

Aug. 10, 1943.

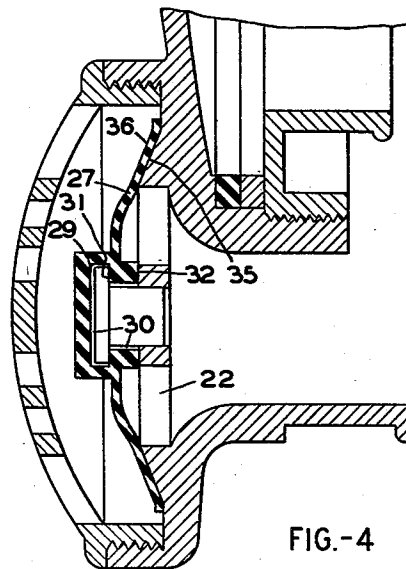
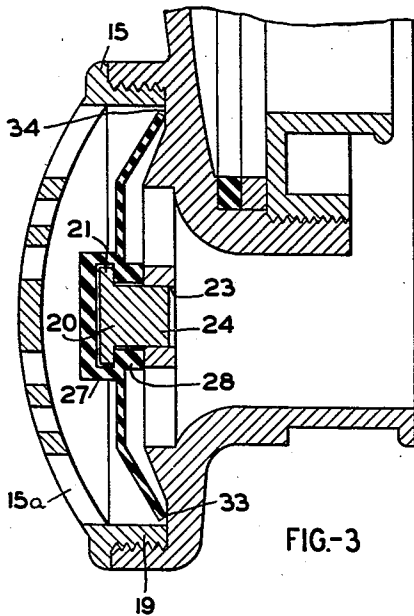
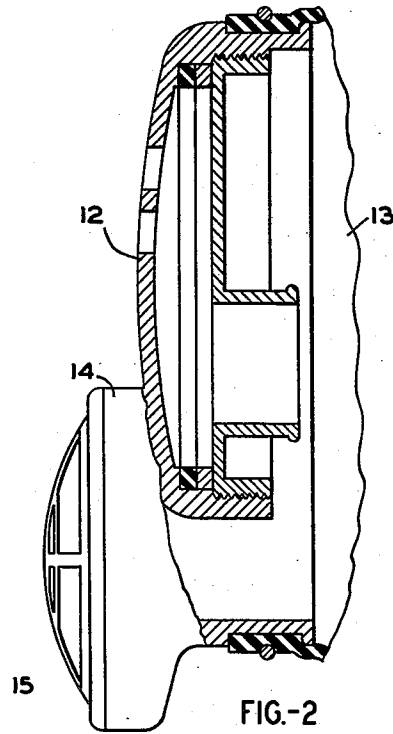
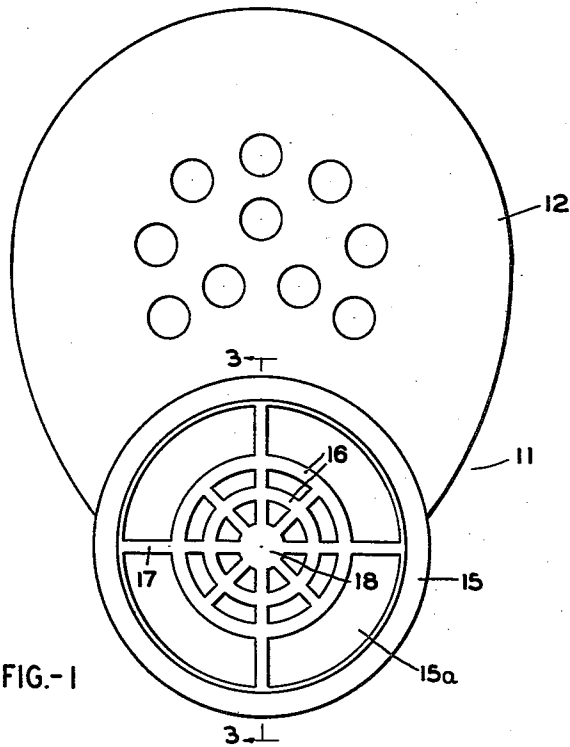
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2,326,651

EXHALATION VALVE STRUCTURE FOR PROTECTIVE MASKS

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2 Sheets-Sheet 1



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2 Sheets-Sheet 2

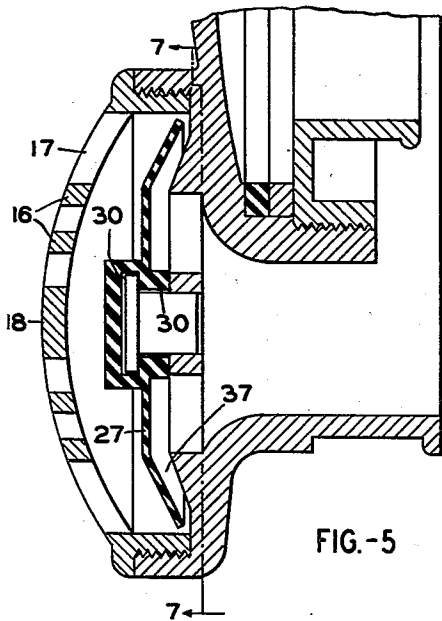


FIG.-5

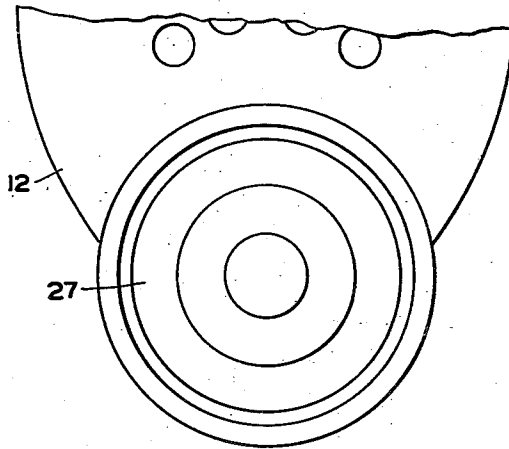


FIG.-6

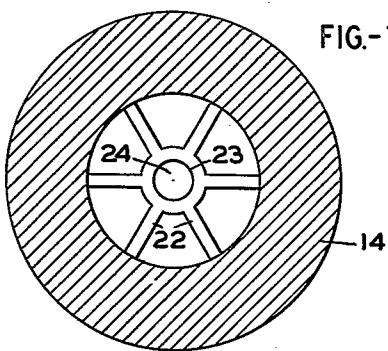


FIG.-7

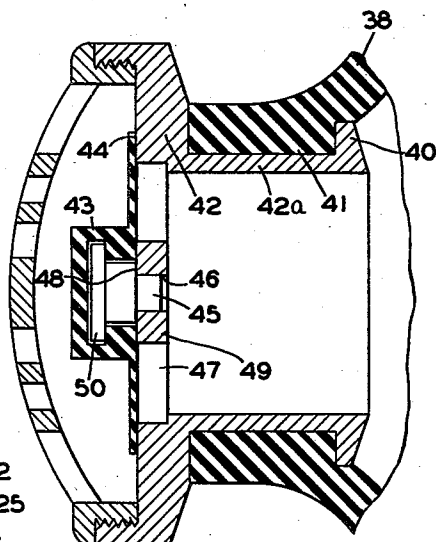


FIG.-8

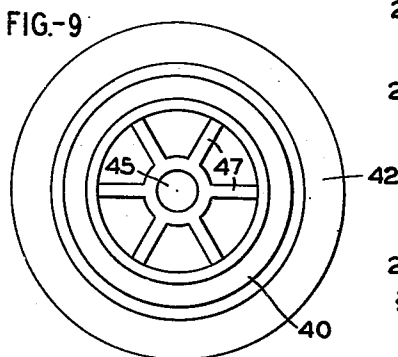


FIG.-9

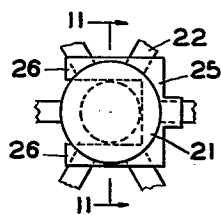


FIG.-10

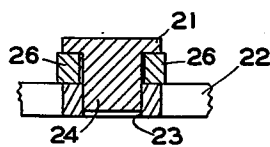


FIG.-11

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EXHALATION VALVE STRUCTURE FOR
PROTECTIVE MASKS

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Application September 20, 1941, Serial No. 411,614

4 Claims. (Cl. 251-119)

The invention relates to respiratory devices, such as gas and like types of masks, and more particularly, to exhalation valves for devices of this nature. Such exhalation valves are usually conveniently positioned in that portion of the mask which, while in service, is arranged in general juxtaposition to the mouth and nose of the wearer, said portion being generally termed the face piece.

A serviceable gas mask must include suitable means for supplying a breathable atmosphere from a convenient portable source. It must also include suitable valve means for permitting exhalation by the wearer, the exhalation valve being usually a one-way valve so as to prevent ingress of toxic vapors.

For convenient general use, a gas mask may also include other elements, for instance some means, impermeable to gases, for the transmission of speech vibrations therethrough. Such latter means is shown, for example, in my copending application, Serial No. 389,129, filed April 18, 1941. The present application discloses and claims distinctly novel and improved exhalation valves applicable both to a face part such as is disclosed in the aforesaid copending application and also to respiratory devices in general.

As will be readily appreciated by anyone who has worn a respiratory device for any appreciable length of time, one of the principal objections to its use arises from the sense of discomfort experienced by the wearer, especially with respect to the action of exhalation. This is particularly true in the case of those of the civilian population who are afflicted by bronchial, pulmonary, or cardiac diseases, or in the case of individuals, either civilian or military, who are involved in strenuous activities which cause hurried or labored breathing, accompanied by physical fatigue. It is common knowledge in military circles that a company of soldiers required to do strenuous construction work, or to run uphill, or otherwise intensify the usual physical pace, complain of breathing handicaps imposed by the use of the gas mask. It is common knowledge, also, that individuals not under watchful supervision are inclined to forego the use of a respiratory mask altogether, rather than be in a condition of discomfort, even when there is some possibility of encountering toxic atmosphere.

Tests have demonstrated that the sense of discomfort above mentioned bears a direct relationship to the physical effort required to open the exhalation valve of the respiratory device.

It would further appear that the exhalation

valves of prior respiratory devices have been so constructed and arranged, in order to have the valve members of such valves so tightly engage their seats to prevent ingress of toxic vapors that the physical effort required to move the valve members from their seats during exhalation was so fatiguing as to make such prior devices quite unsatisfactory. Furthermore those prior exhalation valves which were of the rubber diaphragm type were so distorted due to the tension arising from the mounting method as to produce permanent set or make them otherwise too insensitive for ease of exhalation. Moreover prior exhalation valves including those of the diaphragm type have been of more or less complicated character, expensive to manufacture and mount, and unsuitable for use as a standard valve for all masks.

The general object of the present invention is the provision of an exhalation valve for respiratory devices, such as gas masks and the like, said valve being of exceedingly simple form and construction, capable of being inexpensively manufactured to accurate dimensions in commercial production, and in which the valve member may be easily, quickly and conveniently attached to and removed from its support.

A more specific object of the present invention is the provision of an exhalation valve for respiratory devices of the rubber diaphragm type, the periphery of the diaphragm valve having sufficient contact with the valve seat to effectively prevent ingress of toxic vapors during inhalation but which can be so easily moved from its valve seat during exhalation as to avoid any fatigue or discomfort on the part of the wearer of the respiratory device.

Another specific object of the present invention is the provision of an exhalation valve having a valve member of disk-like form and of imperforate character, said valve member having a centrally disposed socket for enabling said member to be easily and quickly attached to and removed from its supporting stud, the mounting of said valve member being such that the rubber material of which it is made is not distorted or given a permanent seat which would otherwise result in a short life and faulty valve operation. Another specific object of the present invention is the provision of an exhalation valve of the character heretofore referred to, and in which the disk-like valve member and its supporting stud are so constructed and arranged as to insure the accurate mounting of the valve member under predetermined conditions.

Another object of the present invention is the provision of an exhalation valve which includes a disk-like valve member of rubber or like material and a support therefor which may be made of organic plastic material, said plastic support having the valve seat thereon, and capable of being given a form and shape which enables it to be used with various types of respiratory devices, such as the so-called gas masks, oxygen masks, dust masks and the like.

Other objects and advantages will be apparent to those skilled in the art on a consideration of the following description of two embodiments of the invention, in conjunction with the attached drawings, in which

Fig. 1 is a front elevation of a mask face part containing an exhalation valve;

Fig. 2 is a vertical sectional view thereof, with a part of the lower portion of the face part in elevation;

Fig. 3 is an enlarged fragmentary section on the line 3—3 of Fig. 1, with the periphery of the exhalation valve element in edge or line contact with the valve seat;

Fig. 4 is a view similar to Fig. 3 but showing the periphery of the valve element in surface contact with the valve seat, the relation of the parts during inhalation;

Fig. 5 is a view similar to Fig. 3 but showing the valve element unseated as a result of exhalation;

Fig. 6 is a front elevation of the lower portion of the face part, the perforate cap of the valve housing of such part being removed;

Fig. 7 is a detail vertical section, on the line 7—7 of Fig. 5;

Fig. 8 is a vertical section of the mask face part containing a somewhat modified exhalation valve, the portion of the mask in which said face part is mounted being broken away;

Fig. 9 is a rear view of the face part of Fig. 8 as seen from the interior;

Fig. 10 is a plan view illustrating one method of mounting the supporting stud for the valve member of either of the aforesaid exhalation valves; and

Fig. 11 is a section on the line 11—11 of Fig. 10.

Before the present invention is described in detail, it is to be understood that such invention is not limited to the details of construction and/or the specific arrangement of parts herein illustrated and/or described, as the invention obviously may take other forms. It also is to be understood that the phraseology or terminology herein employed is for the purpose of description and not of limitation.

For purposes of illustration, Figs. 1 to 7 inclusive of the drawings show a gas mask face piece generally designated by reference numeral 11, and preferably fabricated from organic plastic material, such as cellulose acetate, by a pressure casting operation. The contours of the face piece generally, and of the structural elements of the exhalation valve now to be described, are so simple that, whether fabricated in several sections or integrally, the casting operation is a simple one.

The face piece here shown in Figs. 1 to 7 inclusive includes speech transmission means in a housing 12, said means not being described in detail herein since not an essential element of the present invention. The face piece is carried by a pliable face-enveloping member 13 in

conventional manner, said face piece being shown only in fragmentary manner in Fig. 2.

The face part 11 comprises an exhalation valve housing 14, the purpose of which is to enclose, support and protect the exhalation valve now to be described. The open front of the housing 14 carries a foraminous cap 15 which, in the embodiment shown, consists of a dome-shaped front portion having radially spaced annular members 16 supported by radial struts 17, said struts radiating from a central boss 18 and being integral with the annular members 16. While the cap may be attached to the housing in various ways, it is shown (see Fig. 3) as having a cylindrical skirt or flange 19 which is exteriorly threaded to fit a corresponding internal thread on the cylindrical wall of the housing 14. This cap protects the vitally important exhalation valve member from intentional or accidental impacts, the results of which might be of serious consequence to a wearer of the mask. As will be readily apparent from an examination of Figs. 1 and 3, the openings of the cap 15, especially the outer set of openings 15a, are of sufficient area to prevent any appreciable impedance to the outward flow of exhaled gases, and yet do not effect any material weakening of the cap.

Located centrally within the valve chamber defined by the housing 14 is a forwardly projecting stud or button 20 preferably having an enlarged head 21. Said stud is supported on a spider 22 which is preferably formed integrally with the housing 14 and which is centrally perforated at 23 to receive and retain the shank 24 of the stud. While the stud may be formed integrally with the spider, the method of construction and assembly hereinafter described and shown in Figs. 10 and 11 is more suited to a uniform precision such as is desired, if not actually required, in a device of the character here involved.

In mounting the stud 20 in the spider aperture 23, the internal peripheral wall of said aperture is first coated with a suitable adhesive, such as acetone. A suitable spacing gage 25, of U form, is then placed with its leg members 26 straddling the aperture. The shank 24 of the separately formed stud 20 is then inserted in the aperture as far as said gage will permit, or in other words, until the stud head 21 comes in contact with the gage legs 26, and the stud is maintained in this position for a brief period until incipient hardening of the adhesive permits withdrawal of the gage. By this method, a high degree of accuracy and precision is obtained in the positioning of the stud head 21 relative to the spider 22, with a result to be soon described. If the stud 20 is cast integrally with the spider 22 of housing 14, the shank of said stud would give rise to certain additional problems of mold design, requiring lateral withdrawal of certain die inserts which define said shank, thereby leaving upon the shank so called parting lines or minor flash projections which, even if not evident enough to require a trimming or machining operation, would have a tendency to impair the unstressed operation of the valve member 27 which is mounted on the stud 20 and which valve member is now to be described.

As here shown, said valve member is a one-piece, imperforate disk or diaphragm of rubber or like material and of inverted saucer-like form in cross section. Extending centrally through

said disk or diaphragm 27 and projecting from opposite faces thereof is a tubular and somewhat thickened hub-like part 28, closed at its front end and defining a rearwardly opening recess or socket 29 for the reception of the stud 20. The forward end of said recess or socket is suitably enlarged to receive the head 21 of the stud 20, and as will be readily understood, assembly of the valve disk or diaphragm 27 with its supporting stud 20 is readily effected by drawing the tubular hub of said disk or diaphragm over the projecting portion of said stud, with the consequent location of said stud in the recess or socket 29 of the valve member. As best shown in Figs. 3 to 5 inclusive, the reduced part of the valve member hub is of such length as to just contact the under surface of the stud head 21 in the plane designated by the reference numeral 31, and to just contact the spider 22, in the plane designated by the reference numeral 32.

A clearance space 30 (see Fig. 4) of minute dimension, in the order of one thousandth ($1/1000''$) of an inch in sectional extent, preferably is provided in the valve socket or recess 29 around the stud 20, except in the contacting planes 31 and 32 heretofore referred to. Since these two contacting areas 31 and 32 are of minor extent as compared with the total surface area of the valve 27, the major portion of the valve is maintained in an unstressed, floating condition, although positively positioned with respect to its seat 33 by the cooperating effect of the contacting surfaces 31—32. The aforesaid clearance spaces 30 permit any slight displacement arising from flexure of the valve material as the valve member moves through its functional cycle in use thereof.

The operation of the valve is as follows, with special reference to Figs. 3, 4 and 5. Fig. 3 shows the normal position of the valve member 27, in idle condition, a circular line contact being maintained between the peripheral edge of the valve diaphragm and the valve seat 33 on the bottom face of the valve chamber 34. The accuracy of assembly heretofore described, and the generally floating suspension of the valve member 27 contribute to permit a most sensitive and stress-free contact of the periphery of the valve member with its seat 33, which obviously is essential in a satisfactory respiratory device.

A slight inhalation effort temporarily reduces the pressure on the inner valve member face which immediately brings about a planar contact of the valve member periphery with the valve seat 33, said valve seat having a conically inclined portion 35 designed to be engaged by a similarly inclined portion 36 of the valve diaphragm. This provides a sealing contact of substantial extent during inhalation, the relative position of the cooperating parts at this time being shown in Fig. 4.

Fig. 5 shows the position of the valve member during exhalation, the periphery of the valve member being lifted from its seat, as shown by reference numeral 37, to an extent determined by the energy of exhalation, but amply sufficient to allow egress of the exhaled gases without any perceptible discomfort such as has been experienced with the less sensitive valves heretofore available. The clearance spaces 30 around the flanged head and shank of the stud 20 permit more ready flexure of the valve member than could be obtained if the valve member were in tight fitting contact with the stud. Comparative tests of this present valve simultaneously with tests on valves heretofore available have indi-

cated that this present valve, while definitely leakproof in neutral position and during inhalation, may be opened at a considerably lower exhalation pressure than prior valves, with comparable leakproof characteristics. For this reason, the present valve causes no feeling of discomfort and as a result, the wearer of a mask containing the present exhalation valve is not tempted to remove his mask, as has heretofore been done, even in the face of danger, by the wearers of masks utilizing prior exhalation valves.

While the supporting stud 20 for the valve member 27 is shown as carried by a spiderlike member 22, it may obviously be carried by a perforated plate, or by other supporting means which permits passage therethrough of exhaled gases.

Figs. 8 and 9 illustrate a face part 42, of a form particularly suitable for oxygen, dust and like masks, said face part containing an exhalation valve embodying a somewhat modified form of the present invention. As shown, said face part includes a valve housing generally similar to the one heretofore described and from which extends, rearwardly, a tubular portion 42a. Located within the valve chamber defined by said housing is a centrally disposed stud on which is mounted an exhalation valve member 43 which differs from the valve member 27 heretofore described only in that the peripheral portion of valve member 43 is of generally flat form, the valve seat 44, with which the valve member 43 has coplanar contact for sealing purposes, being of like flat form.

Although the tubular portion 42a of this second face part 42 may be detachably secured to a mask member in any suitable manner and by any suitable means, I have shown it in this embodiment as being provided with a rear terminal flange 40, the plane of the flange being normal to the cylindrical axis of the tubular portion. There is thus provided, between the flange 40 and the flared front portion which constitutes the valve housing, a circumferential depression in which a matched annular projecting portion 41 of the flexible mask 38 may be seated in snap-in relationship. This construction enables the mask part 38 and the face part 42 to be easily, quickly and conveniently assembled. It also permits ready substitution of a new face part in case the old one is damaged or the like.

I have further shown, in Fig. 8, a stud construction differing somewhat from that shown in Figs. 1 to 7. The shank of the present stud is provided with a reduced end 45 to seat in the bore 46 of the supporting spider 47, thereby providing a shoulder 48 disposed to contact the spider hub 49. In forming the stud the location of the shoulder 48 and the stud head 50 are accurately predetermined to obtain, in the final valve assembly, a precision in the dimensional relation of the parts which is commensurate with that obtained with the spacing gage already described. In the present embodiment the spacing gage may be dispensed with since the stud is inserted in the central bore 46 of the spider until the shoulder abuts the spider. The gage of course may be used if it is desired to terminate the stud insertion somewhat short of actual shoulder contact such as described.

It is apparent from the drawings that the manner of mounting the valve member 43 on its supporting stud is similar to that already described in connection with the embodiment previously referred to. It also is to be understood that the face part 42 of Figs. 8 and 9 may be

constructed, if desired, with a valve seat of the contour of the valve seat of the face piece of Figs. 1 to 7 inclusive, for use with a valve member having the inverted saucer-like form of the valve member 27.

As previously indicated, the face parts 11 and 42, including the detachable caps thereof, are preferably fabricated from organic plastic material by pressure molding processes. The valve members or diaphragms 27 (Figs. 1 to 7) and 43 (Figs. 8 and 9) are preferably formed from rubber or rubberlike material, either natural rubber or synthetic rubber.

Other features and advantages of the present invention will occur to those skilled in the art to which it relates.

What I claim is:

1. An exhalation valve structure for a respiratory device such as a gas mask, said valve structure comprising a wall portion provided with an exhalation aperture, a resilient valve member of disk-like form normally engaging at its peripheral edge the said wall portion to normally seal said aperture, said valve member being imperforate and having a centrally located undercut socket, and a headed projecting member carried by said wall portion and seated in said socket for supporting said valve member, said headed projecting member being in contact with the valve member only throughout a minor portion of the interior surface area of said socket.
2. An exhalation valve structure for a respiratory device such as a gas mask, said valve structure comprising a wall portion provided with an exhalation aperture, a valve member having a resilient, imperforate disk-like portion normally engaging at its periphery the said wall portion to thereby seal said aperture, said disk-like portion having a centrally located socket, and a stud having a shank carried by and rigid with said wall portion, and having a head spaced from said wall portion and seated in said socket, said

valve member having an annular flange below said disk-like portion and surrounding said stud between its head and said wall portion, said flange being of greater thickness than the periphery of said disk-like portion.

3. An exhalation valve structure for a respiratory device such as a gas mask, said valve structure comprising a wall portion provided with an exhalation aperture, a valve member having a resilient, imperforate disk-like portion normally engaging at its periphery the said wall portion to thereby seal said aperture, said disk-like portion having a centrally located socket, and a stud having a shank carried by and rigid with said wall portion, and having a head spaced from said wall portion and seated in said socket, said valve member having an annular flange below said disk-like portion and surrounding said stud between its head and said wall portion, said disk-like portion being spaced from the head of said stud, and said flange being in contact with said wall portion and the head of said stud.

4. An exhalation valve structure for a respiratory device such as a gas mask, said valve structure comprising a wall portion provided with an exhalation aperture, a valve member having a resilient, imperforate disk-like portion normally engaging at its periphery the said wall portion to thereby seal said aperture, said disk-like portion having a centrally located socket, and a stud having a shank carried by and rigid with said wall portion, and having a head spaced from said wall portion and seated in said socket, said valve member having an annular flange below said disk-like portion and surrounding said stud between its head and said wall portion, said disk-like portion being spaced from the head of said stud, and said flange being in contact with said wall portion and the head of said stud but being free of contact with the shank of said stud.

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