

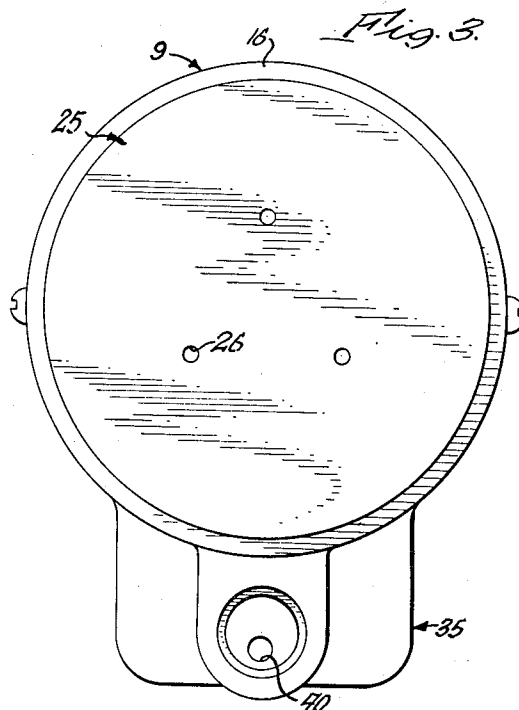
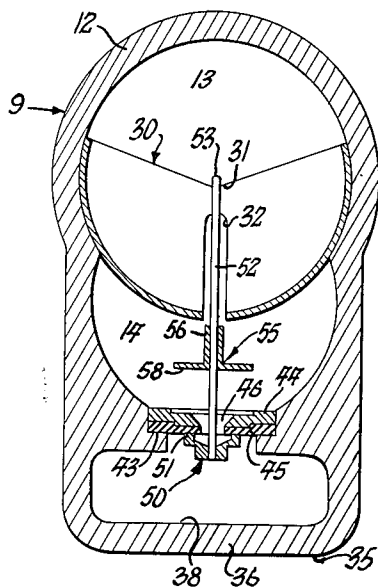
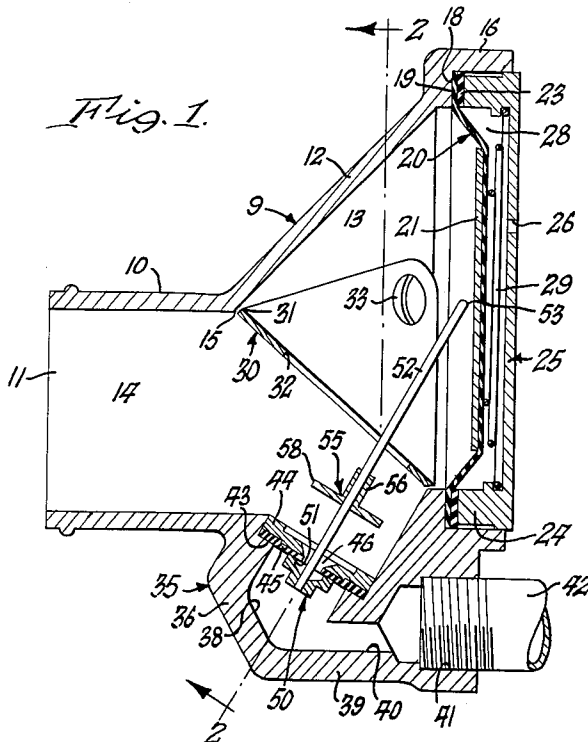
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CONTROL DEVICE FOR BREATHING APPARATUS

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CONTROL DEVICE FOR BREATHING APPARATUS

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5 Claims. (Cl. 128—142)

This invention relates to a regulator mounted on a mask to control the supply of gas thereto and is more particularly shown as embodied in a regulator responsive to the demand and mounted in a mask to control the supply of air or oxygen to the mask.

This application is a continuation in part of my copending application for Demand Valve, filed October 9, 1952, Serial No. 313,866.

One of the principal objects of the present invention is to provide such a regulator which is highly sensitive and is useful against high pressures of air or oxygen and is operated by relatively slight pressure variations such as those caused by the inhalation of the wearer of the mask.

Another object is to provide such a regulator which is very compact and can be readily installed in the mask to control a high pressure air or oxygen line leading to the mask. By carrying a high pressure line directly to the mask, it is unnecessary to use pressure reducing valves; a smaller and less clumsy line can be brought to the mask to facilitate its application and removal; there is a reduced pressure drop between the regulator and the demand zone thereby to increase the sensitivity of the regulator; and there is no danger of contamination of the air or oxygen supply through leakage since under high pressure the leakage would always be to the exterior to expel contaminants.

Another object is to provide such a regulator responsive to demand in which the pressure responsive member, in this case a diaphragm, is effectively isolated from the stream of air or oxygen supplied to the mask and is essentially responsive only to the demand created by the inhalation of the wearer.

Another object is to provide such a regulator which includes a demand valve that is partially self-energizing so that once opened it tends to keep itself open. By such characteristics a mask equipped with the regulator is less tiring since while a certain amount of inhalation energy is required to open the demand valve, much less energy is required to hold the demand valve open so that little effort is required by the wearer of the mask for the greater part of each inhalation.

Another object is to provide such a regulator which includes a demand valve that is partially self-energizing on closing so as to avoid the necessity for a closing spring or to permit of reducing the strength of such a spring. By eliminating or reducing the strength of such a closing spring less inhalation energy is required to open the demand valve since opening of the valve is not against a high spring loading.

Another object is to provide such a regulator which is simple and reliable in construction and operation so as to always be operative without danger of leakage of the high pressure air or oxygen.

Another object is to provide such a regulator which does not have critical tolerances or fits.

Another object is to provide such a regulator in which the pressure drop is so regulated that when the demand valve is once opened it works against a pressure inter-

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mediate that of the supply and demand so that less effort is required to sustain the open condition of the valve.

Other objects and advantages of the invention will be apparent from the following description and drawings in which:

Fig. 1 is a longitudinal section through a mask regulator embodying the present invention.

Fig. 2 is a transverse sectional view taken on line 2—2, Fig. 1.

Fig. 3 is an elevational view taken from the right of Fig. 1.

The regulator forming the subject of the present invention can be used in conjunction with a full face mask, a half mask or an oral or nasal type of mask and is shown as having a metal body 9 cast to provide a generally cylindrical neck 10 having an open end 11 and which open end is adapted to be attached to and communicate with the interior of the mask. The body is also formed to provide a wedge-shaped, preferably conical enlargement 12, the axis of which is eccentric to but shown as parallel with the axis of the neck 10. The conical enlargement 12 provides a wedge-shaped chamber 13 which is preferably conical as shown and enlarges in a direction opposite from the open end 11 of the neck 10. The neck 10 provides a cylindrical chamber 14 which is in communication with the interior of the mask and this chamber is in communication with the chamber 13, through an opening 15 the shape of which is determined by the intersection of the cylindrical and conical forms of the chambers 14 and 13, respectively, but which extends along a plane intersecting the axes of these two chambers.

The enlarged end of the wedge-shaped or conical chamber 13 is formed to provide a mouth having an outwardly projecting cylindrical rim 16 which is formed to provide an internal axially outwardly facing shoulder 18. Against this axially facing shoulder is fitted the rim 19 of a circular rubber diaphragm 20. On its central part a circular metal plate 21 is secured to the face of the rubber diaphragm 20 which faces the conical chamber 13. The rim 19 of the rubber diaphragm is backed by a rubber ring 23 and this rubber ring is in turn backed by the thickened rim 24 of a cap 25. The transverse wall of this cap 25 can be provided with vent openings 26 so that the ambient pressure obtains in the chamber 28 between the cap 25 and the rubber diaphragm 20. A spiral compression spring 29 can be arranged in this chamber 28 and compressively interposed between the cap 25 and rubber diaphragm 20. This spring is only required if the pressure inside the mask and in the chamber 14 is to be maintained slightly higher than ambient. If the pressure in the mask is to be maintained slightly lower than ambient, no such spring 29 is required. It will be seen that the presence of this spring, however, provides a safety factor in that by its maintaining a slightly higher than ambient pressure in the mask any leakage is out from the mask and not into the mask.

A feature of the invention resides in the provision of a removably fitted baffle or wall 30 to segregate the chambers 13 and 14. This baffle or wall is in the form of a segment or section of a wedge or cone with its pointed end 31 arranged to fit the pointed end of the wedge-shaped or conical chamber 13 and with its body part fitting the internal conical walls of this conical chamber 13 so as to bridge the opening 15 between the chambers 13 and 14. This baffle or wall 30 is provided with an elongated slot 32 which is in the plane of the axes of the chambers 13 and 14 as well as the wall or baffle 30 and hence perpendicular to the rubber diaphragm 20. The baffle or wall 30 can be held in position by a pair of diametrically opposite screws 33.

The body 9 is provided on its side diametrically opposite the wedge shaped or conical enlargement 12 with a

boss 35 which is formed to provide an angular neck 36 having a bore 38 which opens into the demand chamber 14 and the axis of which is directed through the slot 32 toward the center of the diaphragm 20. The boss 35 is also formed to provide portion 39 which is shown as extending parallel with the axes of the chambers 13 and 14 and which is internally provided with a restricted orifice 40 communicating with the chamber 38. In line with this orifice 40 the boss 35 is shown as provided with a threaded bore 41 which communicates with the orifice and into which is screwed the high pressure air inlet pipe or line 42.

The bore 38 is enlarged at its end near the demand chamber 14 to provide an annular shoulder 43 facing the demand chamber. A metal valve seat disk 44 having a rubber facing 45 is press fitted against this annular shoulder 43 with the rubber facing 45 against the seat 43 so that it faces the interior of the bore 38 and away from the demand chamber 14. The valve seat disk 44 and its rubber facing 45 are provided with a central through opening 46. Preferably this opening 46 in the valve seat disk 44 is of conical form enlarging and with its axis directed toward the center of the diaphragm 20.

The valve head is in the form of a cup 50 with an axially extending rim 51 seated on the rubber facing 43 around the orifice 46. In this cup-shaped valve head 50 is anchored one end of a valve stem or rod 52 which projects through the opening 46 of the rubber facing 45 and valve seat disk 44 and also through the slot 32 in the baffle or wall 30 so that it extends into the chamber 13 as well as through the chamber 14. This valve stem or rod has a rounded end 53 arranged in close proximity to the center of the metal disk 21 mounted on the diaphragm 20.

Fast to this rod, within the chamber 14, is arranged a baffle or vane member 55. This baffle or vane member 55 is shown as having a tubular neck 56 press fitted around the rod 52 and the effective surface 58 of this vane or baffle, that is, the face opposing the valve seat disk 44, is shown as being flat and arranged perpendicularly to the valve stem or rod 52.

In the operation of the regulator as above described, the high pressure of the gas supplied from the line 42 through the restricted orifice 40 to the bore or chamber 38 within the angularly extending portion 36 of the boss 35 presses against the cup-shaped valve head 50 and holds its bead or rim 51 firmly against the rubber facing 45 of the valve seat disk 44. Accordingly this valve head 50 is held perpendicularly to the valve seat disk 44 and the valve stem or rod 52 is likewise held in a position perpendicular to this valve seat disk. In this position the rounded end 53 of this valve stem or rod is held in closely spaced relation to the center of the metal plate 21 on the diaphragm 20 on the side of this diaphragm facing the demand chamber 14.

When the user of the mask inhales, the pressure in the mask is reduced and accordingly the pressure in this demand chamber 14 is reduced. Since the slot 32 in the conical wall or baffle 30 establishes communication between the chambers 14 and 13, the pressure in the chamber 13 is likewise reduced.

Accordingly the diaphragm 20 is moved to the left as viewed in Fig. 1 to contact and move the free end 53 of the valve stem 52 laterally to the left. This tips the cup-shaped valve head 50 laterally and hence separates one side of the bead 51 of this valve head from the rubber facing 45 and permits the high pressure gas to escape through the orifice or valve opening 46 into the demand chamber 14.

In so flowing into the chamber 14, the high pressure gas strikes the baffle or vane 55. Since this vane is now tipped with reference to the axis of the valve orifice 46, the flow of the gas tends to tip this vane further and hence to drive the valve head 50 toward a further tipped and further opened position. Thus, the impact

of the gas flow from the open valve is greater on the right hand side of the baffle or vane 55, as viewed in Fig. 1, than on the left hand side thereof and hence the kinetic force of the gas stream tends to tip the valve stem 52 further to the left and to open the valve head 50 further. Of course, this kinetic force of the gas stream against the vane or baffle 55 is not sufficient to take control of the demand valve away from the diaphragm 20 but it reduces the force of this diaphragm required to hold the valve open. Since the force of the diaphragm 20 is a function of the reduced pressure in the chambers 13 and 14, it is apparent that, once the valve is opened, less negative pressure is required in the chambers 14 and 13 to hold the valve open. Since this negative pressure, in an air or oxygen mask, is provided by the inhalation of the user, it will be seen that while a certain inhalation effort is required to open the demand valve, less inhalation effort is required to hold the valve open and to complete the inhalation. Accordingly it will be seen that the vane or baffle 55 renders the demand valve partially self energizing to a degree which reduces the total inhalation effort. By actual experience this inhalation effort is reduced a very substantial degree.

It has been found that the part of the chamber 14 surrounding the vane 55 must be large enough to permit the ready escape of the gas stream impinging against this vane.

The restricted orifice 40 also acts, along with the vane 55, to reduce the inhalation effort required to keep the valve head 50 open during an inhalation. Thus, with this valve head 50 closed, the pressure in the bore or chamber 38 is, of course, the same as the line pressure in the supply line 42. When the valve is opened, however, and gas starts to flow, there is a pressure drop across the restricted orifice 40 which provides a reduced pressure in the bore or chamber 38 as compared to the pressure in the supply line 42. It is the pressure in the bore or chamber 38 which acts against the convex side of the valve head 50 and tends to close it. Since the restricted orifice 40, when the valve is open, reduces this pressure as compared with line pressure, it will be seen that this restricted orifice decreases the amount of inhalation effort required to hold the valve open and hence augments the effect of the vane 55 in this regard.

The stream of air passing the vane 55 in the chamber 14 is effectively isolated from the chamber 13. This isolation is achieved by the conical wall or baffle 30 which closes the opening 15 between these chambers. While this wall or baffle 30 has the slot 32 to permit the necessary movement of the valve stem or rod 52, this slot is not large enough to permit the incoming gas passing through the chamber 14 to influence the diaphragm 20. Accordingly this diaphragm is essentially rendered responsive only to negative pressures created by inhalation.

After the inhalation is complete, the pressure in the chambers 14, 13 rises, through the admission of high pressure gas past the demand valve, to the value of the pressure against the side of the diaphragm 20 remote from the chamber 13. If the spring 29 is used this would be slightly higher than ambient, depending on the strength of the spring. Accordingly this diaphragm moves to the right as viewed in Fig. 1 to its normal position. This moves its metal plate 21 out of contact with the free end 53 of the valve stem 52 and permits the valve parts to assume a closed position.

The closing of the valve, when its parts are so released, is essentially a function of the static pressure of the high pressure air in the chamber 38 against the convex side of the valve head 50. This static pressure exceeds the kinetic force of the gas stream striking the vane or baffle 42 and hence is effective in closing the valve. This closing force can be augmented by a return spring as shown in my said copending application

but such a spring is not essential to the operation of the valve.

From the foregoing it will be seen that the present invention provides a simple and sensitive regulator for mounting on masks which is adopted for use with a high pressure line to the mask and which requires less inhalation effort to operate due to the partial self-energizing characteristics on both opening and closing of the demand valve of the regulator. The regulator is also compact to permit of its being incorporated directly in a mask.

I claim:

1. A mask regulator for supplying gas in response to the inhalation demand of the wearer, comprising a body having a first chamber in direct and open communication with the interior of the mask, a second chamber connected to said first chamber by an opening of reduced size as compared with either of said chambers and formed in the casing wall jointly providing said chambers, a diaphragm forming that wall of said second chamber opposite said opening and exposed to ambient pressures on the side thereof remote from said second chamber, a baffle member arranged across and blocking said opening connecting said chambers and having an aperture to permit equalization of gas pressures in said chambers but isolating said diaphragm from a stream of gas passing through said first chamber, a demand valve arranged to admit gas to said first chamber and including an operating member housed in said first and second chambers and extending through said aperture and arranged to be operated by said diaphragm, and means arranged to supply gas under pressure to said demand valve.

2. A mask regulator for supplying gas in response to the inhalation demand of the wearer, comprising a body having an opening at one end providing direct and open communication between the interior of the mask and a first chamber arranged at said one end of said body, a second chamber of wedge-shaped form at the opposite end of said body, said wedge-shaped chamber enlarging to provide a mouth opening exteriorly of said body and said wedge-shaped chamber being connected to said first chamber by an opening formed in the casing wall jointly providing said chambers and extending along the axis of said wedge-shaped chamber, a diaphragm across said mouth and exposed on its exterior face to ambient pressures, a baffle member arranged across and blocking said opening connecting said chambers and having an elongated aperture extending along a plane generally parallel with said axis of said wedge-shaped chamber, said elongated aperture permitting equalization of gas pressures in said chambers but isolating said diaphragm from a stream of gas passing through said first chamber, a demand valve mounted in a wall of said first chamber and including an operating member housed in said first and second chambers and extending through said elongated aperture and arranged to be moved by said diaphragm along said plane to open said demand valve, and means arranged to supply gas under pressure to said valve.

3. A mask regulator for supplying gas in response to the inhalation demand of the wearer, comprising a body having an opening at one end providing direct and open communication between the interior of the mask and a first chamber arranged at said one end of said body, a second chamber of wedge-shaped form at the opposite end of said body, said wedge-shaped chamber enlarging to provide a mouth opening exteriorly of said body, a diaphragm across said mouth and exposed on its exterior face to ambient pressures, said chambers being connected with each other through a common opening, a wedge-shaped baffle member removably fitted

in said wedge-shaped chamber and arranged to block said common opening, said wedge-shaped wall member having an elongated aperture extending along a plane generally perpendicular to and intersecting a central part of said diaphragm, said elongated aperture permitting equalization of the gas pressures in said chambers but isolating said diaphragm from a stream of gas passing through said first chamber, a demand valve mounted in a wall of said first chamber and including an operating member housed in said first and second chambers and arranged to be moved by said diaphragm along said aperture to open said demand valve, and means arranged to supply gas under pressure to said valve.

4. A mask regulator for supplying gas in response to the inhalation demand of the wearer, comprising a body formed with a generally cylindrical chamber open at one end to provide direct and open communication between said chamber and the interior of the mask, said body being formed to provide a wedge-shaped chamber with its axis in offset relation to the axis of said cylindrical chamber and with its interior wall converging toward said open end of said cylindrical chamber and enlarging toward a mouth and said wedge-shaped chamber being connected to said first chamber by an opening formed in the casing wall jointly providing said chambers and extending along the axis of said wedge-shaped chamber, a diaphragm over said mouth and exposed on its outer side to ambient pressure, a wedge-shaped baffle member removably fitted in said wedge-shaped chamber and arranged across and blocking said opening and having a slot arranged in a plane perpendicular to said diaphragm, a demand valve in the wall of said cylindrical chamber in line with said slot and diaphragm and including an operating member extending through said cylindrical chamber, slot and wedge-shaped chamber and arranged to be operated by said diaphragm, and means arranged to supply gas under pressure to said valve.

5. A mask regulator for supplying gas in response to the inhalation demand of the wearer, comprising a body having a first chamber provided at one end with an inlet and at its other end with an outlet in direct and opened communication with the interior of the mask, said body being provided with a second chamber arranged in offset relation to said first chamber opposite said inlet, and said body being provided with an opening formed in the wall jointly providing said chambers and said opening connecting said chambers, a diaphragm providing a wall of said second chamber opposite said opening and exposed on its outer face to ambient pressures, a baffle member arranged across and blocking said opening connecting said chamber and having an elongated aperture extending along a plane intersecting said chambers, a valve head engaging said valve seat and tiltable to permit gas to flow through said inlet, a valve stem fast at one end to said valve head and projecting through said inlet, first chamber elongated aperture and second chamber with its free end in position to be engaged and moved by said diaphragm, means arranged to apply gas under pressure to said valve seat and valve head, and vane arranged in said first chamber fast to said valve stem and arranged in the path of the gas escaping from said inlet so that the impact of said escaping gas tends to maintain said valve stem in its tilted position.

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