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PASSENGER MASK ASSEMBLY

Filed June 15, 1959

Fig. 1.

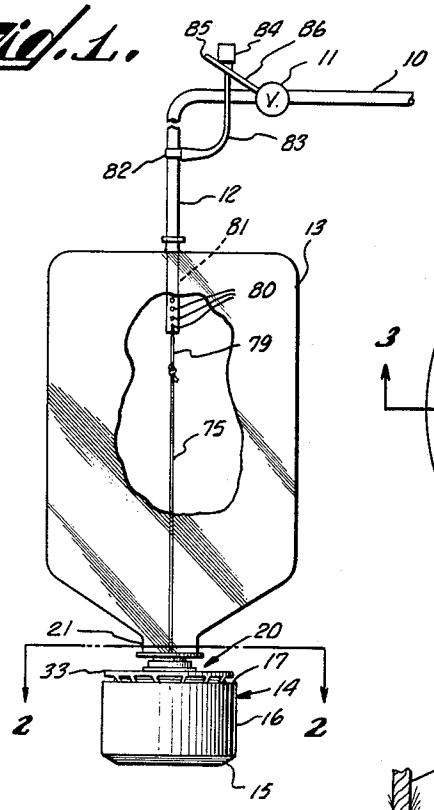


Fig. 2.

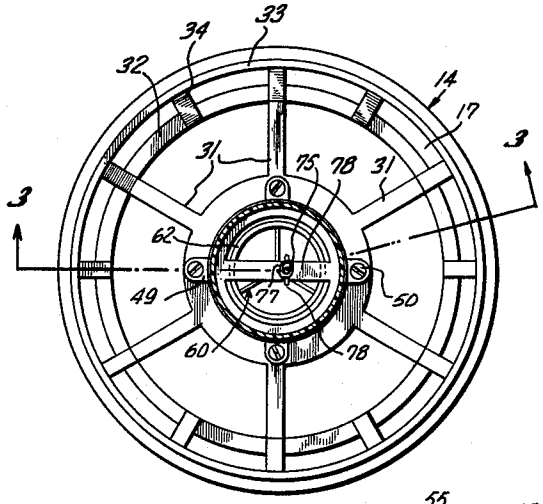
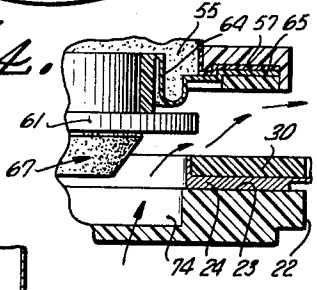


Fig. 4.



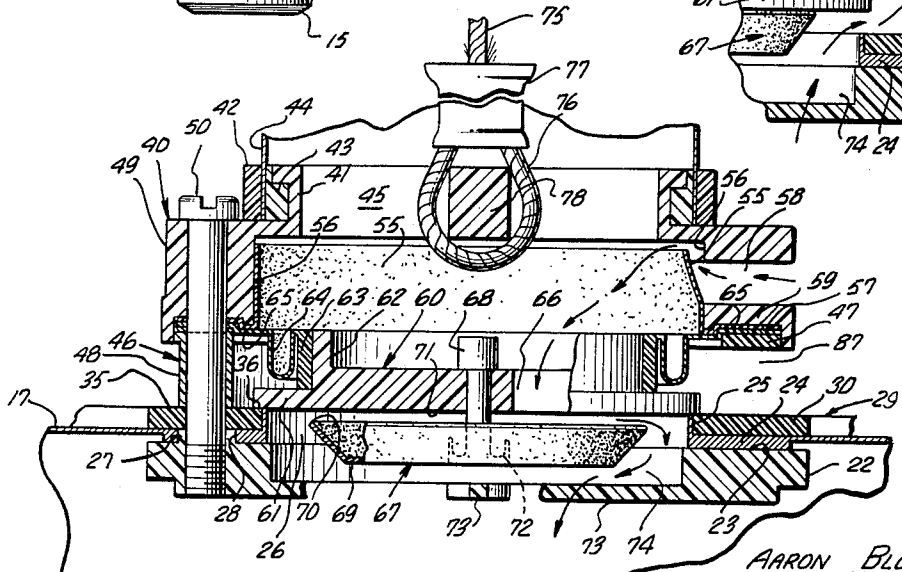


Fig. 3.

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PASSENGER MASK ASSEMBLY

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The invention relates to breathing equipment and has special reference to an exceptionally light-weight breathing mask containing a mechanism such that it is capable of diluting a supplemental oxygen supply with ambient air and passing it to the subject by use of an extremely light-weight piece of equipment which is comfortable to wear and which is so light in weight that there is no appreciable weight penalty in connection with its use.

When the need arises for oxygen at high altitudes, the first need is for a relatively high concentration of oxygen which, however, should not persist for an indefinite length of time. Although special types of breathing equipment have been developed heretofore intended by some adjustment or other to take care of these needs, the equipment has been somewhat complicated, expensive and heavy and, as a consequence, not readily suited to infrequent application to a subject nor to subjects unaccustomed to the use of such equipment.

Those masks heretofore made use of to a large degree have been provided with a contoured edge presumably of such shape as to fit the irregularities of the face, but because of this the masks must be worked out in many different shapes and sizes because of being not sufficiently flexible to adapt to the many different shapes and sizes of faces encountered.

In other respects, also, the available breathing equipment is relatively heavy and must not only be securely strapped to the helmet or to the face of the subject, but must incorporate in the fastening means expedients for adjustments to accommodate different conditions and to improve the comfort of the mask on the face in positions wherein it must be worn for many hours of continuous use. Masks for use by the crews of aircraft, moreover, are those which can more readily be used by persons of long experience in the use and handling of such equipment, and are of such type that they have not been readily adaptable to use by passengers who may have occasion to take advantage of the mask only on very few occasions and then without benefit of instruction with respect to how the mask should be placed on the face and thereafter made use of.

It is therefore among the objects of the invention to provide a new and improved breathing mask equipped with a dilutor valve in series with the inhalation check valve whereby to assure first a supply of oxygen of relatively high concentration followed by the automatic addition of ambient air which takes place as the subject continues to breathe.

Another object of the invention is to provide a new and improved breathing attachment equipped with a composite light-weight valving mechanism so constructed that the inhalation and exhalation check valves are constructed in a unitary assembly with an ambient air check valve whereby to produce a compact light-weight and efficient valving mechanism.

Still another object of the invention is to provide a new and improved breathing mask which is of such construction that it can be fitted comfortably to virtually any face without need for adjustment.

Another object of the invention is to provide a new and improved breathing mask which is exceptionally light in weight so that when the occasion comes for applying it to the face, it can be lifted and held to the face without special experience being needed on the part of the subject, and with relatively little effort due to the ease of adjustability by mere pressure and the light-weight construction of the device.

Still another object of the invention is to provide a new and improved breathing mask of simple light-weight design especially suited to use by inexperienced passengers in high altitude flight which automatically mixes ambient air with a supply of oxygen while the subject is inhaling thereby to enable supplying of passengers with a proper amount of oxygen from a common source without the necessity of expensive tubing, duct work and valves.

A further object of the invention is to provide a new and improved light-weight breathing mask of such versatility that it can be quickly adjusted to the face of any subject, which is of such design that it can be hung in a readily accessible place within easy reach when needed, and which by reason of its design and construction, is relatively tamperproof.

Still further among the objects of the invention is to provide a new and improved light-weight breathing mask designed for construction of particularly inexpensive materials and one wherein small light-weight parts can be made with a virtually maximum degree of uniformity, and which moreover necessitates relatively few separate parts without, however, impairing the provision of an extremely reliable breathing mask.

With these and other objects in view, the invention consists of the construction, arrangement and combination of the various parts of the device whereby the objects contemplated are attained, as hereinafter set forth, pointed out in the appended claims, and illustrated in the accompanying drawings.

In the drawings:

FIGURE 1 is an elevational view of the breathing mask assembly partially broken away and in the position it would occupy when suspended above the passenger seat.

FIGURE 2 is a cross-sectional view taken on the line 2—2 of FIGURE 1.

FIGURE 3 is a partial longitudinal sectional view taken on the line 3—3 of FIG. 2 showing the valve positions during inhalation.

FIGURE 4 is a fragmentary longitudinal sectional view showing valve positions during exhalation.

In the embodiment of the invention chosen for the purpose of illustration there is shown an oxygen supply line 10 at the end of which is a shut-off valve 11 from which extends a length of flexible tubing 12. The tubing extends into a flexible bag 13 which will ultimately serve as a reservoir of oxygen supplied to it through the tubing. At the lower end of the bag, as viewed in FIGURE 1, is a face receptacle 14, a beveled rim 15 of which is adapted to be pressed against the face of a subject surrounding the mouth and nose. It should be understood that the receptacle is of very light weight synthetic plastic so that a wall 16 thereof, the beveled rim 15, and a bottom 17 may be bent and flexed freely so as to press the rim continuously throughout its perimeter against the varying contours of the face of the subject without any adjustment being needed other than mere pressure against the face.

Inasmuch as pure oxygen will customarily be supplied through the supply line 10 to the bag 13, most conditions under which the mask will be used require a mixing of the oxygen with ambient air which would be present in the cabin of an airplane. Consequently, there is provided a composite valve device 20 between a lower end 21 of the bag 13 and the face receptacle 14 which facilitates the mixing of oxygen and ambient air during inhalation by the subject, and which, by the functioning of suit-

able outflow check valves, shuts off the supply of oxygen and ambient air during exhalation and facilitates the exhaust of air from the subject.

The composite valve device is one constructed primarily of synthetic plastic materials in the interest of preserving a very light weight construction of carefully fitted parts and in the interest of the supply of large quantities at a moderate price.

In order to secure the composite valve device to the bottom 17 of the face receptacle 14, there is provided a substantially annular inner plate 22 which underlies the bottom 17 at a location within the face receptacle 14. The inner plate has an upper surface 23 which presses against the underside of a thickened rim 24 which, together with an annular lip 25, defines an opening 26 through the bottom of the face receptacle. Bosses 27 on the inner plate extend through appropriate holes 28 in order to improve the means of attachment and sealing effect.

On the opposite side of the bottom 17 is an outer plate 29 which includes an annular portion 30 located immediately opposite the inner annular plate 22 so that these two elements can be pressed against opposite sides of the thickened rim 24 when assembled, thereby to produce a properly sealed attachment. The outer plate, moreover, includes spokes 31 which extend radially outwardly and carry a pair of concentric stiffening rings 32 and 33 joined together by intermediate spokes 34. The outermost ring 33 is substantially coincident with the corner where the bottom 17 joins the side wall 16 and thereby provides a stiffening means for the bottom portion of the face receptacle. Moreover, the annular portion 30, the rim 24 and the inner plate 22 may be considered as comprising a reinforcement for the opening through the bottom.

An outer face 35 of the annular portion 30 serves as a valve seat at the inside perimeter at the location indicated by the reference character 36.

A valve body 40 a has fitting 41 thereon at the upper side which receives outer and inner plastic rings 42 and 43, respectively, at a neck 44 of the bag whereby to anchor the bag to the body with a gas tight joint. The body may be described as defining a chamber 45. To mount the body at a location spaced from the outer plate 29 and its annular portion 30, there is provided a spacer ring indicated generally by the reference character 46, the spacer ring comprising an annular ring element 47 and legs 48. On the body, also, are bosses 49, and screws 50 extend through the bosses, the legs 48, the annular portion 30, and threadedly into the inner plate 22 whereby to secure all parts together in assembled position.

Within the body is a relatively thin substantially cylindrical valve element 55, the cylindrical wall of which is adapted to press against an interior cylindrical wall 56 of the chamber 45. The cylindrical valve element has a flat flange 57 thereon which extends outwardly to a position against the lower side of the body. Spaces 58 intermediate the bosses 49 and an annular lower rim 59 of the valve body provide for the ingress of ambient air to the chamber 45 when the cylindrical valve element is unseated. The valve element 55, therefore, permits inflow of air, but serves as a check in the respective inflow passageways when the pressure is reversed.

A composite valve member indicated generally by the reference character 60 consists of a plate 61 which extends outwardly to a position overlying the valve seat 36 which is a portion of the upper face 35 of the outer plate 29. An upwardly extending rim 62 of the composite valve member provides means for attachment of a thickened edge 63 of an annular flexible sealing connection 64, an outer flat portion 65 of which is contained between the annular ring element 47 and the annular rim 59 of the body. The presence of the sealing connection provides a floating connection and mounting for the composite valve member 60. Attention is also directed to the fact that as a matter of economy and convenience the same ring element 47 may be employed to jointly attach both the flexible sealing connection 64 and the cylindrical valve element 55 to the rim 59 in operating position.

In the composite valve member 60 are supply passages 66 which communicate between the chamber 45 and the interior of the face receptacle. To close the supply passages there is provided an inflow check valve element 67 which comprises a stem 68 anchored to the mid-portion of the composite valve member 60 and a disc 69, a rim 70 of which makes contact with a lower face 71 of the composite valve member 60. The disc 69 may be one of a type provided with a flexible annular inner portion 72 which permits the entire disc to lift from its seat without the necessity of any movement in the stem 68.

A spider comprising legs 73 intersecting at a mid-point serves to stiffen the inner plate 22 and provides a space 74 within which the outflow check valve 67 can operate effectively.

When installed, the face receptacle 14, the bag 13, and the flexible tubing 12 may, if desired, be compacted together and stored in a suitable box or receptacle not shown which in fact frequently forms part of the luggage rack immediately above each passenger seat. When there is a demand for supplying oxygen by use of the mask, it is necessary only for the subject to grasp the face receptacle 14 and draw it downwardly toward himself until he is able to place the beveled rim 15 against his face in the area surrounding his nose and mouth and there press it snugly into contact. The motion of drawing the face receptacle downwardly is made use of in opening the valve 11, inasmuch as oxygen is supplied from a common supply through the supply line 10 which is employed as a means of regulating the amount of oxygen available to each of the individual masks from some common control. To effect an opening of the valve 11 without jeopardizing the connections or adjustment of the passenger mask, a special precaution is made use of which comprises a cord 75 which is firmly secured by a loop 76 and fastening 77 to a bar 78 which is an integral portion of the valve body 40. The opposite end of the cord is provided with a loop 79 which extends through one of the holes 80 in a portion 81 of the flexible tubing 12 which extends into the interior of the bag 13. Although the bag itself may be of very thin walled material, the flexible tubing is relatively heavy walled and of sufficient tensile strength to make it safe to use as an extension of the cord. A collar 82 anchored to an upper portion of the flexible tubing has a cord 83 attached thereto, and connected to the cord 83 is a button 84 contained within a fork 85 of a valve handle 86 so that by pulling upon the face receptacle a pull is exerted through the cord 75, the flexible tubing 12 and cord 83 upon the handle 86 of the valve which turns on the valve so that oxygen will flow through the valve and flexible tubing into the bag 13. If the pull on the cord is too great, the button 84 will merely pull out of the fork 85 so that no damage will result.

By providing a reservoir of oxygen in the flexible bag 13, an immediate supply of oxygen will be available in quantity adapted to achieve successful operation of the valving mechanism. It will be understood that there is a continuous supply of oxygen to the reservoir regulated by a common control in the airplane sufficient to replenish the supply in the reservoir or bag 13 as it becomes used during the breathing cycle.

When the subject first inhales, due to the fact that the pressure inside the bag is greater than the pressure of ambient air, the first gas fed to the subject through the passages 66 will be oxygen of the concentration present in the reservoir. This is a most useful portion of the cycle because by introducing oxygen in the first part of the inhalation cycle through the lungs, the subject is assured of a higher concentration of oxygen in the alveolar sacks which in turn transmits the oxygen to the arterial blood flow and maintains a maximum level of oxygen arterial saturation.

As soon as the oxygen in the reservoir bag has been depleted, the ambient air inflow check valve will open. This valve will not open prior to depletion of the reservoir supply because of the higher differential pressure across the ambient air inflow check valve. That is to say, the pressure on the inside of the cylindrical part of the valving assembly is higher than on the outside during the first part of the inhalation cycle or inspiratory process. As soon as inhalation reaches a certain level depleting the oxygen supply in the bag, then the inflow check valve for ambient air will open and the subject will then fill his lungs with ambient air and to some extent with oxygen which continues to be supplied to the bag through the tubing **12**. The last phase of the inhalation cycle will fill the subject's lungs and distend them to the normal extent.

Thereafter upon exhaling, both of the inflow check valves are closed and the outflow check valve in the exhaust passage opens, permitting free discharge of exhaust gases from the lungs.

Attention is called to the very thin wall of the cylindrical valve element **55** which when flexed inwardly permits an ample flow of air through the spaces **58**. This same circumstance assists in closing this particular valve under a slight pressure differential when inhalation of a high concentration of oxygen is needed.

During this portion of the cycle, the valve member **60** is in the position shown in FIG. 3 with its annular plate portion **61** seating upon the valve seat **36** of the outer plate **29**.

Since there is very little resistance to aspiration supplied by the pressure of oxygen within the reservoir **13**, the composite valve member **60** is readily lifted, lifting the valve element **60** from the plate **29** around its entire perimeter, thereby permitting a free outflow of exhaust gases through the exhaust gas spaces **87** of the housing. Also when exhalation takes place the check valve **67** is seated.

When necessity for oxygen ceases, the face receptacle is merely removed from the face and the inflow check valve **67** and cylindrical valve **55** will normally reseat. The valve **11** can ultimately be turned to shut-off position manually.

As a further indication of the lightness and compactness hereinabove described, it will be understood that the cylindrical valve element **55** has a wall thickness in practice of approximately .007 inch, and that the flexible walls of the face receptacle are constructed preferably of rubber like material in thickness of about .015 inch. Those flexible sections within the valve device exemplified by the sealing connection **64** and the portion **72** of the valves **67** may be as thin as .003 inch. Virtually no metal parts comprise the valve device except the screws **50**. All of the remaining parts may preferably be constructed of light weight synthetic plastic, thereby to provide a valve structure extremely light in weight and accurate with respect to the fit of the several parts. In practice it has been found that the entire mask assembly inclusive of the face receptacle, composite valve device, the bag, and appropriate flexible tubing may be as light as 2½ ounces. The device thus described is particularly well adapted to aircraft travel, and due to its simplicity in operation, is especially effective for use by persons inexperienced with conventional breathing equipment.

Although we have herein shown and described our invention in what we have conceived to be the most practical and preferred embodiment, it is recognized that departures may be made therefrom within the scope of our invention, which is not to be limited to the details disclosed herein but is to be accorded the full scope of the claims so as to embrace any and all equivalent structures and devices.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

1. A breathing mask assembly for passing sequentially breathing gases from a selected source to a subject comprising a face receptacle, means forming a passage therethrough, a reinforcement around said passage comprising a plate retained in sealing engagement with the receptacle around the edge of said passage and having a passageway therethrough, said reinforcement having an outwardly facing exhaust valve seat thereon, a valve body secured to said reinforcement and having a chamber therein, exhaust gas passage means between said exhaust valve seat and the exterior, a composite valve member comprising an exhaust valve element adapted to seat on said outwardly facing exhaust valve seat, means forming a mixed gas supply passage through said composite valve member in communication between said chamber and said passageway, and an inflow check valve element normally closing said mixed gas supply passage, a movable sealed connection between said composite valve member and said body, said chamber having an unobstructed opening, a flexible reservoir bag attached to said body with the interior of said bag being in constant open communication with said chamber through said unobstructed opening and said chamber providing an unobstructed path for gases from said bag to said mixed gas supply passage, a flexible supply tube connecting said bag with said source, an arcuate interior wall for said chamber, means forming auxiliary passage means for ambient air through said interior wall between the exterior and said chamber on the upstream side of said inflow check valve, a flexible relatively thin substantially arcuate valve element normally closing said auxiliary passage means, said arcuate valve element being subject to flexure to open position to admit ambient air to said chamber during the inhaling cycle of the subject, said arcuate valve element and said inflow check valve being shiftable to closed positions and said exhaust valve element being shiftable to open position during exhaling cycle of the subject.

2. A breathing mask assembly for passing sequentially breathing gases from a selected source to a subject comprising a face receptacle, means forming a passage therethrough and a reinforcement around said passage comprising an annular plate retained in sealing engagement with the receptacle around said passage and having a passageway therethrough, said reinforcement having an annular outwardly facing exhaust valve seat, an annular valve body secured to said reinforcement and having a chamber therein, a composite valve member comprising an exhaust valve element adapted to seat on said outwardly facing exhaust valve seat and exhaust passage means between said valve seat and the exterior, means forming a mixed gas supply passage through said composite valve member and an inflow check valve element on said composite valve member normally closing said mixed gas supply passage, a movable sealed connection between said composite valve member and said body, said chamber being in constant communication between said mixed gas supply passage and said source of gas, a cylindrical interior wall for said chamber, auxiliary passage means for ambient air through said cylindrical interior wall between the exterior and said chamber and on the upstream side of said inflow check valve, a relatively thin substantially cylindrical valve element normally closing said auxiliary passage means, said cylindrical valve element being subject to flexure to open position to admit ambient air to said chamber and said gas supply passage during the inhaling cycle of the subject, said cylindrical valve element and said inflow check valve being shiftable to closed positions and said annular valve element being shiftable to open position during exhaling cycle of the subject.

3. A breathing mask assembly for passing sequentially breathing gases to a subject comprising a flexible walled face receptacle, means forming a gas passage through the said receptacle, a multiple valve member having a passageway therethrough adapted to communicate with said gas

passage and an annular outwardly facing exhaust valve seat surrounding said passageway, a valve body on said receptacle and spaced means separating said body from the receptacle at a location surrounding said passageway and forming exhaust passage means therebetween, said multiple valve member having an annular valve element reciprocably mounted therein at a location adapted to engage said exhaust valve seat and having a mixed gas supply passage therethrough, an inflow check valve for said mixed gas supply passage, a chamber in said body, means forming ambient air passage means through said body to said chamber on the upstream side of said inflow check valve and inflow check valve means for said ambient air passage means, a flexible compensator bag attached to said body and in constant communication with the mixed gas supply passage, and a flexible supply tube connected to said bag.

4. A mask assembly comprising a breathing attachment for the face of a subject, a flexible reservoir bag, a flexible tube connecting said reservoir bag with an oxygen supply line having a control valve therein, a diluter valve device connecting said reservoir bag with said breathing attachment, said diluter valve device comprising a valve housing on said attachment having a passage therethrough in communication respectively between said reservoir and said attachment, an inflow check valve in said passage, said housing having an ambient air passage formed therein for admitting air from outside the device into said first passage, said ambient air passage being disposed on the upstream side of said inflow check valve, a second inflow check valve in said ambient air passage, said housing having an exhaust gas passage formed therein between the attachment and the ambient air passage, said exhaust gas passage being on the downstream side of said inflow check valve, and an outflow check valve in said exhaust passage and means connecting said flexible tube and said control valve for activating said control valve to supply oxygen through said tube to said bag in response to a pull on said tube.

5. A diluter valve device comprising a valve mounting structure including a valve housing having an upstream end and a downstream end and a passage extending therethrough to and between said ends, said passage comprising an inflow section at the upstream end, an outflow section at the downstream end and a mixer section intermediate said inflow and outflow sections, and a freely moving inflow check valve in said passage at the downstream end thereof, said housing having an ambient air passage for admitting air from outside the device into said first passage, said ambient air passage being located on the upstream side of said inflow check valve and in communication between the mixer section and the exterior, said housing having a second inflow check valve in the ambient air passage, the portion of said passage between the inflow section and the downstream side of said second inflow check valve being open under all conditions of operation of said diluter valve device, the portion of said passage between the downstream side of the second inflow check valve and the first inflow check valve being open under all conditions of operation of said diluter valve device, said second inflow check valve comprising a freely moving valve element and an exhaust gas passage through said mounting structure having an outflow check valve therein.

6. A diluter valve device comprising a valve mounting structure including a valve housing having an upstream end and a downstream end and a passage extending therethrough to and between said ends, a freely moving inflow check valve in said passage at the downstream end thereof, said housing having an ambient air passage including a substantially concentric cylindrical ambient air valve seat extending around the circumference of said body for admitting air from outside the device into said first passage, said ambient air passage being located on the upstream side of said inflow check valve, said housing having a second inflow check valve in the ambient air passage, said second inflow check valve comprising a freely moving substantially cylindrical flexible resilient valve element having one end thereof sealed in said housing adjacent the ambient air passage and the other end thereof resiliently impressed into engagement with said ambient air valve seat, and an exhaust gas passage through said mounting structure having an outflow check valve therein.

7. A diluter valve device comprising a valve mounting structure including a valve housing having an upstream end and a downstream end and a passage extending therethrough to and between said ends, an axially movable supporting member in said housing including a transverse plate, a freely moving inflow check valve device in said passage at the downstream end thereof and mounted on said plate, a rim intermediate said upstream and downstream ends of said housing and a flexible sealing connection between said plate and said rim, said housing having an ambient air passage including a substantially concentric cylindrical ambient air valve seat extending around the circumference of said body for admitting air from outside the device into said first passage, said ambient air passage being located on the upstream side of said inflow check valve and on the upstream side of said rim, said housing having a second inflow check valve in the ambient air passage, said second inflow check valve comprising a freely moving substantially cylindrical flexible resilient valve element having one end thereof sealed upon said rim adjacent the ambient air passage, the other end of said resilient valve element being resiliently impressed into engagement with said ambient air valve seat, and an exhaust gas passage through said mounting structure having an outflow check valve therein.

8. A passenger mask assembly comprising a mask member including a wall and a diluter valve device supported on said wall, said wall having an aperture therethrough and a thickened rim around the edge of said aperture, said valve device comprising a valve body having an upstream end, a downstream end and a supply passage between said ends, a separate rim forming part of said valve body adjacent said wall, an inner plate on the inside of said wall having an aperture therethrough, an outer plate on the outside of said wall having an aperture therethrough in communication with said last identified aperture and said supply passage, an axially moving supporting member in said supply passage having a flexible connection to the valve body adjacent said separate rim and having an inflow check valve device mounted thereon, said thickened rim comprising valve seat means forming an annular exhaust valve seat around the aperture in said wall, a plate on said supporting member comprising an exhaust valve element adapted to seat on said seat, and a common anchoring means securing said inner and outer plates in assembled relationship with said valve body and the portion of said wall and the thickened rim thereon forming said valve seat means.

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