

March 10, 1959

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2,876,785

ARTIFICIAL RESPIRATION APPARATUS

Filed Oct. 30, 1953

2 Sheets-Sheet 1

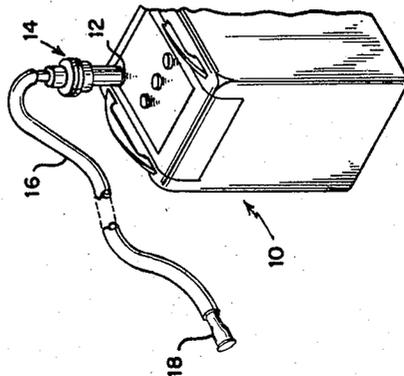


FIG. 1

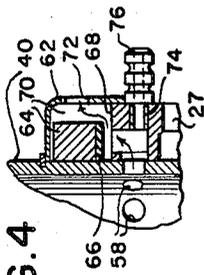


FIG. 4

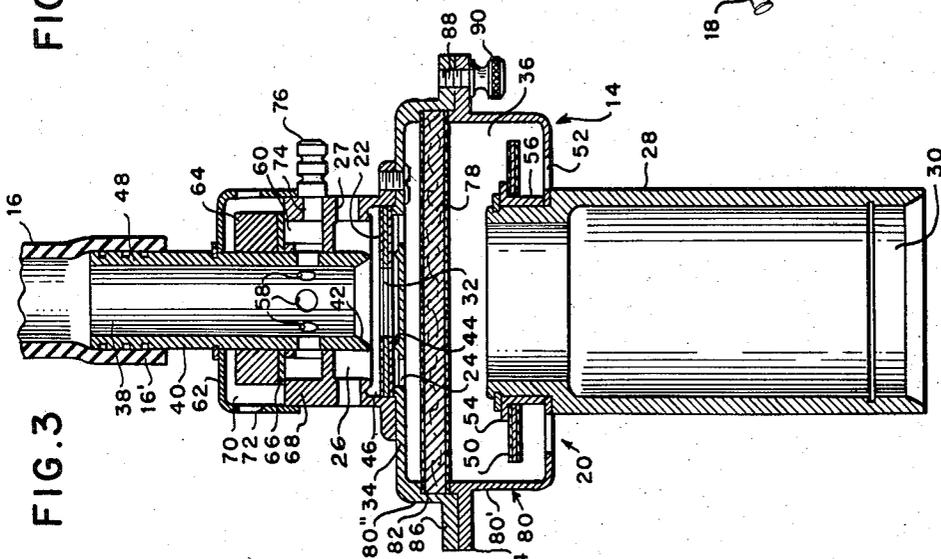


FIG. 3

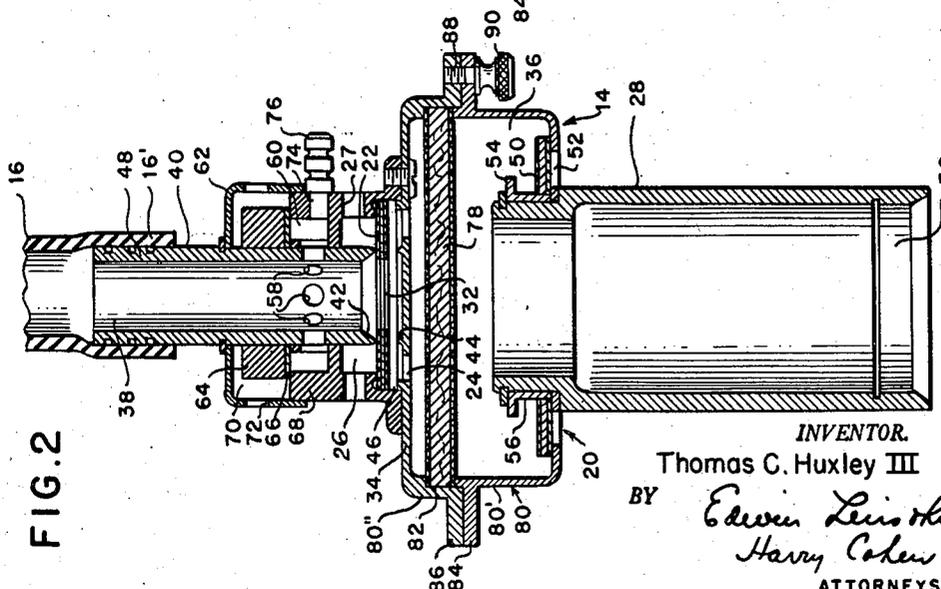


FIG. 2

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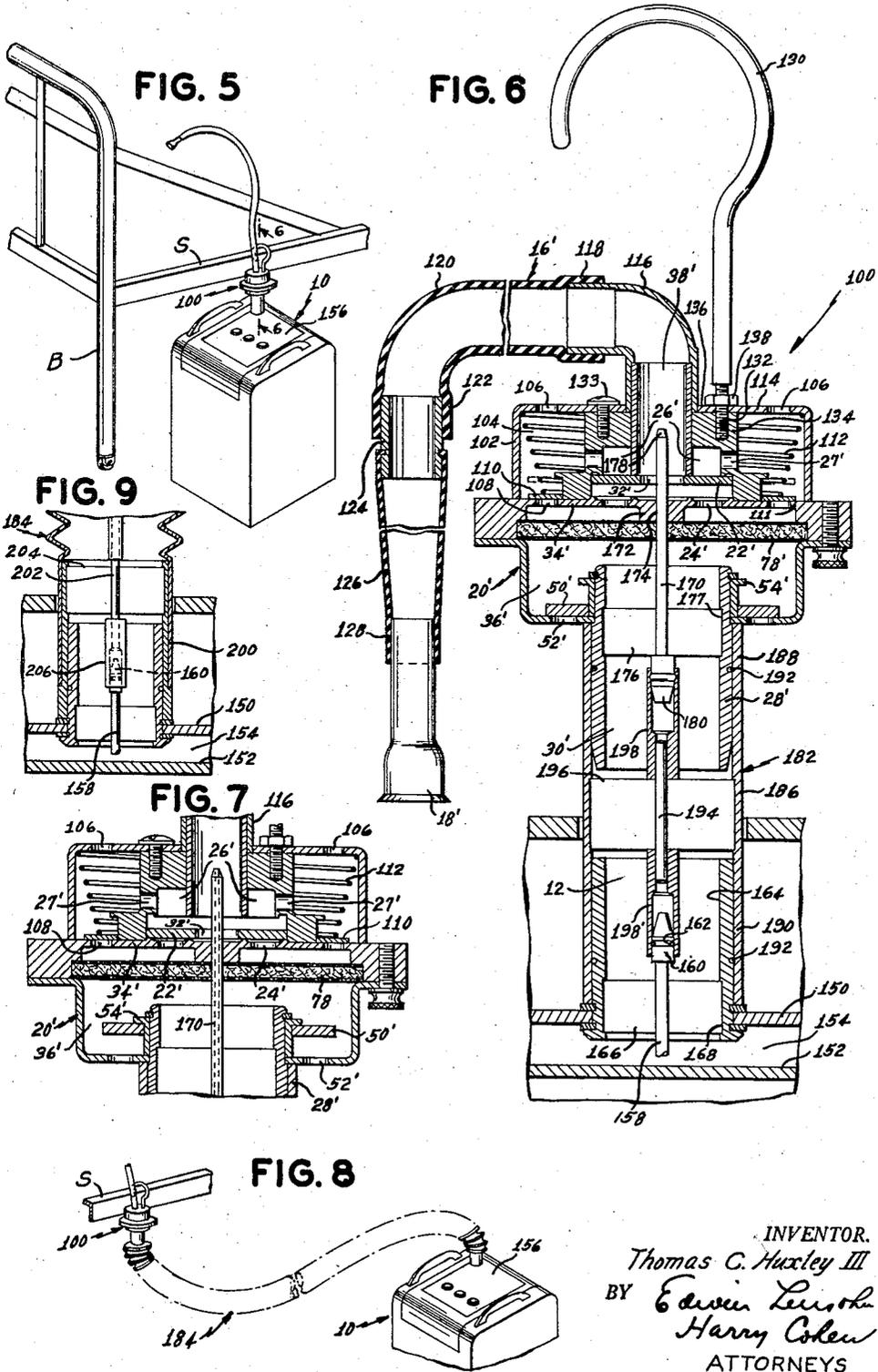
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2,876,785

## ARTIFICIAL RESPIRATION APPARATUS

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Continuation of application Serial No. 341,037, March 9, 1953. This application October 30, 1953, Serial No. 389,350

24 Claims. (Cl. 137—63)

This invention relates generally to improvements in artificial respiration apparatus and, more particularly, to improvements in devices for supplying air to a patient for breathing purposes through the patient's mouth.

One object of the present invention is the provision of an improved positive pressure device, adapted for use with a cyclically operable air pump adapted to alternately produce sub-atmospheric pressure and super-atmospheric pressure, which is effective to cyclically supply air directly to a patient for breathing purposes.

Another object of the present invention is the provision of an improved positive pressure device of the afore-noted character which is adapted to be used in association with the air pump to supply air directly to a patient when the cuirass is removed especially in cases where he requires treatment necessitating removal of the cuirass.

Another object of the present invention is the provision in artificial respiration apparatus having a pump and control unit adapted for operative association with a positive pressure device of the aforementioned character, of pressure indicating means positioned in close proximity to the control unit with said indicating means measuring pressure directly supplied by said device.

Another object of the present invention is the provision in artificial respiration apparatus of the above character of interchangeable coupling means for interconnecting the pump and control unit to the positive pressure device whereby the proximity of the positive pressure device to the pump and control unit may be varied.

Yet another object of the present invention is the provision of a generally improved positive pressure device of the aforementioned character which is simple in design and construction, economical to manufacture, and highly efficient in the accomplishment of its intended purposes.

The above and other objects, features and advantages of the present invention will be more fully understood from the following description considered in connection with the accompanying illustrative drawings.

In the drawings:

Fig. 1 is a perspective view of the positive pressure device formed according to the present invention shown connected to respirator pumping apparatus;

Fig. 2 is a longitudinal sectional view of the positive pressure device showing the position of the parts under one pressure condition;

Fig. 3 is a view similar to Fig. 2 showing the position of the parts under another pressure condition; and

Fig. 4 is a fragmentary longitudinal sectional view of the positive pressure device showing the parts thereof under still another pressure condition;

Fig. 5 is a view similar to Fig. 1 showing a modified form of positive pressure device positioned in close proximity to a bed;

Fig. 6 is a sectional view, on an enlarged scale, taken

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on the line 6—6 of Fig. 5 and showing the position of the parts under one pressure condition;

Fig. 7 is a view similar to part of Fig. 6 showing the position of the parts under another pressure condition;

Fig. 8 is a perspective view of the positive pressure device shown in Figs. 5-7 with the device shown connected to respirator pumping apparatus by means of a modified form of coupling device; and

Fig. 9 is a fragmentary longitudinal sectional view showing the interconnection of the coupling device shown in Fig. 8 to the respirator pumping apparatus.

With reference to the drawing, and more particularly with reference to Fig. 1 thereof, there is shown respirator pumping apparatus 10 housing an air pump which is cyclically operable to alternately produce sub-atmospheric pressure and super-atmospheric pressure at the port 12 of said apparatus. The respirator pumping apparatus 10 may be of any desired design and construction and the apparatus illustrated is of the type fully shown and described in my copending application Ser. No. 295,181, filed June 24, 1952, now Patent No. 2,762,200, for Artificial Respiration Apparatus and assigned to the assignee of the present application. The port 12 of apparatus 10 is normally adapted to be in fluid communication with one or more cuirasses and said apparatus will be effective to periodically supply air to and withdraw air from said one or more cuirasses. The cuirass may be of the type shown in my Patent No. 2,466,108 or in my pending application, Ser. No. 294,163 filed June 18, 1952, now Patent No. 2,772,673, both assigned to the assignee of this application. It will be understood that the air pump disposed in apparatus 10, when operatively associated with a cuirass, alternates between partial vacuum and normal pressure of the air within said cuirass at a controlled and variable rate to successfully simulate normal respiration. At times it is necessary or desirable to supply air directly to a patient when the cuirass is removed from the patient so that such patient may be treated at body areas which are normally covered by the cuirass. At such times when the cuirass is removed from the patient, the positive pressure device 14 may be associated with apparatus 10 in a manner to be subsequently described in detail so as to supply the air directly to the patient.

The positive pressure device 14 is adapted to be interposed between the conduit 16 and the port 12 in fluid-flow relation with the latter, it being noted that the conduit 16 terminates in a mouth piece 18 which is adapted to be inserted in the patient's mouth for supplying air directly to the patient. Thus in the normal use of the apparatus a cuirass will be operatively associated with the apparatus 10 and when said cuirass is removed from the patient's body it is merely necessary to connect the positive pressure device 14 to the port 12 whereby it will be apparent that said device is adapted to be alternately used in association with the apparatus 10. As fully shown and described in the aforementioned copending application, it is to be noted that the port 12 is normally adapted for association with a complementary conduit which is in fluid communication with a cuirass and for operatively associating the positive pressure device 14 with the apparatus 10 it is merely necessary to remove said conduit connected to the cuirass and secure said positive pressure device to port 12. The conduit 16 is adapted for periodic fluid communication with the port 12 whereby to periodically supply air at super-atmospheric pressure to the patient.

The positive pressure device 14 comprises a casing 20 housing valve means for interconnecting port 12 and conduit 16 for fluid communication when the pump disposed in apparatus 10 is operative to produce super-at-

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mospheric pressure at said port, said valve means being also operative to disconnect the port 12 from fluid communication with the conduit 16 when the pump is operative to produce sub-atmospheric pressure at said port. More particularly, the valve means for periodically interconnecting the port 12 and conduit 16 for fluid communication comprises a shuttle valve 22 which is operatively associated with the passages 24 and 26, said shuttle valve being adapted to move from the position shown in Fig. 3 to the position shown in Fig. 2 when super-atmospheric pressure is admitted to the tubular portion 28 of casing 20. It is to be noted that the tubular portion 28 defines a port 30 at one end of the device 14 and that said portion is adapted to be received in port 12 of the apparatus 10, said device when operatively associated with the apparatus 10 being in an upright position. The shuttle valve 22 is of disk-like formation and has a central aperture 32 extending therethrough. The passage 24 is of annular configuration and is defined in the plate 34 of the casing 20, said passage communicating with the interior chamber 36 of said casing. The annular passage 24 is in fluid communication at all times with the port 30 and said passage is adapted for fluid communication with the port 38 defined by the tubular portion 40 when the shuttle valve 22 is in the raised position, shown in Fig. 2. The passage 26 which is in fluid communication with the atmosphere through the circumferentially spaced series of apertures 27 is out of communication with the passage 24 when the shuttle valve 22 is in the raised position shown in Fig. 2. The inner end 42 of the tubular portion 40 constitutes a valve seat for the shuttle valve 22 when the latter is in the raised position, it being noted that the port 38 is in fluid communication with the passage 26 when the shuttle valve 22 is in its lowered position. The plate 34 which has the annular passage 24 defined therein is provided with an annular rim 44 which is adapted to provide a valve seat for the shuttle valve 22 when the latter is in its lowered position, as shown in Fig. 3. The valve 22 is gravitationally urged in its lowered position in which the passage 24 will be closed and said shuttle valve is guided for vertical movement in casing 20 by the annular interior surface portion 46 of said casing. When air at super-atmospheric pressure flows into port 30 from port 12 the shuttle valve 22 will be pressure urged into the position shown in Fig. 2 in which said air at super-atmospheric pressure will enter the annular passage 24 and discharge through port 38, said air entering the port 38 through the central passage 32 in the shuttle valve. Thus when air at super-atmospheric pressure is admitted into the interior chamber 36 of the casing 20, the shuttle valve 22 responds substantially without delay in a single step operation to close the passage 26 leading to the atmosphere and open the passage 24 permitting the latter to be in fluid communication with passage 32 and port 38, the latter in turn being in fluid communication with the mouthpiece 18 through conduit 16. It is to be noted that the end 16' of the conduit 16 is dimensioned complementary to the end portion 48 of tubular portion 40 and is adapted to be positioned thereon in fluid-tight relation therewith. From the above it will be apparent that the mouthpiece 18 and port 12 will be in fluid communication with each other when the pump of apparatus 10 is operative to produce super-atmospheric pressure at said port. Thus when super-atmospheric pressure is admitted into the chamber 36 of casing 20 the shuttle valve 22 will be pressure raised to close the passage 26 and will be at the same time open passage 24 for fluid communication with port 38 through the shuttle valve passage 32. It will also be apparent from the above that when sub-atmospheric pressure is applied to the interior chamber 36 of the casing 20, the shuttle valve 22 will seat on annular rim 44 whereby to shut off the passage 24 from fluid communication with the passage 32 and consequently with port 38. It is also to be noted that when the shuttle valve is in its lowered

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position and seated on rim 44 the port 38 will be in fluid communication with the passage 26 and will accordingly be in fluid communication with the atmosphere. Thus when sub-atmospheric pressure is applied to the chamber 36 of the casing 20 the patient can breathe out through the passage 26 leading to the atmosphere. It is to be noted that the elastic recoil of the patient's lungs will allow the patient to exhaust air after receiving air at super-atmospheric pressure in the above manner. Thus when apparatus 10 is operative to produce sub-atmospheric pressure in the chamber 36 of casing 20 the patient can readily breathe out through the port 38 which under such conditions will be in fluid communication with the passage 26, and apertures or vents 27.

The casing 20 is also provided with separate valve means for venting the interior chamber 36 of said casing to the atmosphere when apparatus 10 is operative to produce sub-atmospheric pressure at port 12 and consequently in said interior chamber 36 of said casing, said separate valve means comprising an annular valve member 50 which is operatively associated with a companion annular port 52 which communicates with the atmosphere. The valve member 50 is adapted to provide fluid communication between the chamber 36 and the atmosphere when apparatus 10 is operative to produce sub-atmospheric pressure at port 12. Thus the valve member 50 is normally gravitationally urged in a position to close the port 52 and when sub-atmospheric pressure is applied to the chamber 36 the valve member 50 will be vertically moved to the raised position shown in Fig. 3 in which said valve member will abut the peripherally extending shoulder 54 disposed in the casing 20. Thus the valve means constituted by the valve member 50 and its associated port 52 is adapted to vent the chamber 36 to the atmosphere when sub-atmospheric pressure is applied to said chamber. The valve member 50 which is of flat disk-like formation is centrally apertured and is guided for vertical movement by the complementary annular portion 56 of the casing structure 20. It will also be apparent that when super-atmospheric pressure is applied to the chamber 36, the port 52 will be pressure closed by the valve member 50, and when sub-atmospheric pressure is applied to said chamber said valve member will be raised against the annular shoulder 54 to vent said chamber to the atmosphere through the annular port 52.

The casing structure 20 is further provided with independent valve means for limiting the amount of super-atmospheric pressure supplied to the conduit 16 from the port 12. More particularly, the tubular portion 40 at its lower end is provided with a series of apertures 58 spaced circumferentially of said portion, said apertures communicating with the annular chamber 60 defined in the casing 20. Tubular portion 40, interior of the casing portion 62 of casing 20, has operatively associated therewith the valve member 64, the latter being gravitationally urged to the position shown in Figs. 2 and 3, and being movable to the position shown in Fig. 4 when the amount of super-atmospheric pressure entering chamber 36 is above a predetermined amount. The annular valve member 64 has a lower part 66 of a preferably resilient material of annular configuration which is adapted to seat on the valve seat portions 68 disposed in the casing portion 62 when said valve member is in its normal lowered position shown in Figs. 2 and 3. When the pressure admitted to the chamber 36 is above a predetermined maximum amount the valve member 64 will be raised from the seat 68 and the excess pressure will be vented to the atmosphere through the annular passage 70 and the series of circumferentially spaced apertures 72 in the casing portion 62 as shown in Fig. 4. It will be apparent that when the valve member 64 is seated on seat 68 the annular passage 70 and the apertures 72 will be out of fluid communication with the chamber 60 whereby air supplied to the chamber 36 will be discharged through the mouthpiece 18 and into the patient's mouth. Thus

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the valve member 64 and associated structure constitutes means for limiting the amount of super-atmospheric pressure supplied to a patient through the conduit 16 to a predetermined maximum.

If desired, annular chamber 60 may be provided with an outlet port 74 which is in fluid communication with the conduit 76, the latter being operatively associated with any suitable pressure gauge (not shown). Thus the port 74 is provided to tap the pressure from the chamber 60 to a suitable pressure gauge so that pressure conditions in the casing 20 may be noted at a glance. A suitable filter 78 may be disposed in the chamber 36 for filtering the air supplied to the patient by the apparatus 10, said filter being of conventional construction and being secured in the casing 20 in any conventional manner. In the illustrated embodiment the casing portion 80 of casing 20 is provided with an annular groove 82 which is adapted for the reception of the annular filter 78, the latter being dimensioned complementary to said annular groove. Any suitable means may be provided for the disassembly of the casing 20 and in the illustrated embodiment the casing portion 80 is formed of two parts 80' and 80'' which are provided with peripherally extending flanges 84 and 86, respectively, which are adapted to mate in the assembled condition of the device 14. The flanges 84 and 86 will be provided with a plurality of circumferentially spaced apertures 88 which are adapted to register for the reception of fastener elements 90, the latter providing a ready means for the assembly and disassembly of the casing portion 80. Although only one fastener element 90 is shown associated with the registered apertures 88 of the flanges 84 and 86, it is to be understood that a plurality of said fastener elements are utilized and will be spaced circumferentially of the flanges 84 and 86, corresponding to the spacing of the registered apertures 88.

From the above it will be apparent that the positive pressure device 14 aforescribed is adapted to be used alternately in association with a cuirass to supply air directly to a patient when the cuirass is removed from the patient so that he may be treated at body areas which are normally covered by the cuirass. When the cuirass is re-positioned on the patient's body the positive pressure device 14 may be removed from unit 10 and the latter will be operatively associated with said cuirass to simulate the breathing operation. Thus sub-atmospheric pressure and super-atmospheric pressure will be alternately and cyclically produced in the chamber 36 of the device 14 and only the super-atmospheric pressure will flow to the mouthpiece 18 and consequently to the patient since the application of sub-atmospheric pressure to the chamber 36 will be effective to close the passage 24, at which time the mouthpiece will be in fluid communication with the passage 26 leading to the atmosphere, said passage providing means for permitting the patient to exhaust air after the application of positive pressure.

It will be understood that the valve member 64 is of a preselected weight so as to raise from seat 68 when the amount of super-atmospheric pressure entering chamber 36 exceeds a predetermined amount. The maximum amount of pressure entering chamber 36 may be varied by substituting another valve member 64 of proper weight in the assembly or, if desired, adjustable spring means may be associated with valve member 64 whereby to provide a readily adjustable means for limiting the maximum amount of pressure supplied to the patient.

With reference to Figs. 5-8, there is shown a positive pressure device 100 which is similar to the positive pressure device 14 aforescribed in detail except in the respects now to be specifically noted. The positive pressure device 100 is adapted to be interposed between the conduit 16' and the port 12 of apparatus 10 in fluid flow relation with said port, it being noted that the conduit 16' terminates in a mouth piece 18' which is adapted to be inserted in the patient's mouth for supplying air di-

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rectly to the patient in the aforescribed manner. The positive pressure device 100 comprises a casing 20' which houses valve means for interconnecting port 12 and conduit 16' for fluid communication when the pump disposed in apparatus 10 is operative to produce super-atmospheric pressure at said port, said valve means being also operative to disconnect the port 12 from fluid communication with the conduit 16' when the pump is operative to produce sub-atmospheric pressure at said port. The casing 20' is provided with a casing part 102 which defines the auxiliary chamber 104, the latter being vented to the atmosphere by means of the vent holes 106. Disposed between the interior chamber 36' and the auxiliary chamber 104 is an annular passage 108 which is normally closed by the annular valve member 110. Disposed in the auxiliary chamber 104 is a conical spring 112 of the compression type which is adapted to bias the valve member 10 into the closed position as shown in Figs. 6 and 7. Thus one end of the compression spring 112 coacts with an adjacent face of the valve member 110 and the opposite end of said spring coacts with the interior face 114 of the casing part 102. Thus the chambers 36' and 104 are normally out of fluid communication and under excess super-atmospheric pressure conditions the valve member 110 will be displaced from its seat 111 whereby excess super-atmospheric pressure will be vented to the auxiliary chamber 104 and then to the atmosphere through the vent ports 106. Accordingly the annular valve member 110 is operative to vent super-atmospheric pressure above a predetermined amount supplied through the port 12 to the auxiliary chamber 104 which is vented to the atmosphere. The maximum amount of pressure permitted in chamber 36' may be varied by substituting another spring 112 of the desired tension or, if desired, adjustable spring means may be associated with the valve member 110 whereby to provide a ready means for limiting the maximum amount of pressure supplied to the patient. As aforescribed, the valve means for periodically interconnecting the port 12 and conduit 16' for fluid communication comprises a shuttle valve 22' which is operatively associated with the passages 24' and 26', said shuttle valve being adapted to move from the position shown in Fig. 7 to the position shown in Fig. 6 when super-atmospheric pressure is admitted to the tubular portion or fitting 28' of casing 20'. The passage 26' is in fluid communication with the auxiliary chamber 104 through the circumferentially spaced series of apertures 27' whereby it will be apparent that when the shuttle valve 22' is in the raised position the passage 26' and chamber 104 will be out of fluid communication with the passage 24'. Thus when air at super-atmospheric pressure is admitted into the interior chamber 36' of casing 20', the shuttle valve 22' will close the passage 26' leading to the atmosphere through chamber 104 and open the passage 24' permitting the latter to be in fluid communication with the mouthpiece 18' through conduit 16'. It is also to be noted that when the shuttle valve 22' is in its lowered position the port 38' will be in fluid communication with the passage 26' and will accordingly be in fluid communication with the atmosphere through the auxiliary chamber 104 which, as aforesaid, is vented to the atmosphere. Thus when sub-atmospheric pressure is applied to the chamber 36' the patient can breathe out through the passage 26' leading to the chamber 104 which is vented to the atmosphere. From the above it will be apparent that the auxiliary chamber 104 is in fluid communication at all times with passage 26' and is adapted for fluid communication with chamber 36' when super-atmospheric pressure above a predetermined amount is supplied through port 12 to the chamber 36'.

The tubular portion 116 is in the form of an elbow fitting which is interconnected with the end 118 of the length of tubing 120 in fluid sealing relation therewith. The opposite end 122 of the length of tubing 120 is connected to fitting 124 in fluid sealing relation there-

with, it being noted that said fitting is also interconnected with the tapered tube 126. The smaller diameter end 128 of the tube 126 is interconnected with the mouthpiece 18' in fluid sealing relation therewith. From the above it will be apparent that the conduit 16' for interconnecting device 100 to the mouthpiece is constituted by the length of tubing 120, fitting 124 and tube 126. The device 100 is preferably provided with a suitable hook 130 which is adapted for a purpose which will be evident from the description which follows, the threaded shaft part 132 of said hook being adapted to be received in aligned apertures provided in the part 134 and the wall part 136 of casing part 102. It will be understood that the aperture provided in part 134 is threaded complementary to part 132 and that the latter together with screws 133 provide for the securement of part 134 to casing part 102. Threadedly engaged on shaft 132 is a nut 138 which is adapted to be clamped against part 136 for clamping hook 130 in its adjusted position and for securing part 134 to part 132 as will be readily apparent. Where necessary or desirable the hook 130 may be utilized to support the device 100 at a convenient position, for example on the support S of bed B. Accordingly the hook 130 may be utilized to support the device 100 at a position dictated by convenience or necessity and it will be readily apparent that said hook may be interengaged with any suitable support means for supporting the positive pressure device at the desired position.

Pursuant to the present invention there is provided an arrangement in which the pressure indicating means is positioned in close proximity to the controls of apparatus 10 with said indicating means measuring pressure at port 38' and consequently the pressure being supplied to the mouthpiece 18' and to the patient. Certain features of this arrangement are fully shown and described in the copending application of Nelson G. Kling and Thomas C. Huxley III for Improvements In Artificial Respiration Apparatus, Serial No. 383,792, filed October 2, 1953, now Patent No. 2,832,335 and the copending application of Nelson G. Kling and Thomas C. Huxley III for Improvements In Artificial Respiration Apparatus, Serial No. 362,316, filed June 17, 1953, now Patent No. 2,779,329, said applications being assigned to the assignee of the present invention. As fully shown and described in said copending applications, the pump housed in apparatus 10 comprises a fixed head 150 and a piston or relatively movable head 152 which is mounted for reciprocation, said fixed head and said movable head defining therebetween the sealed pumping chamber 154. The instrument panel 156 of apparatus 10 has suitably mounted thereon a pressure gage (not shown) which is in close proximity to the control knobs of said apparatus. The pressure gage disposed on instrument panel 156 is adapted to measure pressure directly at port 38' and consequently the pressure supplied to a patient in a manner now to be described in detail. The pressure gage is provided with a pressure transmitting tube portion 158 which extends in pumping chamber 154 and terminates in a free end portion 160 which is constituted by a fitting which is adapted for a purpose which will be evident from the description which follows. It is to be here noted that apparatus 10 corresponds in all respects to the corresponding apparatus of the aforesaid to copending applications. Thus the fitting 160 is constituted by a tapered end portion of the tube portion 158 and is provided with a peripherally extending groove having a sealing ring 162 positioned therein. The tube portion 158 is in fluid flow relation with the pressure indicating gage on the instrument panel 156 and terminates in a free end portion constituted by the fitting 160 which is disposed in the region of fitting 164 which defines port 12. The tube portion 158 is supported centrally of fitting 164 in a fixed relative position by the radially extending arms 166 which are received in the peripherally extending

recess 168, as aforesaid in detail in the aforesaid referred to copending applications.

Disposed in casing 20' in coaxial relation therewith is a longitudinally extending open ended pressure communication tube 170 which is adapted to be interconnected with the tube portion 158 and consequently to the pressure indicating gage in a manner to be described in detail hereinafter. The thickened central portion 172 of plate 34' is apertured therethrough as indicated at 174 for the reception of tube 170, said portion 172 being adapted to support tube 170 in casing 20' in conjunction with the radially extending arms 176 which are secured to said tube and in recess 177 as aforesaid with reference to arms 156. Thus the tube 170 is supported centrally of casing 20' at longitudinally spaced points by means of the portion 172 and by the radially extending arms 176. The free end portion 178 of tube 170 terminates in the region of port 38' whereby the pressure indicating gage is adapted to indicate pressure at said port and consequently the pressure supplied to the patient through mouthpiece 18' when device 100 is operatively associated with apparatus 10 in the manner to be described hereinafter. The free end portion 180 of tube 170 is disposed in the tubular portion 28' in coaxial relation therewith and is constituted by a tapered fitting which corresponds in all respects to the fitting 160 aforesaid. Thus the pressure communication tube 170 is adapted to be interconnected with the tube portion 158 in a manner to be described hereinafter and when so connected the pressure indicating gage of apparatus 10 is adapted to directly indicate pressure supplied to a patient during the positive pressure phase of the pumping means of said apparatus.

The instant artificial respiration apparatus is provided with interchangeable coupling or conduit means for interconnecting the pump and control unit of apparatus 10 to the positive pressure device 100 whereby the proximity of the latter device to the pump and control unit may be varied. Thus the positive pressure device 100 may be interconnected with apparatus 10 by means of the coupling member 182 shown in Fig. 6 or the flexible tube 184 which is similar in all respects to the corresponding tube of the aforesaid to copending applications.

The coupling member 182 comprises a rigid body part 186 which terminates in structurally similar integral fittings 188 and 190, said fittings being formed complementary to the tubular portion or fitting 28' and fitting 164 of device 100 and apparatus 10, respectively. It will be understood that fittings 188 and 190 and fittings 28' and 164 are structurally similar and companion pairs of said fittings are adapted to be releasably interconnected in fluid sealing relation whereby coupling member 182 when interconnected with apparatus 10 and device 100 defines a fluid passage between ports 12 and 30'. The fittings 28' and 164 are preferably provided with a sealing ring 192 whereby to provide for a fluid tight interconnection between coupling member 182, apparatus 10, and device 100. Longitudinally extending in member 182, in coaxial relation therewith, is a pressure communication tube 194 which is supported in the body part 186 of member 182 by means of the radially extending arms 196 which are structurally similar to arms 166 and 176. The pressure communication tube 194 terminates in structurally similar fittings 198 which are disposed in the region of the fittings 188 and 190 in fixed relation therewith. The fittings 198 are formed complementary to the fittings 160 and 180 aforesaid and are adapted for releasable interconnection therewith in fluid sealing relation. Thus fittings 160 and 180 are structurally similar and are formed complementary to the structurally similar fittings 198. It is to be noted that fittings 198 and 198' are disposed in a fixed relation with the fittings 188 and 190, respectively, said arrangement providing for the simultaneous plug-in connection of the

body fittings 188 and 190 and the tube fittings 198 and 198', respectively, as a unit to apparatus 10 and device 100. On the interconnection of the coupling member 182 to fitting 164 of apparatus 10 the companion fitting 198' will be automatically interconnected with its complementary fitting 160, the latter fitting being associated with the pressure indicating gage on the instrument panel 156 in the aforescribed manner. Thus fittings 190 and 198' provide for the interconnection of the tube 194 with the fitting 160 of the tube portion 158 on the plug-in interconnection of the member 182 with apparatus 10. Similarly on the interconnection of the coupling member 182 with device 100 the fitting 198 will be automatically interconnected with its complementary fitting 180 of tube 170 whereby there will be defined a pressure communication passage from the pressure indicating gage to the free end portion 178 of tube 170 when said member 182 is interconnected between apparatus 10 and device 100. Thus tube portion 158 will be automatically connected to tube 170 in fluid flow relation therewith on the interconnection of device 100 and apparatus 10 with the coupling member 182. It is to be noted that either end of member 182 may be plugged in the apparatus 10 and device 100 in the aforescribed manner. Thus where it is desired to connect device 100 to apparatus 10 in close proximity thereto the coupling member 182 aforescribed will be utilized to provide for said interconnection.

With reference to Figs. 8 and 9, if it is desired to connect the device 100 to apparatus 10 and to position said device at a distance from said apparatus the coupling device or conduit 184 will be utilized, said coupling device or conduit being structurally similar to the corresponding conduit of the aforesaid to copending applications. Thus the conduit 184 which is adapted to connect apparatus 10 to device 100 in fluid flow relation therewith is preferably of flexible and resilient construction. The terminal ends 200 of conduit 184 are structurally identical and are in the form of fittings which are adapted for releasable interconnection to the fittings 28' and 164 in fluid sealing relation therewith. As aforesaid, the fittings 200 of the conduit or coupling device 184 are structurally identical whereby either end of said conduit may be interchangeably associated with the apparatus 10 and device 100 in the aforescribed manner. Extending longitudinally in the conduit 184 is a pressure transmitting tube 202 which is supported centrally of said conduit at longitudinally spaced points by the radially extending arms 204. Both terminal end portions of tube 202 are structurally similar and define fittings 206 which are adapted to be releasably connected to the fittings 160 and 180, which are formed complementary thereto. Thus the conduit 184 is adapted to be utilized in conjunction with apparatus 10 and device 100 interchangeably with coupling member 182. One end fitting 200 of conduit 184 is adapted to be interconnected with fitting 164 and the opposite end fitting 200 of said conduit is adapted to be interconnected with the fitting 28' of device 100. The pressure transmitting tube 202 terminates at both ends in fittings 206 which are formed complementary to the fitting 160 and 180 as aforescribed, said fittings 206 being adapted for releasable fluid sealing connection with fittings 160 and 180 on the interconnection of fittings 200 with apparatus 10 and device 100. Thus, as shown in Fig. 9, one end fitting 200 of conduit 184 is adapted for interconnection with the fitting 164 of apparatus 10 and on such interconnection the fittings 206 and 160 will be automatically releasably interconnected whereby to provide for the interconnection of the tube 202 with the pressure indicating gage on instrument panel 156. The opposite end fitting 200 of conduit 184 will be similarly interconnected with the device 100 and said interconnection will automatically provide for the interconnection of a fitting 206 of tube 202 with the fitting 180 of tube 170 whereby to provide

for a pressure transmission passage from the end 178 of tube 170 to the pressure indicating gage. Accordingly if it is desired to position device 100 at a distance from apparatus 10 as shown in Fig. 8, a conduit 184 will be utilized to provide for the interconnection between said apparatus and said device. Thus companion fittings 200 and 206 of conduit 184 are disposed in fixed relation to each other and provide for the simultaneous connection of said fittings as a unit to different devices, for example apparatus 10 and device 100. The pressure indicating gage, which is positioned in close proximity to the control devices of apparatus 10, measures pressure directly in the region of port 38' of device 100 irrespective of whether coupling member 182 or conduit 184 is utilized for interconnecting the positive pressure device 100 with apparatus 10. It will be understood that the positive pressure device 14 aforescribed may be provided with a pressure communication tube similar to the tube 170 whereby to provide for the direct reading of pressure at port 38 from a position remote therefrom. In practice, after device 100 and apparatus 10 are interconnected as aforescribed, the pressure control knobs of said apparatus will be turned to the zero or valve opened position and after the pump of said apparatus is operating the positive pressure control knob will be turned to its maximum or valve closed position and the negative pressure control knob will be slowly turned until the pressure indicating gage indicates the desired amount of positive pressure.

The present invention is a continuation-in-part of my copending application entitled Improvements In Artificial Respiration Apparatus, Serial No. 341,037, filed March 9, 1953, now abandoned, and assigned to the assignee of the present invention.

While I have shown and described the preferred embodiment of my invention, it will be understood that various changes may be made in the present invention without departing from the underlying idea or principles of the invention within the scope of the appended claims.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. In combination with respirator pumping apparatus having pumping means to periodically supply air to and withdraw air from a port and a conduit adapted for periodic fluid communication with said port, a positive pressure device interposed between said conduit and said port in fluid flow relation with the latter, said device comprising a casing having valve means for interconnecting said port and said conduit for fluid communication when said pumping means is operative to supply air to said port, said valve means being operative to disconnect said port and said conduit from fluid communication when said pumping means is operative to withdraw air from said port, and valve means disposed in said casing independent of said first mentioned valve means for venting said casing to the atmosphere when said pumping means is operative to withdraw air through said port.

2. In combination with respirator pumping apparatus having pumping means to periodically supply air to and withdraw air from a port and a conduit adapted for periodic fluid communication with said port, a positive pressure device interposed between said conduit and said port in fluid flow relation with the latter, said device comprising a casing having valve means for interconnecting said port and said conduit for fluid communication when said pumping means is operative to supply air to said port, said valve means being operative to disconnect said port and said conduit from fluid communication when said pumping means is operative to withdraw air from said port, and valve means disposed in said casing independent of said first mentioned valve means for venting said casing to the atmosphere when said pumping means is operative to withdraw air through said port, and independent valve means provided in said casing for limit-

ing the supply of air to said conduit when the latter and said port are interconnected for fluid communication.

3. In combination with an air pump cyclically operable to alternately produce sub-atmospheric pressure and super-atmospheric pressure at a port, and a conduit adapted for periodic fluid communication with said port, a positive pressure device interposed between said conduit and said port in fluid flow relation with the latter, said device comprising casing structure provided with valve means for interconnecting said port and said conduit for fluid communication when said pump is operative to produce super-atmospheric pressure at said port, said valve means being operative to disconnect said port and said conduit from fluid communication when said pump is operative to produce sub-atmospheric pressure at said port, said valve means comprising a shuttle valve operatively associated with a pair of passages, one of said passages communicating with said port and the other of said passages communicating with the atmosphere, said shuttle valve being adapted to close said other passage and open said one passage when said pump is operative to produce super-atmospheric pressure at said port whereby said port and said conduit will be in fluid communication, and means provided in said casing for venting said casing to the atmosphere when said pumping means is operative to produce sub-atmospheric pressure at said port.

4. In combination with an air pump cyclically operable to alternately produce sub-atmospheric pressure and super-atmospheric pressure at a port, and a conduit adapted for periodic fluid communication with said port, a positive pressure device interposed between said conduit and said port in fluid flow relation with the latter, said device comprising casing structure provided with valve means for interconnecting said port and said conduit for fluid communication when said pump is operative to produce super-atmospheric pressure at said port, said valve means being operative to disconnect said port and said conduit from fluid communication when said pump is operative to produce sub-atmospheric pressure at said port, said valve means comprising a single shuttle valve operatively associated with a pair of passages, one of said passages communicating with said port and the other of said passages communicating with the atmosphere, said casing having valve seats at opposite sides, respectively, of said valve, said shuttle valve being engageable with one of said valve seats to close said other passage and being simultaneously disengageable from said other valve seat to open said one passage when said pump is operative to produce super-atmospheric pressure at said port whereby said port and said conduit will be in fluid communication, said shuttle valve having an opening therethrough which is closed when said valve is engaged with said other valve seat.

5. In combination with an air pump cyclically operable to alternately produce sub-atmospheric pressure and super-atmospheric pressure at a port, and a conduit adapted for periodic fluid communication with said port, a positive pressure device interposed between said conduit and said port in fluid flow relation with the latter, said device comprising casing structure provided with valve means for interconnecting said port and said conduit for fluid communication when said pump is operative to produce super-atmospheric pressure at said port, said valve means being operative to disconnect said port and said conduit from fluid communication when said pump is operative to produce sub-atmospheric pressure at said port, said valve means comprising a single shuttle valve operatively associated with a pair of passages, one of said passages communicating with said port and the other of said passages communicating with the atmosphere, said casing having valve seats at opposite sides, respectively, of said valve, said shuttle valve being engageable with one of said valve seats to close said other passage and

being simultaneously disengageable from said other valve seat to open said one passage when said pump is operative to produce super-atmospheric pressure at said port whereby said port and said conduit will be in fluid communication, and separate valve means disposed in said casing for venting the latter to the atmosphere when said pump is operative to produce sub-atmospheric pressure at said port, said separate valve means comprising a valve member operatively associated with a port communicating with the atmosphere, said valve member being adapted to open said last mentioned port when said pump is operative to produce sub-atmospheric pressure at said first mentioned port, and independent valve means disposed in said casing for limiting the amount of super-atmospheric pressure supplied to said conduit from said first mentioned port.

6. A positive pressure device adapted for use with a cyclically operable air pump adapted to alternately produce sub-atmospheric pressure and super-atmospheric pressure, said device comprising a casing having a pair of spaced ports which are adapted to be in communication with each other cyclically when super-atmospheric pressure is admitted into one of said ports, and valve means for interconnecting said ports when super-atmospheric pressure is admitted into one of said ports, said valve means being operative to disconnect said ports from communication when sub-atmospheric pressure is applied to said one port, said valve means comprising a shuttle valve operatively associated with a pair of passages, one of said passages communicating with said one port and the other of said passages communicating with the atmosphere, said shuttle valve being adapted to close said other passage and open said one passage when super-atmospheric pressure is admitted into said one port, and valve means disposed in said casing independent of said shuttle valve for venting said casing to the atmosphere when sub-atmospheric pressure is admitted into said one port.

7. A positive pressure device adapted for use with a cyclically operable air pump adapted to alternately produce sub-atmospheric pressure and super-atmospheric pressure, said device comprising a casing having a pair of spaced ports which are adapted to be in communication with each other cyclically when super-atmospheric pressure is admitted into one of said ports, and valve means for interconnecting said ports when super-atmospheric pressure is admitted into one of said ports, said valve means being operative to disconnect said ports from communication when sub-atmospheric pressure is applied to said one port, said valve means comprising a shuttle valve operatively associated with a pair of passages, one of said passages communicating with said one port and the other of said passage communicating with the atmosphere, said shuttle valve being adapted to close said other passage and open said one passage when super-atmospheric pressure is admitted into said one port, and valve means disposed in said casing independent of said shuttle valve for venting said casing to the atmosphere when sub-atmospheric pressure is admitted into said one port, said last mentioned valve means comprising a valve member operatively associated with a port communicating with the atmosphere, said valve member being gravitationally urged in a position to close its associated port and being adapted to open the latter when sub-atmospheric pressure is admitted into said one port.

8. A positive pressure device adapted for use with a cyclically operable air pump adapted to alternately produce sub-atmospheric pressure and super-atmospheric pressure, said device comprising a casing having a pair of spaced ports which are adapted to be in communication with each other cyclically when super-atmospheric pressure is admitted into one of said ports, and valve means for interconnecting said ports when super-atmospheric pressure is admitted into one of said ports, said valve means being operative to disconnect said ports

from communication when sub-atmospheric pressure is applied to said one port, said valve means comprising a shuttle valve operatively associated with a pair of passages, one of said passages communicating with said one port and the other of said passages communicating with the atmosphere, valve seats at opposite sides of said shuttle valve, said shuttle valve being movable into and out of engagement with said valve seats, respectively, to close said other passage and open said one passage when super-atmospheric pressure is admitted into said one port, and valve means disposed in said casing independent of said shuttle valve for venting said casing to the atmosphere when sub-atmospheric pressure is admitted into said one port, said last mentioned valve means comprising a valve member operatively associated with a port communicating with the atmosphere, said valve member being gravitationally urged in a position to close its associated port and being adapted to open the latter when sub-atmospheric pressure is admitted into said one port, and additional valve means disposed in said casing for limiting the amount of super-atmospheric pressure flowing through the other of said spaced ports.

9. A positive pressure device adapted for use with a cyclically operable air pump adapted to alternately produce sub-atmospheric pressure and super-atmospheric pressure, said device comprising a casing having a pair of spaced ports which are adapted to be in communication with each other cyclically when super-atmospheric pressure is admitted into one of said ports, and valve means for interconnecting said ports when super-atmospheric pressure is admitted into one of said ports, said valve means being operative to disconnect said ports from communication when sub-atmospheric pressure is applied to said one port, said casing having a fitting defining a fluid passage communicating with said one port, a pressure communication tube disposed within said fitting and extending longitudinally of the latter into said spaced parts, said fitting having means for supporting said pressure communication tube therein whereby to provide for the simultaneous connection of said fitting and said pressure communication tube as a unit to different devices, respectively.

10. A positive pressure device adapted for use with a cyclically operable air pump adapted to alternately produce sub-atmospheric pressure and super-atmospheric pressure, said device comprising a casing having a pair of spaced ports which are adapted to be in communication with each other cyclically when super-atmospheric pressure is admitted into one of said ports, and valve means for interconnecting said ports when super-atmospheric pressure is admitted into one of said ports, said valve means being operative to disconnect said ports from communication when sub-atmospheric pressure is applied to said one port, said casing having a fitting defining a fluid passage communicating with said one port, a pressure communication tube disposed within said fitting and extending longitudinally of the latter, and means including said casing for supporting said pressure communication tube in said fitting in a fixed relative disposition whereby to provide for the simultaneous connection of said fitting and said pressure communication tube as a unit to different devices, respectively.

11. A positive pressure device adapted for use with a cyclically operable air pump adapted to alternately produce sub-atmospheric pressure and super-atmospheric pressure, said device comprising a casing having a pair of spaced ports which are adapted to be in communication with each other cyclically when super-atmospheric pressure is admitted into one of said ports, and valve means for interconnecting said ports when super-atmospheric pressure is admitted into one of said ports, said valve means being operative to disconnect said ports from communication when sub-atmospheric pressure is applied to said one port, said casing having a fitting defining a fluid passage communicating with said one port, a pres-

sure communication tube disposed within said fitting and extending longitudinally of the latter through said casing to the other of said ports, said fitting having means for supporting said pressure communication tube therein whereby to provide for the simultaneous connection of said fitting and said pressure communication tube as a unit to different devices, respectively.

12. In combination with respirator pumping apparatus having pumping means to periodically supply air to and withdraw air from a port and a pressure indicating gage associated therewith, a positive pressure device adapted for fluid communication with said port, said device comprising a casing having a fitting defining a fluid passage, the latter being adapted for fluid communication with said port, a pressure communication tube disposed within said fitting and extending longitudinally of the latter, means for supporting said pressure communication tube in said fitting in a fixed relative disposition, and means providing for the automatic releasable interconnection of said pressure communication tube with said gage upon effecting the interconnection of said positive pressure device fitting with said pumping means.

13. In combination with respirator pumping apparatus having pumping means to periodically supply air to and withdraw air from a port, a conduit adapted for periodic fluid communication with said port, and a pressure indicating gage associated with said pumping means and positioned remote from said conduit, a positive pressure device connected to said conduit in fluid-flow relation with said port, said device having means for interconnecting said port and said conduit for fluid communication when said pumping means is operative to supply air to said port, said means being effective to disconnect said port and said conduit from fluid communication when said pumping means is operative to withdraw air from said port, said device having a pressure communication tube extending therein, one end of said tube being adapted for interconnection with said gage and the opposite end thereof terminating in a free end portion in the region of said conduit whereby said gage indicates the pressure in said region, and means providing for the automatic interconnection of the one end of said tube with said gage on the interconnection of said device with said pumping means.

14. In combination with respirator pumping apparatus having pumping means to periodically supply air to and withdraw air from a port, a conduit adapted for periodic fluid communication with said port, and a pressure indicating gage associated with said pumping means and positioned remote from said conduit, a positive pressure device connected to said conduit in fluid-flow relation with said port, said device having means for interconnecting said port and said conduit for fluid communication when said pumping means is operative to supply air to said port, said means being effective to disconnect said port and said conduit from fluid communication when said pumping means is operative to withdraw air from said port, said device having a pressure communication tube extending therein, one end of said tube being adapted for interconnection with said gage and the opposite end thereof terminating in a free end portion in the region of said conduit whereby said gage indicates the pressure in said region, and means providing for the automatic interconnection of the one end of said tube with said gage on the interconnection of said device with said pumping means, said last mentioned means including a coupling member having a pressure communication tube portion extending therein, one end of said tube portion being adapted for interconnection with said gage and the opposite end of said tube portion being adapted for interconnection with said one end of said tube on the interconnection of said coupling member with said device and said pumping means.

15. In combination with respirator pumping apparatus having pumping means to periodically supply air to and

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withdraw air from a port, a conduit adapted for periodic fluid communication with said port, and a pressure indicating gage associated with said pumping means and positioned remote from said conduit, a positive pressure device connected to said conduit in fluid flow relation with said port, said device having means for interconnecting said port and said conduit for fluid communication when said pumping means is operative to supply air to said port, said means being effective to disconnect said port and said conduit from fluid communication when said pumping means is operative to withdraw air from said port, said device having a pressure communication tube extending therein, one end of said tube being adapted for interconnection with said gage and the opposite end thereof terminating in a free end portion in the region of said conduit whereby said gage indicates the pressure in said region, a coupling member having a pressure communication tube portion extending therein, opposite ends of said tube portion being adapted for interconnection with said one end of said tube and said gage, respectively, on the interconnection of said coupling member with said device and said pumping means, and means providing for the automatic releasable interconnection of said opposite ends of said tube portion with said one end of said tube and said gage, respectively, on the interconnection of said coupling member with said device and said pumping means.

16. In respirator apparatus having pumping means adapted to periodically supply air to and withdraw air from a port, a conduit adapted for periodic fluid communication with said port, a casing for housing said pumping means having an instrument panel associated therewith, and a pressure indicating gage positioned on said panel, a positive pressure device connected to said conduit in fluid-flow relation with said port, said device having means for interconnecting said port and said conduit for fluid communication when said pumping means is operative to supply air to said port, said means being effective to disconnect said port and said conduit from fluid communication when said pumping means is operative to withdraw air from said port, said device having a pressure communication tube extending therein, one end of said tube being adapted for interconnection with said gage and the opposite end thereof terminating in a free end portion in the region of said conduit whereby said gage indicates the pressure in said region, a coupling member adapted to interconnect said device and said port in fluid-flow relation, said casing and said device having fittings formed complementary to said coupling member, said casing fitting being in fluid communication with said port, a tube portion in fluid-flow relation with said gage and terminating in a free end portion in the region of said casing fitting, a pressure communication tube portion extending in said coupling member, opposite ends of said tube portion being adapted for interconnection with said one end of said tube and said free end portion, respectively, on the interconnection of said coupling member with said casing and device fittings, and means providing for the automatic releasable interconnection of said opposite ends of said tube portion with said one end of said tube and said free end portion, respectively, on the interconnection of said coupling member with said casing and device fittings.

17. In respirator apparatus provided with a chamber within which the air pressure is rhythmically varied and which comprises a pump in fluid-flow communication with said chamber for rhythmically varying the air pressure in the latter, a coupling device connected between said pump and said chamber and providing the said fluid communication therebetween, a pressure communication tube positioned within said coupling device and extending longitudinally of the latter between the opposite ends thereof, said tube being completely disposed internally of the fluid flow passage between the pump and

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said chamber, a pressure indicating gage positioned in the vicinity of said pump, a releasable fitting completely disposed internally of said fluid flow passage and connecting said pressure tube to said gage internally of the fluid flow passage between the pump and said chamber for releasably connecting said pressure tube to said gage, a tube portion completely disposed internally of said fluid flow passage and terminating in a free end portion in the region of said chamber, and a releasable fitting completely disposed internally of said fluid flow passage and connecting said pressure tube to said tube portion internally of the fluid-flow passage between the pump and said chamber for releasably connecting said tube portion to said gage so that the pressure in the region of said free end portion may be indicated at a point remote therefrom.

18. In respirator apparatus provided with a chamber within which the air pressure is rhythmically varied and which comprises a pump in fluid-flow communication with said chamber for rhythmically varying the air pressure in the latter, a coupling device connected between said pump and said chamber and providing the said fluid communication therebetween, a pressure communication tube positioned within said coupling device and extending longitudinally of the latter between the opposite ends thereof, said tube being completely disposed internally of the fluid-flow passage between the pump and said chamber, a pressure indicating gage positioned in the vicinity of said pump, a releasable fitting completely disposed internally of said fluid-flow passage and connecting said pressure tube to said gage internally of the fluid-flow passage between the pump and said chamber for releasably connecting said pressure tube to said gage, a tube portion completely disposed internally of said fluid-flow passage and terminating in a free end portion in the region of said chamber, and a releasable fitting completely disposed internally of said fluid-flow passage and connecting said pressure tube to said tube portion internally of the fluid-flow passage between the pump and said chamber for releasably connecting said tube portion to said gage so that the pressure in the region of said free end portion may be indicated at a point remote therefrom, said coupling device comprising a length of flexible tubing terminating in fittings formed complementary to fittings associated with said pump and said chamber.

19. In respirator apparatus provided with a chamber within which the air pressure is rhythmically varied and which comprises a pump in fluid-flow communication with said chamber for rhythmically varying the air pressure in the latter, a coupling device connected between said pump and said chamber and providing the said fluid communication therebetween, a pressure communication tube positioned within said coupling device and extending longitudinally of the latter between the opposite ends thereof, said tube being completely disposed internally of the fluid flow passage between the pump and said chamber, a pressure indicating gage positioned in the vicinity of said pump, a releasable fitting completely disposed internally of said fluid-flow passage and connecting said pressure tube to said gage internally of the fluid-flow passage between the pump and said chamber for releasably connecting said pressure tube to said gage, a tube portion completely disposed internally of said fluid-flow passage and terminating in a free end portion in the region of said chamber, and a releasable fitting completely disposed internally of said fluid-flow passage and connecting said pressure tube to said tube portion internally of the fluid-flow passage between the pump and said chamber for releasably connecting said tube portion to said gage so that the pressure in the region of said free end portion may be indicated at a point remote therefrom, said pump and said chamber having fittings adapted for releasable interconnection with said coupling device, and the latter comprising a rigid

body part terminating in fittings formed complementary to said pump and chamber fittings.

20. In respirator apparatus provided with a chamber within which the air pressure is rhythmically varied and which comprises a pump in fluid-flow communication with said chamber for rhythmically varying the air pressure in the latter, a coupling device connected between said pump and said chamber and providing the said fluid communication therebetween, a pressure communication tube positioned within said coupling device and extending longitudinally of the latter between the opposite ends thereof, said tube being completely disposed internally of the fluid-flow passage between the pump and said chamber, a pressure indicating gage positioned in the vicinity of said pump, a releasable fitting completely disposed internally of said fluid-flow passage and connecting said pressure tube to said gage internally of the fluid-flow passage between the pump and said chamber for releasably connecting said pressure tube to said gage, a tube portion terminating in a free end portion in the region of said chamber, and a releasable fitting connecting said pressure tube to said tube portion internally of the fluid-flow passage between the pump and said chamber for releasably connecting said tube portion to said gage so that the pressure in the region of said free end portion may be indicated at a point remote therefrom, and means providing for the automatic releasable interconnection of said releasable fittings connecting said pressure communication tube to said gage and said tube portion on the interconnection of said coupling device with said pump and chamber, respectively.

21. In combination with an air pump cyclically operable to alternately produce sub-atmospheric pressure and super-atmospheric pressure at a port, and a conduit adapted for periodic fluid communication with said port, a positive pressure device interposed between said conduit and said port in fluid flow relation with the latter, said device comprising casing structure provided with valve means comprising spaced valve seats and a single valve engageable with and disengageable from said valve seats for interconnecting said port and said conduit for fluid communication when said pump is operative to produce super-atmospheric pressure at said port and to disconnect said port and said conduit from fluid communication when said pump is operative to produce sub-atmospheric pressure at said port, said casing structure having a passage communicating with the atmosphere, and means providing for fluid communication between said conduit and said passage when said pump is operative to produce sub-atmospheric pressure at said port.

22. A positive pressure device adapted for use with a cyclically operable air pump adapted to alternately produce sub-atmospheric pressure and super-atmospheric pressure, said device comprising a casing having a pair of spaced ports which are adapted to be in communication with each other cyclically when super-atmospheric pressure is admitted into one of said ports, first valve means within said casing for interconnecting said ports when super-atmospheric pressure is admitted into one of said ports, said valve means being operative to disconnect said ports from communication when sub-atmospheric pressure is applied to said one port, first vent means provided in said casing for fluid communication with the other of said ports, said first valve means being operative to disconnect said other port from communication with said first vent means when super-atmospheric pressure is admitted into said one port and to connect said other port for communication with said first vent means when sub-atmospheric pressure is applied to said one port, second valve means provided in said casing, and second vent means provided in said casing for fluid communication with said one port, said second valve means being operative to disconnect said one port from communication with said second vent means when super-

atmospheric pressure is admitted into said one port and to connect said one port for communication with said second vent means when sub-atmospheric pressure is applied to said one port.

23. A positive pressure device adapted for use with a cyclically operable air pump adapted to alternately produce sub-atmospheric pressure and super-atmospheric pressure, said device comprising a casing having a pair of spaced ports which are adapted to be in communication with each other cyclically when super-atmospheric pressure is admitted into one of said ports, first valve means within said casing for interconnecting said ports when super-atmospheric pressure is admitted into one of said ports, said valve means being operative to disconnect said ports from communication when sub-atmospheric pressure is applied to said one port, first vent means provided in said casing for fluid communication with the other of said ports, said first valve means being operative to disconnect said other port from communication with said first vent means when super-atmospheric pressure is admitted into said one port and to connect said other port for communication with said first vent means when sub-atmospheric pressure is applied to said one port, second valve means provided in said casing, and second vent means provided in said casing for fluid communication with said one port, said second valve means being operative to disconnect said one port from communication with said second vent means when super-atmospheric pressure is admitted into said one port and to connect said one port for communication with said second vent means when sub-atmospheric pressure is applied to said one port, third valve means provided in said casing, and third vent means provided in said casing for fluid communication with said other port, said third valve means being operative to disconnect said other port from communication with said third vent means and to connect said other port for communication with said third vent means when a predetermined super-atmospheric pressure is applied to said other port.

24. A positive pressure device adapted for use with a cyclically operable air pump adapted to alternately produce sub-atmospheric pressure and super-atmospheric pressure, said device comprising a casing having a pair of spaced ports which are adapted to be in communication with each other cyclically when super-atmospheric pressure is admitted into one of said ports, first valve means within said casing for interconnecting said ports when super-atmospheric pressure is admitted into one of said ports, said valve means being operative to disconnect said ports from communication when sub-atmospheric pressure is applied to said one port, first vent means provided in said casing for fluid communication with the other of said ports, said first valve means being operative to disconnect said other port from communication with said first vent means when super-atmospheric pressure is applied to said one port, second valve means provided in said casing, and second vent means provided in said casing for fluid communication with said one port, said second valve means being operative to disconnect said one port from communication with said second vent means when super-atmospheric pressure is admitted into said one port and to connect said one port for communication with said second vent means when sub-atmospheric pressure is applied to said one port, third valve means provided in said casing, and third vent means provided in said casing for fluid communication with said other port, said third valve means being operative to disconnect said other port from communication with said third vent means and to connect said other port for communication with said third vent means when a predetermined super-atmospheric pressure is applied to said other port, said first valve means being

disposed intermediate said second and said third valve means.

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