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DEMAND VALVE

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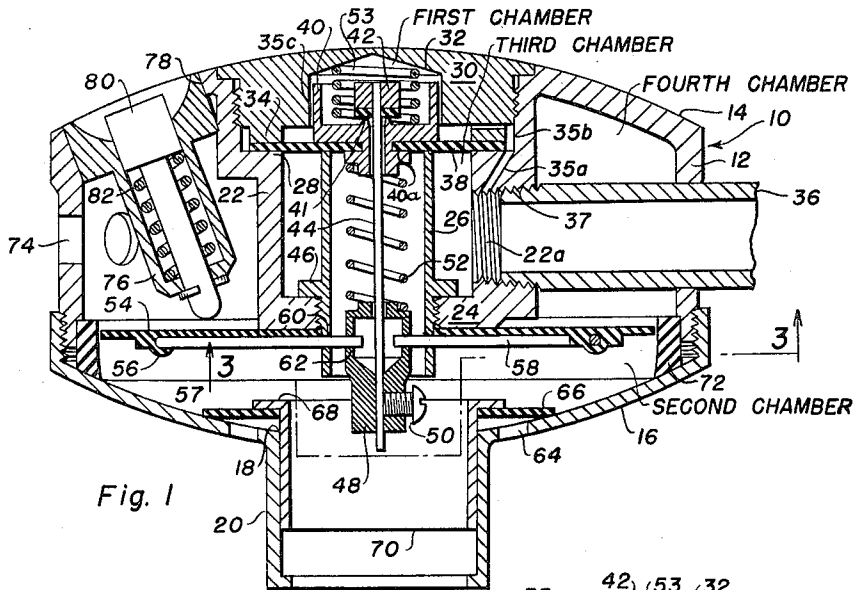


Fig. 1

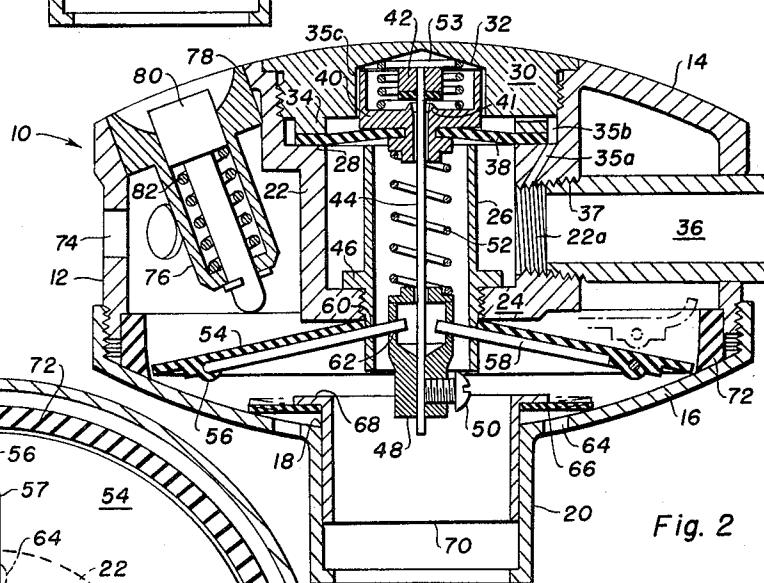


Fig. 2

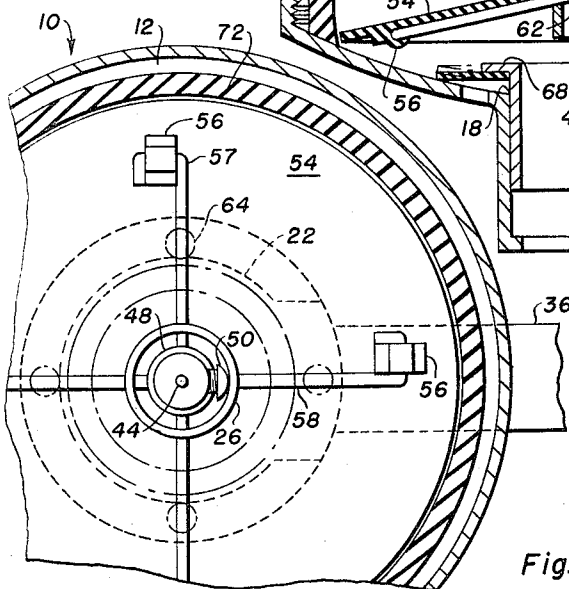


Fig. 3

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1

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DEMAND VALVE

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7 Claims. (Cl. 137—64)

This invention relates to valve structure having a wide variety of applications. One application of it is as a demand valve for controlling the supply of a gas, such for example as oxygen, to a patient, as part of inhalator apparatus for use in connection with resuscitating a person suffering from partial asphyxiation resulting from shock, drowning, smoke, or other causes including heart attack.

An object of the invention is to provide such a structure in a compact, light weight unit which can be operated with very low inhalation and exhalation force exerted by the patient.

Another object of the invention is to provide such a device which is simple in structure and dependable in operation.

Other objects of the invention will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, arrangements of parts, and in the several steps and relation and order of each of said steps to one or more of the others thereof, all as will be pointed out in the following description, and the scope of the application of which will be indicated in the following claims.

The invention will best be understood if the following description is read in connection with the drawings, in which,

Figure 1 is a vertical section of an embodiment of the invention.

Figure 2 is a view similar to Figure 1 showing the valve in flow position; and

Figure 3 is a view taken on the line 3—3 of Figure 1.

The embodiment of the invention shown and described herein comprises the housing 10 comprising the circular outer wall 12 joining the outer periphery of an annular top wall 14 to a dish-shaped bottom wall 16, having a central opening or port 18 surrounded by an outwardly extending flange or nipple 20. The free end of a conduit (not shown) leading to a face mask, not shown, of any well known kind used for covering a patient's mouth and nose, may be slipped over or otherwise connected to said flange 20, the inhalation or exhalation force exerted by the patient being communicated through said conduit to said port 18, and alternately causing gas to be supplied through said port to said conduit and said patient and causing gases exhaled by the patient to pass to and through port 18 into said housing and to be exhausted therefrom as will be described.

Projecting inwardly around the inner periphery of said annular top wall 14 is a circular wall 22 extending first downwardly part way to said bottom wall 16 and then inwardly defining a circular well partially closed on the bottom. Through the opening in said bottom portion 24 of wall 22 extends a tubular member 26. Said wall 22 is stepped outwardly near its top defining an annular shoulder 28. The wall 22 above shoulder 28 is internally threaded to receive the screw cap 30 the inner face of which has a centrally disposed concavity 32. Screw cap

2

30 has a skirt 34 through which extends a port 35c which communicates between said concavity 32 and a supply line 36 through passage 35a in wall 22 and a space 35b left unfilled by said screw cap and surrounding skirt 34.

The gas supply line 36 has an exteriorly threaded end 37 which is screwed into the interiorly threaded port 22a in the circular wall 22 and registers with the lower end of passage 35a. Some gas flows from supply line 36 into and through the grooves of the threaded end portion 37 and thus into passage 35a which acts as a bleed line supplying a little gas under pressure into the space above the flexible diaphragm 38.

Resting on shoulder 28 is the flexible diaphragm or flap valve 38 which is retained in place by the clamping action of screw cap 30 acting on the outer periphery of said diaphragm. The space above diaphragm 38 is a first or pilot valve chamber. Diaphragm 38 centrally carries an annular member 40 which serves as the movable part of the main valve, and has projecting upwardly around its central bore a flange 41 which constitutes the seat of pilot valve 42 the stem 44 of which projects downwardly through the central bore in said member 40 and axially through the vertically disposed tubular member 26, which, as stated above, extends through the bottom portion 24 of wall 22. Member 40 is a cup shaped member which has a downwardly extending flange portion with the peripheral groove 40a to receive the inner margin of diaphragm 38. Member 26 has around its outer surface a circular flange 46 which overlaps and rests on the bottom portion 24 of said wall 22, and the outer surface of member 26 and the surrounding face of the bottom portion 24 of wall 22 are threadedly engaged.

Mounted on and around the lower end of stem 44 is a yoke member 48, secured on said stem as for example by the lock screw 50. Preferably but not necessarily a spring 52 is provided around stem 44, between yoke 48 and the lower end of member 40, biasing member 40 upwardly, and a spring 53 is provided within concavity 32 between member 40 and the top of said concavity, biasing member 40 downwardly.

Surrounding member 26 near its lower end is the flexible partition member 54 having disposed in a circle on its under surface adjacent its periphery a number of lugs 56, the horizontally extending bores of which receive and retain the hooked ends 57 of a number of J-shaped levers 58 which extend through, and are pivoted in, openings 60 in the wall of member 26. The inner ends of said levers extend through openings 62 into the hollow interior of yoke 48.

The levers 58 clamp the inner margin of partition member 54 against the bottom portion 24 of said wall 22, and serve to raise and lower valve stem 44 in accordance with movements of said member 54.

In bottom wall 16 of the housing, disposed at intervals in a circle around port flange 20, is a series of ports 64 which are normally covered by a flap valve 66 a part of which is free and can lift from said ports. The flap valve is retained in place by the flange 68 which extends outwardly from a sleeve 70 press fitted into the space or nipple defined by flange 20.

Within the lower part of the housing and communicating with the port 18 is a second or operating chamber, defined on top by partition member 54 and on the bottom by the dish-shaped bottom wall 16, and laterally by the ring 72 projecting upwardly from said bottom wall 16 just beyond the outer periphery of said member 54. When a suction force is exerted on said second chamber through port 18 the outer marginal portion of member 54 is drawn downwardly thus pivoting levers 58 and causing their inner ends to move upwardly and carry upwardly yoke 48 and valve stem 44, thus raising pilot valve 42 from its seat 41 and permitting gas entering through inlet

3

port 22a to pass through duct 35a into the space, above flap or diaphragm 38 constituting said first chamber, and from there through the central passage in member 40 around valve stem 44, and down through tubular member 26 and through port 18, from which it may be supplied, as for example, to the face mask of a patient being resuscitated.

The raising of pilot valve 42 and the resultant lessening of pressure within said first chamber permits member 40 and the flap or diaphragm 38 to move upwardly, this action being aided by spring 52 if one is employed, thus separating the member 38 from its seat on the top of member 26 and allowing gas to be supplied from supply line 36 and port 22a directly into the space between wall 22 and tubular member 26 and beneath flap or diaphragm 38, constituting a third chamber, and to flow freely from said third chamber into, and down through, member 26, and through said second or operating chamber and out of the housing through port 18.

The space above partition member 54 between the inner circular wall 22 and the outer circular wall 12 of the housing comprises a fourth chamber, and extending through wall 12 are a number of ports 74 which serve as discharge ports, as for example during exhalation of a patient being resuscitated, as will be explained.

In operation, when a demand is put upon the valve the pressure in the second or operating chamber drops and draws the partition 54 down into the chamber thereby causing the levers 58 to pivot in the openings 60 in the wall of tubular member 26 moving their inner ends upwardly and thus moving the pilot valve yoke 48 toward the first chamber, comprising concavity 32 in screw cap 30 and containing the pilot valve 42, and raising the pilot valve from its seat 41, and compressing both springs 52 and 53 if they are employed. When the pilot valve opens it creates a limited flow of gas through said first chamber and conduit 35a—35c from said gas supply source 36, and through the central bore in member 40, and thereby reduces pressure above the flap or diaphragm 38 causing the said member 38 to move off its seat on top of member 26, such action being aided by the force of the spring 52 if said spring is employed. This movement of member 38, which comprises the main valve, allows a full flow of gas from the source of supply through port 22a to supply the demand exerted through port 18. Should the demand exceed the maximum supply flow from supply line 36 the difference between the atmospheric pressure surrounding the valve and the pressure in the operating chamber will raise the flap valve 66 from the inner surface of wall 16 and permit air to enter the said operating chamber through the ports 64, to satisfy the demand.

The above description relates to the operation of the device as part of an inhalator assembly during inhalation, while negative pressure is exerted through port 18. When the user exhales the exhalation gases will flow into said operating chamber through port 18 forcing the partition member 54 upwardly in a direction away from port 18 and this movement of the member 54 causes the levers 58 to be pivoted so that their inner ends move downwardly, in a direction away from said first chamber, moving yoke 48 and valve stem 44 in a direction to cause closing of the pilot valve 42 and main valve i.e. diaphragm 38, and simultaneously the outer margin of member 54 moves above the surrounding ring 72 which forms the side wall of said operating chamber thus allowing the exhalation gases to escape from said second or operating chamber into said fourth chamber and thence to the atmosphere through ports 74.

An arrangement for manual operation of the valve is illustrated in Figures 1 and 2 comprising the sleeve 76, extending into the housing through an opening 78 in the annular top wall 14 of the housing, and a plunger 80 projecting through the inner end of said sleeve with

4

its inner end in close proximity to partition member 54 and preferably directly over one of the levers 58. Plunger 80 is biased by spring 82 in a direction away from said member 54, but upon depressing plunger 80 one of the levers 58 is pivoted in a direction to open the pilot valve and main valve thus causing a supply of gas to be provided for inhalation, and when said plunger is released it is returned by force of spring 82 to its normal position out of contact with member 54, permitting closing of the pilot and main valves and conditioning the device for exhaust of exhalation gases as described above.

It will thus be seen that there has been provided by this invention an apparatus in which the various objects hereinabove set forth together with many thoroughly practical advantages are successfully achieved. As various possible embodiments might be made of the mechanical features of the above invention and as the art herein described might be varied in various parts, all without departing from the scope of the invention, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawing is to be interpreted as illustrative and not in a limiting sense.

What I claim is:

1. A device for controlling the supply of gas from a supply source under constant pressure, to satisfy an intermittent demand, which comprises a housing having therein, a first chamber, a second chamber having a port, a conduit between said first and second chambers and continuously in communication with said second chamber, a third chamber at least partly surrounding said conduit, and a fourth chamber at least partly surrounding said third chamber and separated from it by a common wall, aligned ports in the outer and inner walls of the fourth chamber to receive a gas supply line with its end communicating with the third chamber, a flexible member separating the first chamber from the conduit and the third chamber and extending over an end of the conduit and preventing direct communication between said third chamber and the conduit when seated against the end of said conduit, means securing said flexible member around its outer periphery leaving its center portion free to move toward or away from the end of said conduit, and a bleed line communicating between the third and first chambers, said flexible member having a small passage extending through it and communicating between said first chamber and said conduit, a pilot valve in said first chamber for opening and closing said small passage, and port means in the wall of said fourth chamber communicating with atmosphere, said second chamber having a wall portion movable in response to pressure changes within said second chamber, and link means interconnecting said pilot valve and the movable wall portion of said second chamber, the periphery of said wall portion acting in conjunction with the housing wall to provide a variable area passage leading to said fourth chamber.

2. A device of the kind described comprising, a housing defining a chamber and comprising a movable wall portion, a fixed bottom wall portion with a first port therein through which positive and negative pressures may be exerted, a fixed side wall projecting upwardly around the movable wall portion, said housing also defining a first space adjoining said chamber on the opposite side of said movable wall portion from said first port, said movable wall portion being movable from a position, in which it co-acts with the fixed side wall to provide a seal around its periphery, to a position providing a passage communicating with said first space through which gases entering into the chamber through said first port may be exhausted from said chamber, a port in the housing through which gases may be exhausted from said first space, a reservoir of gas under pressure, a conduit for interconnecting said reservoir and said chamber, a flexible diaphragm member extending over an end of the conduit and over an end of the reservoir, and means controlled by movement of said movable wall portion for

5

flexing said flexible diaphragm member to open and close communication between said reservoir and said conduit.

3. The device claimed in claim 2 in which said means controlled by movement of said movable wall includes a second space on the opposite side of said flexible diaphragm member from said reservoir and said conduit, and means for reducing the pressure in said second space in response to movement of said movable wall portion in one direction, to flex the flexible member and open communication on between said reservoir and said conduit.

4. The device in claim 2 in which said reservoir and conduit are disposed side by side and are separated by a fixed wall, and said flexible diaphragm member extends over said fixed wall and has a portion serving as an end wall for said reservoir and another portion serving as an end wall for said conduit.

5. The device claimed in claim 2 in which said means controlled by movement of said movable wall portion includes, a second space on the opposite side of said flexible diaphragm member from said reservoir and said conduit, a bleed line between said reservoir and said second space, a small passage extending through said flexible member between said second space and said conduit, a pilot valve within said second space for opening and closing said small passage, and a link interconnecting said pilot valve to said movable wall portion.

6. The device claimed in claim 2 in which said means controlled by movement of said movable wall portion includes, a second space on the opposite side of said flexible diaphragm member from said reservoir and said conduit, a bleed line between said reservoir and said second space, a small passage between said second space and said conduit, a pilot valve within said second space

6

for opening and closing said small passage, and a link connecting the movable wall to the pilot valve, spring means in said second space tending to hold the flexible member against the end of said conduit, and spring means tending to move said flexible diaphragm member away from the end of said conduit.

7. The device claimed in claim 2 in which said means controlled by movement of said movable wall portion includes a second space in the housing on the opposite side of said flexible member from said reservoir and said conduit, a bleed line interconnecting the reservoir and said second space, a small passage connecting said second space and said conduit, and a pilot valve within said second space for opening and closing said small passage, a stem secured at one end to the pilot valve and having at its other end a yoke, and a number of arms supporting the movable wall portion, said arms being fulcrumed in said yoke and projecting radially from the yoke.

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