

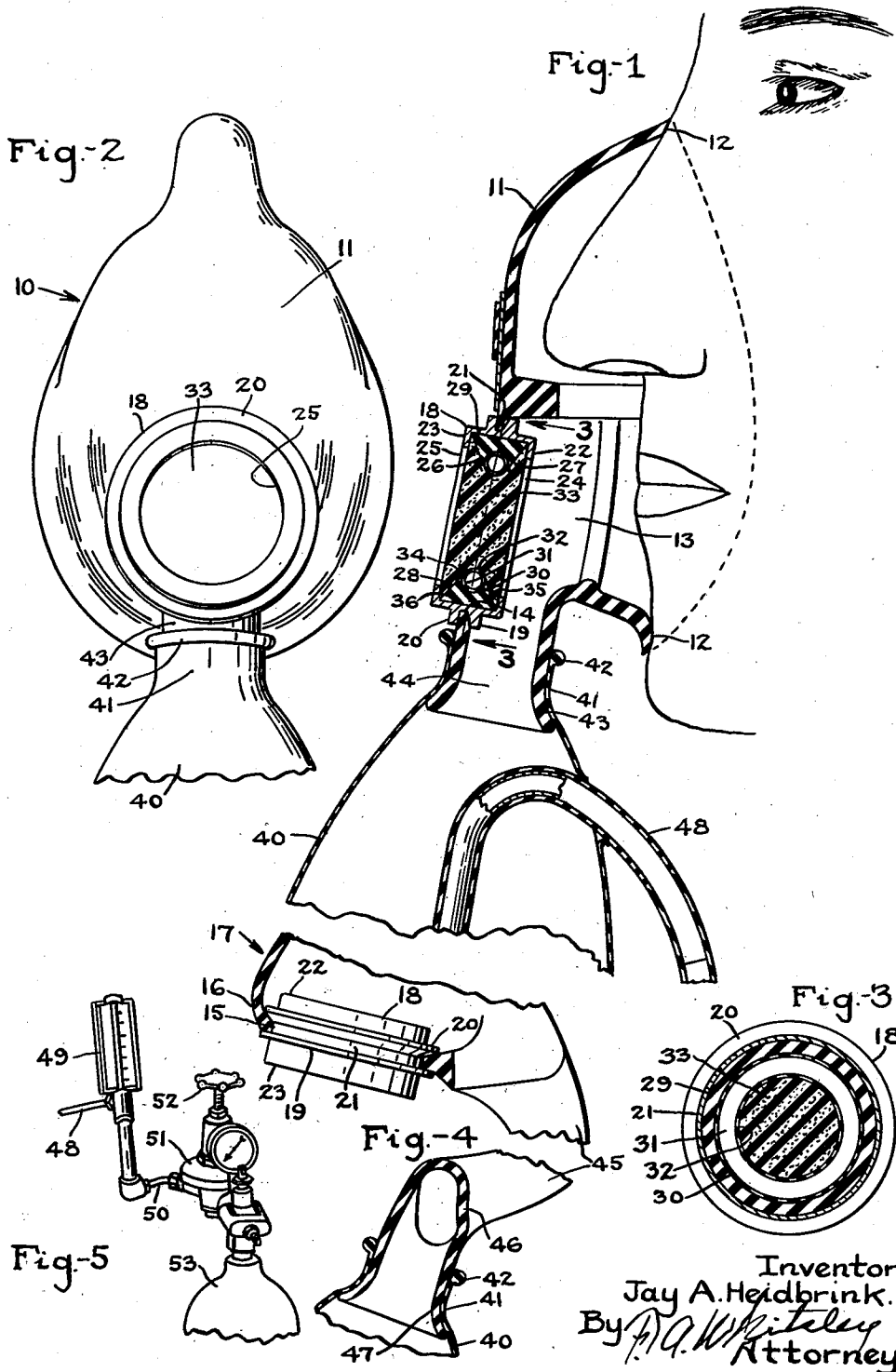
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INHALATION DEVICE FOR USE IN AVIATION AT HIGH ALTITUDES

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INHALATION DEVICE FOR USE IN AVIATION
AT HIGH ALTITUDESJay A. Heidbrink, Minneapolis, Minn., assignor,
by mesne assignments, to Air Reduction Com-
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5 Claims. (Cl. 128—202)

My invention relates to inhalation devices for use in aviation at high altitudes, wherein a mask is employed which provides a breathing chamber sealed upon the face of the wearer so as to include either the nose alone or both the nose and mouth of the wearer, and to which is connected in close proximity thereto a rebreathing bag which is of a volume substantially less than the volume of a full exhalation or inhalation in normal breathing, with oxygen fed to the rebreathing bag and an outlet to atmosphere closed by a layer of porous material such as sponge rubber, which operates to store heat and prevent frost forming on its surface at high altitudes and low temperatures, and which also has the effect of cooperating with the oxygen supply to the rebreathing bag to tend to regulate the relative amounts of oxygen in the alveolar air.

In such devices the sponge rubber closure provides a slight restriction to normal breathing such that upon inhalation the rebreathing bag will be emptied first taking directly into the lungs the oxygen enriched contents of said rebreathing bag, and thereafter the air will enter through the sponge rubber closure to mix with the gases already breathed in the alveolar passageways and produce alveolar air of a suitable oxygen content. Similarly, on exhalation the restriction will have the effect of causing the rebreathing bag to fill with the first of the exhalation and thereafter to permit the latter part of the exhalation, which includes that part most heavily charged with carbon dioxide, to pass through the sponge rubber closure to atmosphere. In this manner not only is suitable alveolar air obtained, but the carbon dioxide released in the lungs is sufficiently expelled from the system.

As the air pressure drops and the air becomes more attenuated in higher elevations encountered, for example, in aviation, this attenuated air will pass more readily through the mesh of the sponge rubber so that there will be changes both in the resistance set up and in the actual volume of air going to the wearer at these higher altitudes. This would have the effect of possibly permitting air to be drawn in and expelled in advance of emptying and filling the rebreathing bag, and also would affect the proportions of oxygen in the alveolar air. On the other hand, if the sponge rubber closure were made so dense as to prevent this result in higher altitudes or at low atmospheric

pressures, it would put too great a load on the breather in lower altitudes.

I have discovered that if the sponge rubber closure in the air admission and exit openings is proportionately compacted as elevation increases in proportion to the elevation attained and consequent decrease of pressure and attenuation of the air, it will at the same time maintain the degree of resistance required for proper preliminary emptying and filling of the rebreathing bag and will retain a desired relation of oxygen delivered to the inhalation device, as shown by the flow meter, to the actual volume of air introduced and expelled from the breathing device. It is, therefore, a principal object of my invention to provide means associated with the sponge rubber closure which will progressively compact the sponge rubber forming such closure as higher and higher altitudes are reached to maintain a substantially constant resistance to inlet and outlet of air and thereby to maintain a substantially constant volume of air breathed on inhalation and expelled on exhalation.

I have discovered that such a result may be effected in a highly satisfactory manner, directly related to degree of elevation and reduction of air pressure, by providing means surrounding the sponge rubber air closure and contacting it, which will expand as air pressure reduces, and which expansion is directed upon the sponge rubber air closure. And it is an object of my invention to provide means surrounding the sponge rubber closure which will have the property of expanding as air pressure drops, and which is so held that the movement of expansion will effect compacting of the sponge rubber closure determined by the degree of elevation and reduction of air pressure.

It is a further object of my invention to provide a mounting for the sponge rubber closure which will hold an expansible annular air-tight tube in a manner surrounding and engaging the sponge rubber closure, whereby the expansion of air in said tube, as air pressure without reduces, will have the effect of gripping and compacting the sponge rubber forming the closure.

It is a further object of my invention to provide a sponge rubber closure having an annular groove therein and seating said closure in a holder with openings through the holder wherein is seated an annular air-tight tube subject to change of air pressure at varying elevations and held to expand only towards the closure to compact the same.

The full objects and advantages of my invention will appear in connection with the detailed description thereof and the novel features by which the advantageous results of my invention are obtained are particularly pointed out in the claims.

In the drawing illustrating an application of my invention in some of its forms:

Fig. 1 is a sectional part fragmentary view showing my invention applied to an oronasal mask as the same will appear when worn by an individual.

Fig. 2 is a front view of the parts shown in Fig. 1.

Fig. 3 is a sectional view taken on line 3—3, 15 viewed in the direction of the arrows, of Fig. 1.

Fig. 4 is a fragmentary view of a part of a nasal mask showing my invention applied thereto.

Fig. 5 is a semi-diagrammatic view of an oxygen tank, regulating valve, and flow meter all of well known construction.

As shown, an oronasal mask 10 is provided with a main body 11 and margins 12 adapted to contact the face of a wearer as shown in Fig. 1, so as to provide a breathing chamber 13 to which the nostrils and mouth of the wearer communicate. An aperture 14 is formed in the front of the oronasal mask positioned opposite the mouth of the wearer, or, as shown in Fig. 4, a similar aperture 15 is positioned in the wall 16 of a nasal mask 17 which comes normally below the nostrils of the wearer. A cylindrical holder 18 is provided with flanges 19, 20, Figs. 1 and 4, which form an annular groove 21. Within this groove 21 is seated the edge of the opening 14 from oronasal mask 11 or the edge of the opening 15 from the nasal mask 17, by which the holder 18 is secured either upon the oronasal mask or the nasal mask, as may be desired.

The holder 18 and the parts carried by it are in substance the same whether applied to the oronasal mask or to the nasal mask, and are shown in detail in Figs. 1 and 3. The holder comprises annular flanges 22 and 23 which surround centrally disposed openings 24 and 25. Within the holder 18 is a ring 26 of hard rubber having sloping walls 27 and 28 and a base wall 29, which latter seats on the inside of the holder 18 between flanges 22 and 23 and engages the bottom insides of said flanges as clearly shown in Fig. 1. Toward the apex of ring 26 is formed an annular groove 30 semi-circular in cross section in which is seated a sealed tube 31 of treated rubber or other material impervious to air passage but capable of a desired degree of elastic expansion. This annular tube 31 provides a central opening 32 in communication in both directions with the openings 24 and 25 through the holder 18.

A pad or button 33 of very fine mesh porous sponge rubber is shaped in cross section as shown in Fig. 1, with a grooved portion 34 adapted to engage the tube 31 and wing portions 35 and 36 extending between flange 22 and ring-wall face 27 on one side, and flange 23 and ring-wall face 28 on the other side.

It will be apparent that the annular tube 30, being subject to the air pressure through the porous sponge rubber button 33 and being filled with air at normal sea level pressure, will, as greater and greater elevations and lower and lower surrounding atmospheric pressures are reached, expand. This expansion can only go in the direction of the sponge rubber button 33

and must result in compacting the sponge rubber of the button a greater or less degree as the air pressure grows less or greater. This compacting of button 33 provides increased restriction of passage of air through it which is inversely proportionate to the tendency of the air as it becomes more attenuated to move in increased volumes through the sponge rubber pad which closes the opening to atmosphere from the breathing chamber. This results in maintaining a substantially uniform volume of inlet of air on inhalation, and also on exhalation, at varying elevations and consequent varying pressures, and also uniform breathing restriction.

A rebreathing bag 40 is provided with a neck 41 reinforced by a band 42 and is adapted to be held upon the tube walls 43 of passageway 44 going from breathing chamber 13 of oronasal mask 11, as clearly shown in Fig. 1. By this means the rebreathing bag 40 is secured upon the oronasal mask 11. By similar means the rebreathing bag 40 is attached to nasal mask 17 wherein a pair of air tubes 45 (of which only one is shown in Fig. 4) unite in a cross tube 46 from which extends a connector tube 47 similar to the connector tube 43 to which the neck 41 of the rebreathing bag 40 is secured.

The rebreathing bag 40 as stated, will be of a size substantially less in maximum volume than the volume of an inhalation or exhalation in normal breathing. Its walls will be formed of flexible rubber of a type which will not freeze or unduly stiffen at very low temperatures, say as low as 60° F. below zero. A tube 48 leads into the rebreathing bag 40 as shown in Fig. 1. This tube extends to a flow meter 49 and a connector tube 50 to a regulating valve 51 operated by a hand valve 52 which is in communication with a supply of compressed oxygen from the oxygen tank 53. The flow meter 49 indicates the volume of flow of oxygen which may be regulated at will by the hand valve 52.

The operation and advantages of my invention have been given in the foregoing detailed description. As higher elevations and greater attenuation of the atmosphere are entered the relative amount of oxygen supplied to the rebreathing bag 40 must be increased, it being understood that through adjustment of valve 52 a constant flow of oxygen into the rebreathing bag, as shown by the flow meter, is set up at whatever rate of flow or volume of oxygen per minute is indicated.

Under normal conditions of use, without the application of my invention to the sponge rubber closure, the restriction to breathing set up thereby would diminish as greater elevations and lower pressures are reached which would result in increased volumes of air relatively going to the lungs, to such an extent as possibly to prevent either emptying or filling of the rebreathing bag. But through the expansion of the annular pneumatic tube, moving only toward the encircled sponge rubber closure, the latter will be compacted more and more as higher elevations and lower air pressures are reached. This compacting will maintain substantially the same restriction to breathing in higher altitudes of air at reduced pressures as in lower or sea level altitudes and pressures, which will maintain substantially the same ratio of input and exit of air through inhalation and exhalation. Also, since the restriction remains substantially constant the emptying of the rebreathing bag upon inhalation before air is drawn in through the

sponge rubber closure, and the filling of the rebreathing bag with the gases of exhalation before any of them pass through the closure to atmosphere will be kept substantially constant. The purposes of the sponge rubber closure are thus attained and there is prevention of undue dilution of the inhaled gases by attenuated air at low pressures and undue exhaust of exhalations to atmosphere, all of which not only maintain the desired comfortable breathing action and proportions of added oxygen to inhaled air, but at the same time prevent waste of the costly oxygen.

I claim:

1. An inhalation device comprising a casing that forms a breathing chamber when the casing is applied to the face of the wearer, a rebreathing bag having connection with said breathing chamber and having a maximum volume substantially less than the volume of an exhalation or inhalation in normal breathing, an aperture from said breathing chamber, a pad of porous material such as sponge rubber in said aperture through which gases on inhalation and exhalation must pass, and means engaging said pad and responsive to variations of air pressure which will act upon the same to compact it as air pressure falls and thus will maintain the breathing restriction set up by the sponge rubber closure substantially constant and will prevent increased volumes of air passing through the pad as air pressure diminishes.

2. An inhalation device comprising a casing that forms a breathing chamber when the casing is applied to the face of the wearer, a rebreathing bag having connection with said breathing chamber and having a maximum volume substantially less than the volume of an exhalation or inhalation in normal breathing, an aperture from said breathing chamber, a pad of porous material such as sponge rubber in said aperture through which gases on inhalation and exhalation must pass, a holder for said pad connected with the casing and an expansible pneumatic tube within the holder and engaging the edges of said pad so that as said pneumatic tube expands due to fall of air pressure it will compact the pad and thus will maintain the breathing restriction set up by the sponge rubber closure substantially constant and will prevent increased volumes of air passing through the pad as air pressure diminishes.

3. In a mask having a breathing chamber adapted when worn to enclose a breathing passage of the wearer and form a breathing chamber about said breathing passage, an aperture from said breathing chamber, a holding member secured to the edges of said aperture, an annular pneumatic tube secured to said holding member, and a sponge rubber pad having its edges engaged by said annular pneumatic tube, said pneumatic tube being responsive to changes in air pressure so that as air pressure falls the pad will be compacted and will increase restraint of external air flow through it, and when air pressure increases the tube will lessen the degree of compaction of the pad to permit greater flow of air through it.

4. In a mask having a breathing chamber adapted when worn to enclose a breathing passage of the wearer and form a breathing chamber about said breathing passage, an aperture from said breathing chamber, a holding ring secured to the edges of said aperture, an annular pneumatic tube secured within said holding ring, and a sponge rubber pad having its edge formed with an annular groove engaged by said annular pneumatic tube and held in the ring thereby, said pneumatic tube being responsive to changes in air pressure so that as air pressure falls the pad will be compacted and will increase restraint of external air flow through it, and when air pressure increases the tube will lessen the degree of compaction of the pad to permit greater flow of air through it.

5. In a mask having a breathing chamber adapted when worn to enclose a breathing passage of the wearer and form a breathing chamber about said breathing passage, an aperture from said breathing chamber, a holding ring secured to the edges of said aperture formed with annular flanges providing an annular channel, an annular holder block having its base engaging the bottom of said channel and having sloping side walls reaching to the inner margins of said flanges, an annular channel in the holder block, a pneumatic tube in said annular channel, and a sponge rubber pad having portions extending into the spaces between the flanges and the holder block and surrounding and engaging said sponge rubber pad and being held positioned in the holder block thereby.

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