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RESUSCITATOR

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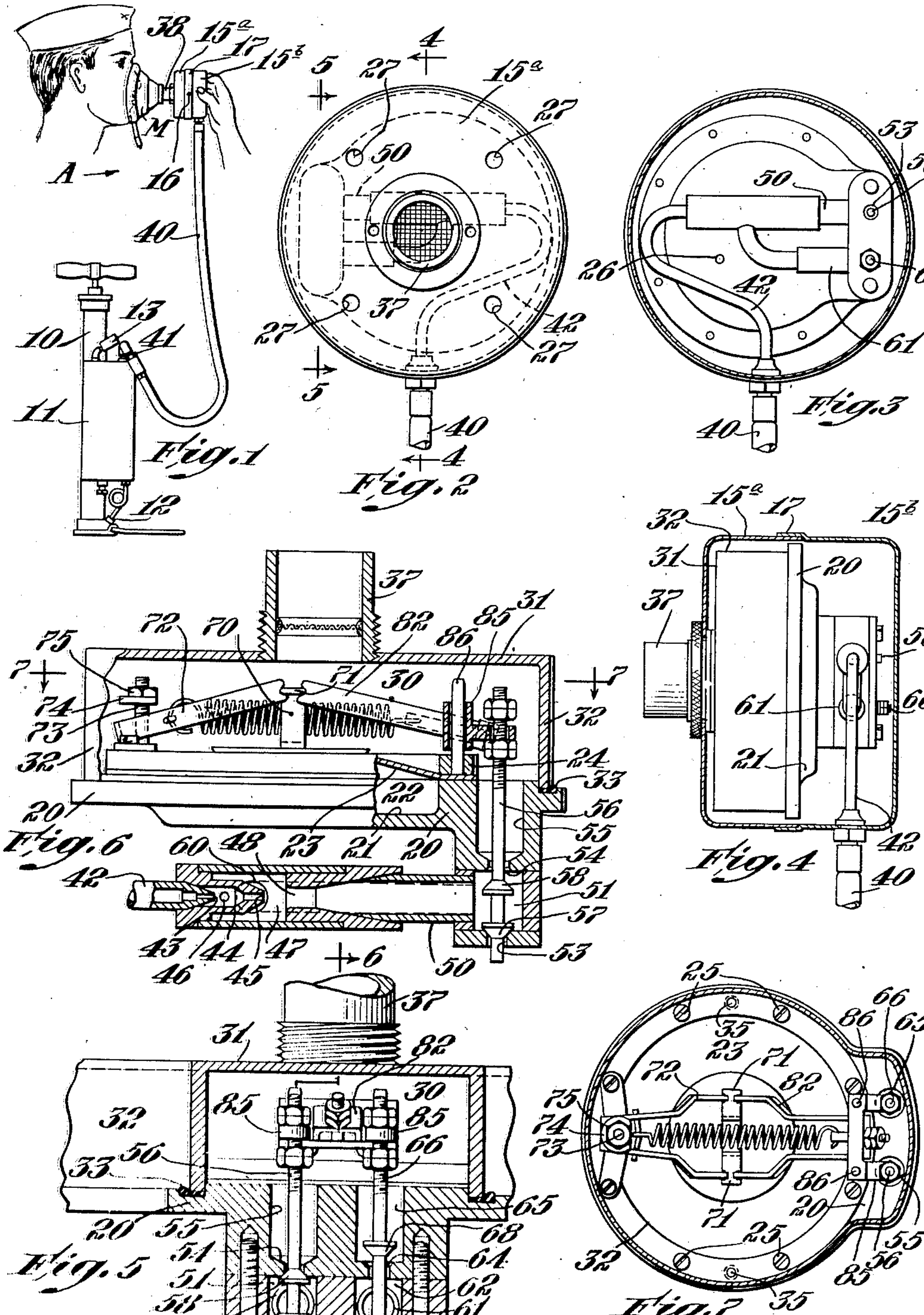

Fig. 1 Fig. 2 Fig. 3 Fig. 4 Fig. 5 Fig. 6 Fig. 7

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RESUSCITATOR

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This invention relates to apparatus of automatic type, wherein gas supplied under pressure acts alternately to inflate and deflate the lungs, designed in particular for treating patients who are unable to breathe normally, as, for example, when suffering from gas asphyxiation, drowning or the like. The principal object of this invention is to provide a small, compact, portable resuscitator which is light and may be conveniently used in the field for first aid purposes.

A further object is to provide a resuscitator which may be manipulated by a single attendant.

Other objects relate to the construction and mode of operation and will be apparent from a consideration of the following description and the accompanying drawing which exemplifies one embodiment of the invention chosen for the purpose of illustration.

In the drawing:

Fig. 1 is a side elevation of the complete apparatus with the face mask in place on a patient's face;

Fig. 2 is an elevation with the mask removed looking in the direction of the arrow A of Fig. 1;

Fig. 3 is a similar view with the mask-attaching portion of the casing broken away;

Fig. 4 is a section taken on the lines **4—4** of Fig. 2;

Fig. 5 is an enlarged section taken on the lines **5—5** of Fig. 2;

Fig. 6 is a section taken on the lines **6—6** of Fig. 5; and

Fig. 7 is a reduced section on the lines **7—7** of Fig. 6.

For effective operation the apparatus requires a source of gas under super-atmospheric, preferably substantially constant pressure. When herein reference is made to a gas, gaseous fluid or the like, such terms are used without limiting intent, being broadly inclusive of pure gases, for example O_2, as well as mixtures of gases, for example atmospheric air; water vapor, etc. As here illustrated, a source of gas under super-atmospheric pressure is provided by the hand-operated plunger type pump **10** (Fig. 1). This pump is provided with a gas storage reservior **11**, the compressed gas from the pump **10** being forced through the check valve **12** on each stroke of the plunger and stored in the reservoir **11**. The pressure gauge **13** indicates the gas pressure in the reservoir **11**. Such a pump serves as a convenient light and portable source of gas under positive pressure for field use of the improved resuscitator device. It should be understood, however, that any other source of gas may be used, such as a cylinder of compressed oxygen.

The operative parts of the resuscitator (Fig. 1) are all contained in the two-piece housing **15**a, **15**b. This housing or casing is hollow and externally shaped and dimensioned to permit it to be held in the palm of one hand, in effect constituting a handle for the mask M which is attached directly to the housing or casing by a rigid connection, thus leaving the other hand free to operate the plunger of the pump. The face mask M is detachably secured to the resuscitator R, preferably by a telescopic rigid connection. The weight of the resuscitator is so small that when a patient reclines, his head can comfortably support the entire resuscitator (exclusive of the pump), its weight being distributed over the area of his face which is in contact with the face mask M.

The two housing parts **15**a and **15**b are detachably secured together by two screws **16** (Fig. 1) which pass through the flange **17** of the member **15**b and the edge portion of the member **15**a which slidably fits within said flange.

All of the operative mechanism of the device is supported by a rigid casting **20**. This casting is provided with a depressed portion **21** which forms one wall of an atmospheric pressure chamber **22** (Fig. 6). The other wall of said chamber is formed by the flexible fabric diaphragm **23** constituting the pressure-actuated element of a fluid-pressure motor which is sensitively responsive to lung pressure. The edges of this disk-shaped diaphragm **23** are secured to the casting **20** by the clamping ring **24** (Fig. 7) which is held in place by the screws **25** which pass through the ring **24**, the diaphragm **23**, and into the casting **20**. A port **26** (Fig. 3) extends out through the part **20** and continuously provides communication between the atmospheric pressure chamber **22** and the atmosphere. The perforations **27** (Fig. 2) in the housing member **15**a admit atmospheric pressure to the interior of the housing **15**a, **15**b.

A valve reversing or motor chamber **30** (Figs. 6 and 5) is provided by a rigid cap member **31** including a cylindrical flange **32**, the lower edge of which engages a gasket **33** which extends around the edge of the upper face of the casting **20**. The flange **32** is held tightly against the gasket **33** by two screws (not shown) which extend through the cap **31** and into the threaded holes **35** (Fig. 7) in the part **20**. A rigid, tubular projection or nipple **37** is secured to or formed integrally with the cap **31** and affords communication between the valve reversing chamber **30** (Fig. 6) and the interior of the mask M (Fig. 1). The mask is directly secured to the casing, the mask having a tubular member **38** (Fig. 1) which telescopes over the outer surface of the tubular member **37**, thus permitting the separation of the mask and casing when desired.

One end of a flexible rubber tube **40** (Fig. 1) is detachably connected with the outlet from the positive pressure gas reservoir **11** by a bayonet coupling **41**. The other end of this tube or conduit **40** is connected to one end of the metallic nozzle tube **42** (Figs. 2, 3 and 4). The opposite end of the tube **42** (Fig. 6) is shaped to constitute the primary nozzle of an aspirator device, having an orifice **43** of restricted cross-section so that the speed of the gas passing through the orifice is accelerated. The gas passing through the orifice is supplied from the positive pressure reservoir **11** through the tube **40**.

The orifice **43** of the primary nozzle delivers the fluid into the interior of the secondary or forcer nozzle **44** which has an orifice **45** of slightly larger cross-section than that of the orifice **43**. A port **46** affords communication between the interior of the nozzle **44** and a Venturi chamber **47** into which the jet of fluid is delivered through orifice **45**. This port **46** is of slightly larger cross-section than that of the orifice **45**. As the jet of air emerges from the port **43** it induces a flow of air from the Venturi chamber **47** in through the port **46** and into nozzle **44**. An exit throat **48** leads from chamber **47**, being coaxial with orifice **45**. The throat **48** merges with a divergent passage coaxial with a tube **50** which leads to valve chamber **51**. An orifice **60** affords communication between the chamber **47** and a tube **61** which leads from the second valve chamber **62** (Fig. 5).

The first valve chamber **51**, hereinafter referred to for convenience as the intermediate delivery chamber, (Figs. 5 and 6), is provided with a port **53** which communicates with the atmosphere and it is also provided with a port **54** which communicates with the chamber **55**, hereinafter referred to for convenience as the upper delivery chamber, communicating with the valve reversing or motor chamber **30**.

The second valve chamber **62**, hereinafter referred to for convenience as the intermediate inlet chamber, is provided with a port **63** which communicates with the atmosphere and it is also provided with a port **64** which communicates with the chamber **65**, hereinafter referred to for convenience as the upper inlet chamber, communicating with the valve reversing or motor chamber **30**.

The motor mechanism is substantially identical with that disclosed in the patent to Sinnett No. 2,268,172, December 30, 1941, comprising a U-shaped member **70** having parallel legs **71**, **71** (Figs. 6 and 7). This member **70** is secured at its base to the center of the diaphragm **23** so that it is carried up and down by corresponding movement of the center of the diaphragm. The inner adjacent ends of the toggle members **72** and **82** are pivotally supported by the edges of the legs **71**, **71** which engage grooves provided in the ends of the toggle members. The coiled tension spring serves to force the adjacent inner ends of these toggle members toward each other at all times, thereby keeping these ends in engagement with the legs **71** at all times.

The outer end of the toggle member **72** passes loosely around the bolt **73** and it is prevented from sliding over the end of the bolt by the washer **74** and the nut **75**.

The outer end of the toggle member **82** passes loosely through a yoke **85** which is mounted for vertical sliding movement on the two pins **86**. The valve stems **56** and **66** have their upper ends secured by nuts to the yoke **85** so that when the yoke moves up and down on the pins **86**, corresponding vertical movement is imparted to these valve stems.

The valve stem **56** is provided with two spaced valve members **57** and **58** (Figs. 5 and 6). When the stem **56** is in the lowered position of Fig. 6, the valve **57** is seated, closing the orifice **53**, and the valve **58** is unseated, permitting gas to pass through the orifice **54**. When the stem **56** is in the elevated position of Fig. 5, the valve **58** is seated, closing the orifice **54**, and the valve **57** is unseated, permitting gas to pass through the orifice **53**.

The valve stem **66** is provided with two spaced valve members **67** and **68**. When this stem is in the elevated position of Fig. 5, the valve **67** is seated, closing the orifice **63**, and the valve **68** is unseated, permitting gas to pass through the orifice **64**. When the stem **66** is in lowered position (not shown) the valve **68** is seated, closing the orifice **64**, and the valve **67** is unseated, permitting gas to pass through the orifice **63**.

In use, the patient usually reclines and the mask is placed over his nose and mouth and held firmly in place by one hand of the operator, sealing both nose and mouth from atmospheric pressure. A constant supply of air under positive pressure is maintained in the positive pressure reservoir **11**. This air, under positive pressure, that is to say, super-atmospheric, is continuously delivered through the restricted orifice **43** (Fig. 6), the larger orifice **45**, and the still larger outlet port **48** and thence through the tube **50** into the valve chamber **51**. When the valves **57** and **58** are in the lowered position of Fig. 6, the air emerging from the chamber **47** through the port **48** is conducted upwardly through the passage **55** into the valve reversing or motor chamber **30**, thence through the tube **37** into the face mask and thence to the patient's lungs. As the lungs receive more and more air and become expanded, greater positive pressure is built up in them and this increased positive pressure is transmitted back to the valve reversing chamber. This increased positive pressure forces the diaphragm **23** (Fig. 6) downwardly into the atmospheric chamber **22**. The diaphragm carries the U-shaped member **70** downwardly with it temporarily elongating the spring. The adjacent inner ends of the toggle members **72**, **82** are also carried downwardly by the legs **71**, **71**. This causes the outer ends of the toggle members **72** and **82** to move upwardly. The upward movement of the toggle member **82** causes the yoke **85** to slide upwardly along the pins **86** thereby elevating the valve stems **56** and **66**. As soon as the stem **56** is elevated, the valve **58** seats and immediately stops the passage of air through the port **54** and causes the air emerging from the tube **50** to go out to the atmosphere through the orifice **53**. This terminates the first forced inhalation, and it is terminated because the lungs have received a normal quantity of air for inhalation when the increased positive pressure in the lungs causes the diaphragm **23** to trip and to reverse the valves.

The moment the stem **56** is elevated (as shown in Fig. 5) the stem **66** is also elevated and the orifice **64** is opened. The air passing at high velocity through the orifices **43** and **45** aspirates air through the orifice **60** and carries it out through the port **48**, the tube **50** and orifice **53** to the atmosphere. This creates negative pressure or suction in the tube **61**, the second valve chamber **62**, the passage **65**, the valve reversing or motor chamber **30**, the members **37**, **38** the face mask M and the patient's lungs, thus drawing gas from his lungs and eventually forcing it out through the orifice **53** to the atmosphere. As the gases are withdrawn from the patient's lungs, the negative pressure in his lungs and in the valve reversing chamber **30** increases and it finally becomes strong enough to draw the center of the diaphragm **23** upwardly again to the position of Fig. 6. This automatically lowers the valve stems **56** and **66**, closing the port **64** and opening the port **54**, thus closing the passage **65** so that negative pressure or suction is no longer created therein. This terminates the period of exhalation and automatically begins the next period of inhalation.

It will be observed that during inhalation the port **63** is open so that air is sucked through it into the valve chamber **62**, the tube **61** and the chamber **47**. This air mixes with the air which is emitted from the tube **42** and passes to the patient during inhalation, thus reducing the quantity of air removed from the positive pressure reservoir **11** during each inhalation.

While I have shown and described one desirable embodiment of the invention, it is to be understood that this disclosure is for the purpose of illustration only and that various changes in shape, proportion and arrangement of parts and the substitution of equivalent elements may be made without departing from the spirit and scope of the invention as set forth in the appended claims.

I claim:

1. In an automatic resuscitator of the kind wherein gas supplied under super-atmospheric pressure provides the energy for alternately inflating and deflating the lungs and having a face mask and a hollow handle rigidly united to the face mask, the handle having therein a motor chamber, a nozzle device comprising a housing provided with a Venturi chamber and a nozzle for delivering a jet of pressure fluid into said chamber, the parts being so designed that a suction is created in the Venturi chamber by the action of the jet, the handle also having therein an upper inlet and an upper delivery chamber each communicating with the motor chamber, the casing also having therein an intermediate inlet chamber and an intermediate delivery chamber, a valve port between the intermediate delivery chamber and the upper delivery chamber, a valve port between the intermediate inlet chamber and the upper inlet chamber, a valve port between each intermediate chamber and the atmosphere, a valve for controlling each of said ports, means for connecting the inlet valves and means connecting the delivery valves, the connecting means being so designed and arranged that when one inlet valve is seated the other is unseated and when one delivery valve is seated the other is unseated, means operative to move all of said valves simultaneously, the connecting means being so arranged that when the inlet port leading to the atmosphere is open the delivery port leading to the atmosphere is closed and vice versa, a conduit leading from the intermediate delivery chamber to the suction side of the nozzle, a conduit leading from the delivery of the nozzle to the intermediate inlet chamber, and means providing a passage leading from the upper delivery chamber to the face mask.

2. In an artificial resuscitator of the kind wherein gas supplies the energy for alternately inflating and deflating the lungs and having a face mask provided with a rigid attaching nipple, a case of a size such that it may be held in the palm of one hand, said case having a rigid nipple constructed and arranged for releasable connection to the nipple on the mask thereby detachably to unite the case and mask, an aspirator nozzle within the case, two pairs of valves within the case, said valves being operative to change the course of the gaseous medium delivered to and from the aspirator nozzle thereby alternately to deliver gaseous medium to the mask and to withdraw gaseous medium from the mask respectively, and a pressure-actuated diaphragm within the case, said diaphragm being operative in response to lung pressure automatically to actuate the valves, the connected nipples of the case and mask providing a single passage through which gas flows to and from the mask, and a single flexible conduit for supplying gas to the nozzle.

3. In a resuscitator of the type, which is automatically operated by gas under pressure, a Venturi chamber, a nozzle arranged to deliver gas into said Venturi chamber, a gas inlet conduit leading from said source of gas to said nozzle, an exhalation conduit leading to said chamber, an exit port leading from said chamber, a motor chamber, a movable pressure-responsive member in said motor chamber, and a conduit affording communication between said motor chamber and the patient, the improvement which comprises a first valve chamber, a second valve chamber, a conduit leading from said exit port to the first valve chamber, a conduit leading from said first valve chamber to the atmosphere, a conduit leading from said first valve chamber to the motor chamber, a valve means operative to open the conduit leading from said first valve chamber to the atmosphere during each period of exhalation by the patient, to close said conduit during each period of inhalation by the patient, to open said conduit leading from the first valve chamber to the valve-reversing chamber during each period of inhalation by the patient and to close said conduit during each period of exhalation, a conduit leading from said Venturi chamber exhalation port to said second valve chamber, a conduit leading from said second valve chamber to said valve-reversing chamber, a conduit leading from said second valve chamber to the atmosphere, and valve means associated with said valve-reversing member adapted to open said conduit leading from said second valve chamber to said valve-reversing chamber during each period of exhalation by the patient, to close said conduit during each period of inhalation, to open said conduit leading from said second valve chamber to the atmosphere during each period of inhalation and to close said conduit during each period of exhalation.

4. A resuscitator comprising a rigid support, means carried by said support defining a Venturi chamber, an atmospheric pressure chamber one wall of which is formed by said support, a flexible diaphragm having its edges secured to said support to close said atmospheric pressure chamber, a port in said support continuously affording communication between said atmospheric pressure chamber and the atmosphere, a rigid mem-

ber secured to the support and, with the latter, providing a motor chamber one wall of which is formed by the diaphragm, a rigid conduit extending from one side of said support, a face mask detachably but rigidly secured to said rigid conduit, said conduit affording communication between said face mask and said motor chamber, a conduit adapted to afford communication between a nozzle leading to said Venturi chamber and a source of gas under positive pressure, an exhalation conduit affording communication between said Venturi chamber and said motor chamber, an inhalation conduit affording communication between said Venturi chamber and said motor chamber, a port affording communication between said inhalation conduit and the atmosphere, and valve means carried by said support and operatively connected with said diaphragm, said valve means being adapted to open communication between said Venturi chamber and said motor chamber through said exhalation conduit during each period of exhalation by the patient, to close said communication during each period of inhalation, to open communication between said Venturi chamber and said port to the atmosphere during each period of exhalation, to close said communication during each period of inhalation, to open communication between said Venturi chamber and said valve-reversing chamber through said inhalation conduit during each period of inhalation and to close said communication during each period of exhalation, whereby a small compact resuscitator is provided which may be supported by the patient's head while he reclines with the face mask in position over his nose and mouth.

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