURE 4 there is illustrated an alternative system wherein the breath pump **80** consists of a pair of similar rebreathing devices **81** and **82** fastened together back-to-back by quick disconnectors **83** and **84**. Each rebreather has a housing **85** and **86** which is closed off at one end by a flexible, deformable diaphragm **87** and **88** made of a thin sheet of polyethylene. Because of this construction, these diaphragms do not have the recoil action of the bellows of FIG. 1 and, consequently, their movement depends completely upon the breathing action of the victim and the operator.

The other ends of rebreathers **81** and **82** are open at **89** and **90**. Adjacent these openings, a multiplicity of splines **91**, **92**, **93**, **94**, etc., are positioned to prevent occulsion of the rebreathing bellows when they approach these ends.

In this modification, the operator's facemask **100** contains check valves **101** and **102** in inlet and discharge lines **103** and **104**, respectively. Similiarly, the victim's facemask **105** is provided with check valves **106** and **107** in inlet and discharge lines **108** and **109**, respectively. It would be pointed out that exhalation valve **107** is not pressure-compensated as is the case in the arrangement of FIG. 1.

Each inlet line has a separate oxygen supply **110**, **113**, pressure reducer **111**, **114** and demand valve **112**, **115** coupled thereto. Positioned between the branch lines feeding oxygene into the inlet lines and facemasks are manually operated flap valves **130** and **116** of the type previously described. These flap valves, when in the positions shown, allow the operator and the victim to inspire air from the surrounding environment while isolating their oxygen supplies. Flap valves **115** and **117** are included in the discharge lines, the former permitting the operator to vent his discharge into the atmosphere when he is in an open circuit breathing mode, and the latter permitting the victim to be be resuscitated with air drawn from the surrounding environment. Carbon dioxide absorbers **118** and **119** are again positioned in the rebreathing loops and a check valve **131** is included between flap valve **117** and line **121**. This valve insures that the mixture present in rebreather **81** is sent to the victim's inlet line **108** and not out through flap valve **117** when the victim is in an open circuit mode.

The operator's inlet and discharge lines **103** and **104** terminate in a short branch line **120** which communicate with the opend end of rebreather **82**. This line can be an extension of housing **86**. Likewise, the victim's inlet and discharge lines **108** and **109** terminate in a branch line **121** which communicates with the open end of rebreather **81**. It would be pointed out that when rebreathers **81** and **82** are assembled in the manner shown they constitute a single breather pump which can be activated by the victim or the operator to control the flow of the gas mixture in the other breathing circuit.

A standard pressure-compensated valve **122**, that is, one similar to the type shown in FIG. 2 but without the occlusion vent in the pressure-sensing line, the annular bellows and having a simple plate instead of the T-shaped closure member, is mounted in the back wall **123** closing branch line **120**. This valve, it will be appreciated, stays closed during the exhalation portion of the operator's breathing cycle. It opens only when the victim's discharge drives diaphragms **87** and **88** to the right, as seen in FIG. 4, with flap valve **130** in the position shown and valves **115** and **117** in their alternative positions. When the operator is on air, valve **122**, therefore, serves to vent his discharge after it has activated pump **80**. However, this action comes about in response to the victim's exhalations.

A second conventional, pressure-compensated valve **125**, similar to **122**, is mounted in the wall portion of discharge line **109** before carbon dioxide absorber **119**. This valve, whose pressure-sensing line is coupled to inlet line **108**, opens only in response to the victim's exhalations when flap valve **117** is in the position shown and allows the pressure to build up within line **109**.

The various alternative breathing modes available to the operator are as follows: First, with flap valves **130** and **115** rotated to their alternative positions, he can operate pump **80** while breathing oxygen from supply **110** in a closed rebreathing mode. With valve **130** moved to its alternative position and valve **115** in the position shown, he can continue to breathe oxygen in an open circuit mode without activating breath pump **80**. Also, when the flap valves are set in these positions, the victim can switch roles and perform as an operator to ventilate the individual wearing facemask **100** with oxygen drawn from supply **110**. When valves **130** and **115** are in the position shown, the operator can inhale air from the surrounding environment and send his discharge out of the system again without activating breath pump **80**.

When valves **116** and **117** are rotated to their alternative positions, the victim can be resuscitated with oxygen in a closed system drawn from supply **113** either in response to the elastic recoil of this respiratory system or the operator's inhalation action. When valve **116** is in the position shown and valve **117** rotated to its alternative position, the victim can inspire air from the surrounding environment, and his discharge can be used to activate pump **80** if this mode of operation is desirable in order, for example, to aid the breathing of the individual wearing facemask **100**. When valves **116** and **117** are set in the positions shown, it will be appreciated, the victim can inspire air and vent his discharge to the atmosphere through valve **125**. And when valve **117** is in the position shown and valve **116** in its alternative position, the victim can be ventilated with air and his discharge again vented through valve **125**.

It would be noted in connection with the system of FIG. 4 that pump **80**, like its counterpart **88** in FIG. 1, provides complete isolation between the operator's and victim's respiratory systems. Moreover, when the pump is subdivided by the removal of fasteners **83** and **84**, each party has a complete breathing system which can function in any of the various modes described hereinbefore. Additionally, either party can operate the combined apparatus to empty the lungs of the other to purge inert or toxic gases therefrom and ventilate that individual with oxygen.

Instead of pump **80** having the construction mentioned above, this apparatus can also be arranged to duplicate the

performance of breath pump 28 by having diaphragms 87 and 88 fabricated, for example, in the form of a sheet of rubber or thin polyethylene stretched across the open end of the housings 81 and 82. With such a design, both diaphragms will move in unison and return to a standby condition at which they will have their normal planar shape. Also, with this type of pump, it will be appreciated, the spring bias on pressure-compensated valve 122 should be strong enough to keep this valve closed when the diaphragms return to their standby condition with flap valve 130 rotated from the position shown. Valve 122 should only be opened by the recoil action of the diaphragms when the operator is breathing air and his discharge is to be vented to the atomsphere after operating breath pump 80.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. In a resuscitation system of the type in which the rescuer's respiratory discharge is utilized to revive the victim, the combination of

a first facemask for use by said rescuer, said facemask including

a supply and discharge line which communicate with the facemask area,

valve means positioned in said lines for permitting a unidirectional flow of gas to take place from said supply line into said facemask area and out said discharge line during each breathing cycle of said rescuer;

a second facemask for use by said victim, said second fasemask including

an inlet and outlet line which communicate with said facemask area,

a first check valve positioned in said inlet line for permitting a unidirectional flow of gas to take place from said inlet line into the facemask area of said second facemask,

a normally closed, pressure-compensated check valve positioned in said outlet line for permitting a unidirectional flow of gas to take place from said facemask area out said outlet line,

said pressure-compensated check valve remaining closed whenever gas is forced from said inlet line through said first check valve into the facemask area of said second facemask during the resuscitation attempt;

first and second air loops interconnecting said supply and discharge lines and said inlet and outlet lines, respectively;

a source of compressed oxygen,

said source of compressed oxygen being coupled to said first and second loops;

means for releasing fresh oxygen from said source into said first loop in accordance with the breathing requirements of said rescuer; and

a breath pump coupled to said first and second loops,

said breath pump being operated by the breathing action of said rescuer to intermittently release oxygen from said source into said second loop and to force the oxygen so released and any other gas mixture within said second loop into said inlet line through said first check valve and into the facemask area of said second facemask.

2. In an arrangement as defined in claim 1,

wherein said breath pump is coupled to said first and second loops by means of self-sealing connectors which seal said loops when said breath pump is decoupled therefrom.

3. In a resuscitation system of the type in which the rescuer's respiratory discharge is utilized to revive the victim, the combination of

a first facemask for use by said rescuer, said facemask including

a supply and discharge line which communicate with the facemask area,

valve means positioned in each line for permitting a unidirectional flow of gas to take place from said supply line into said facemask area and out said discharge line during each breathing cycle of said rescuer;

a second facemask for use by said victim, said second facemask including

an inlet and outlet line which communicate with said facemask area,

first valve means positioned in said inlet line for permitting a unidirectional flow of gas to take place from said inlet line into the facemask area of said second facemask,

a normally closed, pressure-compensated check valve positioned in said outlet line for permitting a unidirectional flow of gas from the facemask area of said second facemask out said outlet line,

said pressure-compensated check valve remaining closed whenever gas is forced from said inlet line through said first valve means into the facemask area of said second facemask during the resuscitation attempt;

first and second air recirculating loops interconnecting said supply and discharge lines and said inlet and outlet lines, respectively;

a supply of compressed oxygen,

said supply of compressed oxygen being coupled to said loops;

a breath pump having an input side coupled to said first loop and an output side coupled to said second loop,

said pump means being operated by the breathing action of said rescuer and during his inhalation effort creating a pressure condition within said outlet line which opens said pressure-compensated valve, assists the victim's passive discharge and causes fresh oxygen from said supply to be released intermittently into said second loop and during his exhalation effort forcing some of the gas mixture within said second loop into said inlet line through said first valve means and into the facemask area of said second facemask.

4. In an arrangement as defined in claim 3,

carbon dioxide absorbers positioned in said first and second loops for treating the gas mixture flowing therearound.

5. In an arrangement as defined in claim 3,

wherein said supply of compressed oxygen is coupled to said loops by self-sealing connectors.

6. In an arrangement as defined in claim 3,

wherein said supply of compressed oxygen is coupled to loops by means of first and second oxygen lines and

wherein a demand valve is positioned in each supply line for controlling the release of fresh oxygen from said supply into said first and second loops.

7. In an arrangement as defined in claim 3,

means for permitting air from the local environment to be inspired by said rescuer while preventing oxygen from said supply from being released into said first loop by said rescuer's breathing action.

8. In an arrangement as defined in claim 3,

second valve means for allowing air from the adjacent atmosphere to be drawn into said second loop by said breath pump or by the inhalation effort of said victim whereby said victim can be revived with or breathe air

and means for venting said victim's discharge from

said second loop out into said atmosphere when said victim is being revived with air or breathing air.

9. In an arrangement as defined in claim 3, wherein said pump means includes

a housing and a bellows accommodated therein,

said bellows subdividing said housing into an outer and inner compartment, with said outer compartment being in communication with said second loop and said inner compartment being in communication with said first loop,

said bellows being preformed to collapse to a mid-position after being distended.

10. In a resuscitation system of the type in which the rescuer's respiratory discharge is utilized to revive the victim, the combination of

a first facemask for use by said rescuer, said facemask including

a supply and discharge line which communicate with the facemask area,

valve means positioned in said lines for permitting a unidirectional flow of gas to take place from said supply line into said facemask area and out said discharge line during each breathing cycle of said rescuer;

a second facemask for use by said victim, said second facemask including

an inlet and outlet line which communicate with said facemask area,

first valve means positioned in said inlet line for permitting a unidirectional flow of gas to take place from said inlet line into the facemask area of said second facemask,

a normally closed, pressure-compensated check valve positioned in said outlet line for permitting a unidirectional flow of gas to take place from said facemask area out said outlet line,

said pressure-compensated check valve remaining closed whenever gas is forced from said inlet line through said first valve means into the facemask area of said second facemask during the resuscitation attempt;

first and second air passageways interconnecting said supply and discharge lines in a first loop and said inlet and outlet lines in a second loop, respectively, for permitting said rescuer and victim to rebreathe their discharge;

a carbon dioxide absorber positioned in each passageway for treating the gas mixture circulating around said loops;

a supply of compressed oxygen;

feed lines coupling said supply of compressed oxygen to said loops;

a breath pump having a housing and an expandable bellows accommodated therein,

said bellows subdividing said housing into an inner and outer compartment and being preformed to return to a collapsed condition;

means for coupling said inner compartment to said first loop and said outer compartment to said second loop whereby when said bellows is expanded by the rescuer's discharge some of the gas mixture present within said outer compartment and said second loop is forced into said inlet line through said first valve means and into the facemask area of said second facemask and whereby when said bellows collapses either in response to the rescuer's inhalation or by its own action, said pressure-compensated valve is opened, the victim's passive discharge is aided and oxygen periodically released from said supply into said second loop.

11. In an arrangement as defined in claim 10,

wherein said breath pump acts as a rebreathing storage device for said rescuer and said victim.

12. In an arrangement as defined in claim 10,

wherein said pump acts as a rebreathing storage container whereby said rescuer's discharge after is distends said bellows can be subsequently rebreathed by said rescuer to minimize the oxygen drawn from said oxygen supply,

said bellows isolating the gas mixture in said first loop from the gas mixture in said second loop whereby contamination of said rescuer and victim is prevented.

13. In an arrangement as defined in claim 10,

a manually operated valve positioned in said first loop,

said manually operated valve in one position permitting a free flow of gas around said loop and in another position opening said loop to the atmosphere to allow air to be drawn therein and through said supply line into the facemask area of said first facemask and blocking said loop at a point between said feed line and said supply line.

14. In an arrangement as defined in claim 10,

a normally closed, pressure-compensated venting valve coupled to said first loop at a location adjacent said breath pump,

said valve being adapted to remain closed during the breathing cycle of said rescuer when said manually operated valve is in said one position and opening when said bellows collapses with said manually operated valve in said other position to allow the gas mixture discharged from said bellows to pass out into atmosphere.

15. In an arrangement as defined in claim 10,

a manually operated, flap valve positioned in said second loop at a location adjacent said outlet line,

said flap valve in one position allowing free circulation of gas through said second loop and in another position venting said rescuer's discharge which passes through said pressure-compensated check valve and said outlet line into said second loop, blocking a downstream side of said loop.

16. In a resuscitation system of the type in which the rescuer's respiratory discharge is utilized to revive the victim, the combination of

a first facemask for use by said rescuer, said facemask including

an intake discharge line which communicate with the facemask area,

valve means positioned in said lines for permitting a unidirectional flow of gas to take place from said intake into said facemask area and out said discharge line during each breathing cycle of said rescuer;

a second facemask for use by said victim, said second facemask including

an inlet and outlet line which communicate with said second facemask area,

check valves positioned in said inlet and outlet lines for permitting a unidirectional flow of gas to take place from said inlet line into the facemask area and out said outlet line;

a first air circulating loop interconnecting said intake and discharge lines;

a second air circulating loop interconnecting said air inlet and outlet lines;

a first and second supply of compressed oxygen;

first and second feed lines connecting said first and second supplies of compressed oxygen to said first and second loops, respectively;

a normally closed demand valve positioned in each feed line for releasing oxgen from each oxygen supply into said air circulating loops when opened by the inhalation efforts of said rescuer and victim;

a first rebreathing storage device coupled to said first loop;

a second rebreathing storage device connected to said second loop,

each of said storage devices having a deformable backwall portion;

means for detachably connecting said first and second rebreathing storage devices in a back-to-back manner with said deformable back wall portions in confrontation, whereby a gas mixture sent into one of said rebreather storage devices forces any gas mixture in the other rebreather storage device out therefrom,

said first and second rebreather storage devices acting as a breath pump and during the rescuer's exhalation effort forcing some of the gas in said second loop into the facemask area of said second facemask and during the rescuer's inhalation effort assisting the victim's passive exhalations and intermittently opening the demand valve in said second feed line to release oxygen into said second loop.

17. In an arrangement as defined in claim **16**,

a carbon dioxide absorber positioned in each loop for treating the gas mixture circulating therearound.

18. In an arrangement as defined in claim **16**,

means for allowing said rescuer to breath air from the surrounding atmosphere and his discharge to pass into said first rebreathing storage device to activate said breath pump, and

means for venting said rescuer's discharge out of said first loop into the surrounding atmosphere after said discharge has activated said breath pump.

19. In an arrangement as defined in claim **16**,

means for allowing air to enter said second loop and be drawn into said second rebreathing storage device during the rescuer's inhalation effort whereby said victim can be ventilated with air during the rescuer's exhalation effort, and

means for discharging the victim's exhalations out said second loop into the surrounding atmosphere when he is being ventilated with air.

20. In a resuscitation system of the type in which the rescuer's respiratory discharge is utilized to revive the victim, the combination of

a first facemask for use by said rescuer, said facemask including

an intake and discharge line which communicate with the facemask area,

valve means positioned in said lines for permitting a undirectional flow of gas to take place from said intake into said facemask area and out said discharge line during each breathing cycle of said rescuer;

a second facemask for use by said victim, said second facemask including

an inlet and outlet line which communicate with said second facemask area,

check valves positioned in said inlet and outlet lines for permitting a unidirectional flow of gas to take place from said inlet line into the facemask area and out said outlet line;

a first air circulating loop interconnecting said intake and discharge lines;

a second air circulating loop interconnecting said air inlet and outlet lines;

a first and second supply of compressed oxygen;

first and second feed lines connecting said first and second supply of compressed oxygen to said first and second loops, respectively;

a normally closed demand valve positioned in each feed line for releasing oxygen from each oxygen supply into said loops in response to the rescuer's and victim's inhalation efforts;

a breath pump coupled to said first and second loops,

said breath pump being capable of being operated by the rescuer's discharge to force some of the gas mixture in said second loop into said victim's facemask area or by the victim's discharge to force some of the gas mixture in said first loop into said rescuer's facemask area,

said breath pump during the rescuer's inhalation effort assisting the victim's passive exhalations and intermittently opening the demand valve in said second feed line to release fresh oxygen into said second loop.

21. In an arrangement as defined in claim **20**,

a carbon dioxide absorber positioned in each air circulating loop for treating the gas mixture flowing therearound whereby said rescuer and victim can rebreathe their own discharge.

22. In an arrangement as defined in claim **20**,

wherein said breath pump can be subdivided into a pair of rebreathing storage devices for permitting said rescuer and said victim to rebreath their discharge and minimize the drain from said supplies of compressed oxygen.

23. In an arrangement as defined in claim **20**,

means for opening said first loop to the atmosphere to permit said rescuer to breath air while preventing his inhalation effort from opening the demand valve in said first feed line whereby the release of oxygen from said first supply into said first loop is prevented.

24. In an arrangement as defined in claim **20**,

a first manually operated flap valve connected in said first loop,

said flap valve in one position not interfering with the flow of gas around said loop and in a second position opening said loop to the atmosphere to allow said rescuer to inspire air while blocking said loop at a point which prevents said rescuer's inhalation efforts from opening the demand valve in said first feed line.

25. In an arrangement as defined in claim **20**,

a normally closed, pressure-compensated venting valve mounted in said first loop,

said pressure-compensated venting valve remaining closed whenever said first loop is unblocked and opening only when the gas mixture in said first rebreathing storage device is sent out therefrom into said first loop with said first flap valve in said second position.

26. In an arrangement as defined in claim **20**,

a second manually operated flap valve positioned in said second loop at a location adjacent said inlet line,

said valve in one position not interfering with the circuiation of gas around said second loop and in a second position allowing air to enter said loop and be drawn into the facemask area of said second facemask by said victim's inhalation and preventing said victim's inhalations from operating the demand valve in said second feed line.

27. In an arrangement as defined in claim **20**,

means for venting the victim's discharge out from said second loop into the atmosphere when said second manually operated valve is in said other position.

28. In an arrangement as defined in claim **20** wherein the means for venting the victim's discharge out from said second loop includes

a normally closed, pressure-compensated venting valve connected in said second loop at a point adjacent said outlet line, and

a third flap valve located between said pressure-compensated venting valve and said second rebreather,

said third flap valve in a first position not interfering with the flow of gas around said loop and in a second position permitting air to enter said loop and be drawn into said second rebreathing setorage device while blocking said loop at a point which prevents said victim's

discharge from passing into said second rebreathing storage device.

29. In an arrangement as defined in claim 20,

wherein said breath pump acts as a rebreathing storage device for said rescuer and said victim whereby the oxygen drain from said oxygen supplies is minimized.

30. In an arrangement as defined in claim 20,

a flap valve coupled to said first loop,

said flap valve in one position not interfering with the flow of the rescuer's discharge around said first loop and into said breath pump and

in a second position venting the rescuer's discharge into the atmosphere.

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