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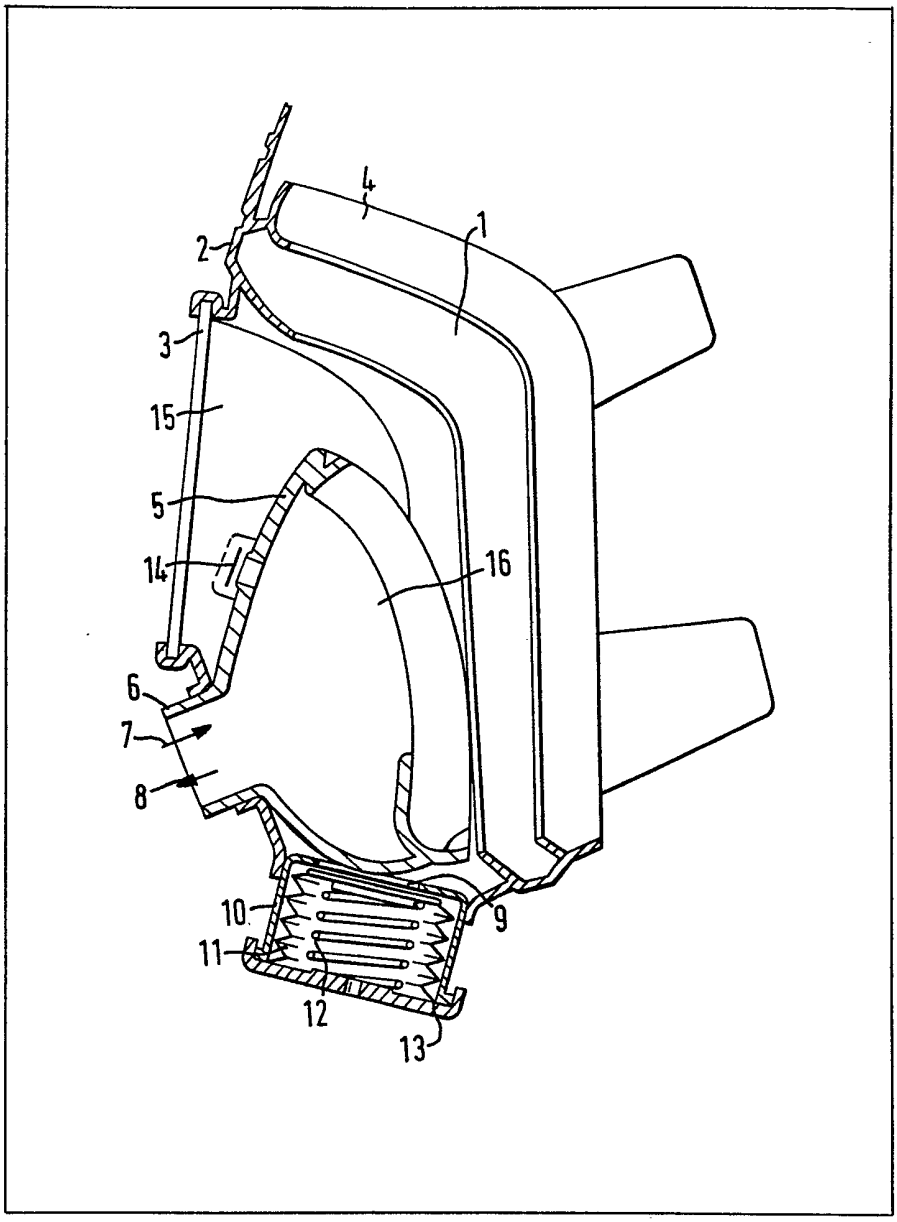
(54) Protective respiratory mask

(57) The mask has a full mask (1) which receives a half mask (5). A check valve (14) opens to the mask interspace (15) and is arranged on the half mask (5). This valve (14) maintains a superatmospheric pressure in the interspace (15), which pressure only allows a flow of expiratory air outwards in the case of leaks.

A leakage compensation means in the wall of the full mask (1) has a spring-loaded bellows (11) which with the pressure of expiration in the mask interspace (15) changes the volume of the latter. In the case of greater leaks the bellows compensates the volume difference by relaxing the spring (12). During this compensation the superatmospheric pressure in the mask interspace (15) and therewith security against the penetration of foreign gases is preserved. Thus a superatmospheric pressure is ensured in the mask interspace (15) during the inspiration phase preventing the penetration of unfiltered atmospheric air.



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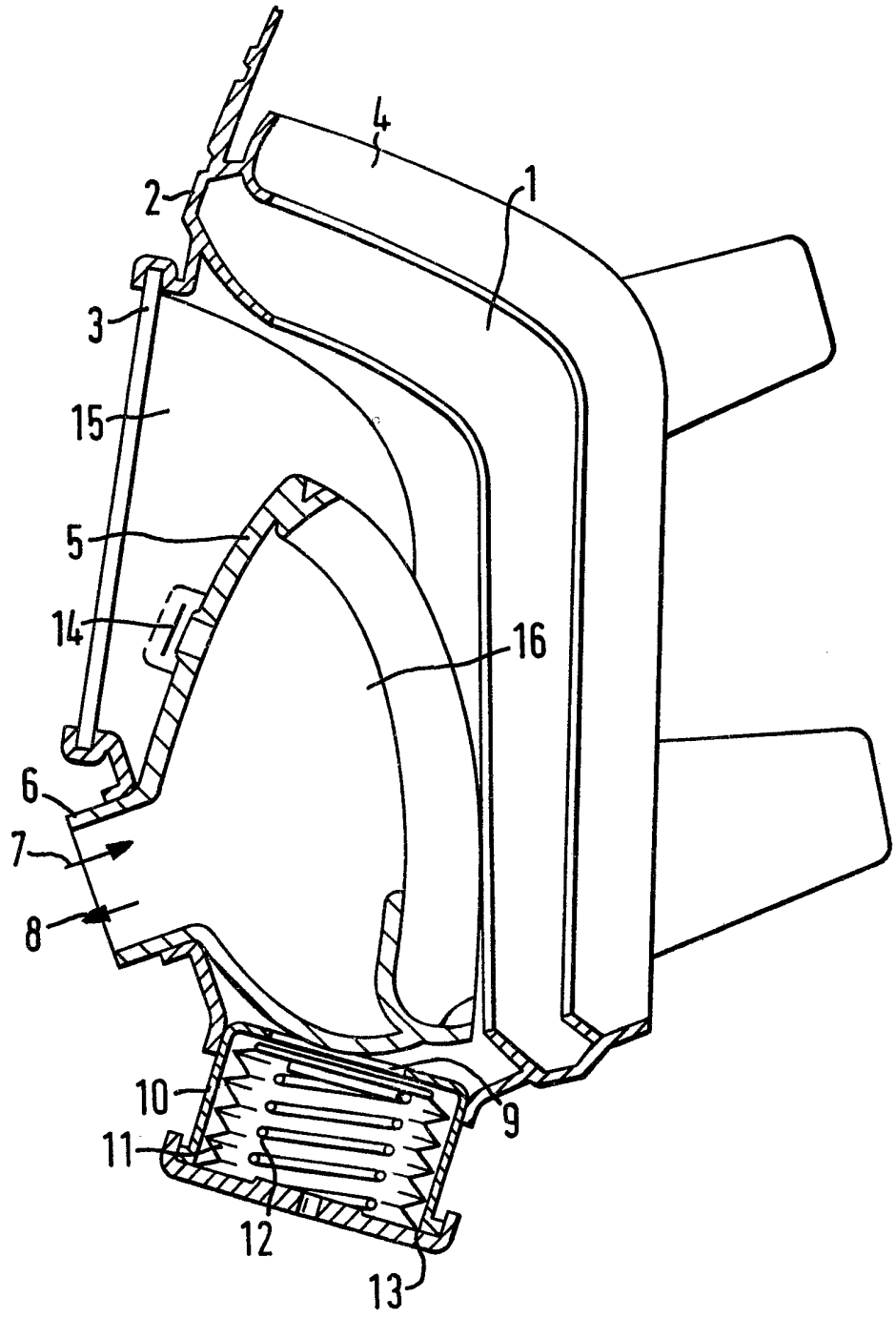
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SPECIFICATION

A protective respiratory mask

This invention relates to a protective respiratory mask, comprising a full mask and a half mask received by the full mask.

A known problem with protective respiratory apparatus is the difficulty of effecting a tight connection of such an apparatus with the respiratory system of a wearer of the apparatus. The safest respiratory connection is a mouth piece. However, it is not always pleasant to wear and requires a commensurate discipline of the wearer of the apparatus. A full mask with an internal mask is prevalent today. The necessary tight connection is only achieved with such a mask, however, if leakiness which remains on account of different face shapes is compensated. In any case, a situation must be prevented wherein air from the surrounding atmosphere is able to enter the interior of the mask through the mask sealing or even wherein oxygen can escape through the mask sealing and possibly constitute a fire hazard.

A protective breathing mask with double sealing rim is disclosed in Swiss Patent Specification No. 473 592. This mask has means for conducting expiratory air through an interspace between the two sealing rims. In this construction, the double sealing rim develops through a seal on the full mask and the internal mask which covers the whole face. Inspiration takes place through a joining piece directly into the internal mask. Expiration takes place by way of a valve, which opens in the direction of expiration, and which is located in the wall of the internal mask, through the interspace between both masks, and either through a further valve device straight towards the outside or back into a circulatory apparatus. A low excess pressure thereby builds up in the interspace so that, on connection to a circulatory apparatus, no environmental air, which may possibly be irrespirable, can enter the mask space through leakages but circulatory air can flow outwards through leakages in the sealing rim of the outer mask. This leads, in some circumstances, to a considerable shortening of usage time as the quantity of gas discharged from the comparatively small supply of oxygen of the apparatus must be replaced; further, the discharged quantity may represent a fire hazard if the oxygen content is high.

A further protective breathing mask, having an internal half mask, for use with protective respiratory apparatus with closed circulation is disclosed in German Offenlegungsschrift No. 30 15 761. In this mask, the entry of environmental air is prevented by way of an excess pressure in the space between both masks, the mask interspace. The internal half mask is arranged in a full mask. This is directly connected with a connecting branch which leads to the protective respiratory apparatus and through which both inspiration and expiration take place.

The internal half mask has in its wall a check valve which opens in the direction of the mask interspace. Upon expiration into the closed circulatory system this valve opens so that expiratory air can flow into the interspace dependent on the resistance to expiration of the protective respiratory apparatus. A superatmospheric pressure thus develops here. During inspiration the check valve is closed. With the sealing of the full mask and of the internal half mask the superatmospheric pressure is maintained. However, when there is even a slight leak the pressure falls during the following inspiration phase towards "zero". The next expiration phase compensates for the fall in pressure again.

It is, however, very difficult to seal the internal half mask as well as the outer full mask. The danger therefore exists that the superatmospheric pressure falls too quickly during the inspiration phase through pressure compensation to the interior space of the internal half mask and that a superatmospheric pressure and thus obstruction against leakages is therewith not given in the mask interspace during the whole phase of inspiration.

In accordance with one aspect of the present invention there is provided a protective respiratory mask comprising a full mask and a half mask received by the full mask which masks define between them a space for respiratory gas, and are provided with a passageway to allow gas to flow to and from a wearer, wherein the half mask is provided with a one-way valve which allows gas to flow from the interior of the half mask to said space to tend to maintain, in use of the mask, a superatmospheric pressure in said space, and wherein the full mask is provided with a variable volume chamber, whose volume varies in response to the pressure in said space against the action of biasing means for decreasing the volume of said space in response to a decrease in gas pressure in said space and vice versa.

The mask may be such that the variable volume chamber houses said biasing means and the volume of the variable volume chamber decreases in response to an increase in gas pressure in said space.

Alternatively the mask may be such that the interior of said variable volume chamber is in communication with said space, and said biasing means acts against the exterior of the variable volume chamber so that the volume of the variable volume chamber increases in response to an increase in gas pressure in said space.

Preferably said variable volume chamber is housed in a housing disposed in a wall partially defining the full mask, the interior of the housing being in communication with said space, and the housing being provided with a rigid wall to which said biasing means is attached.

The full mask may be provided with a transparent region to allow vision of a wearer of the mask; and the housing, which may also be made at least partially of a transparent material, may be arranged in a front wall of the full mask in

the field of vision of the wearer. In one embodiment, at least part of said housing may form a part of said transparent region.

In accordance with another aspect of the present invention there is provided a protective respiratory apparatus comprising a closed circulatory system including a protective respiratory mask according to said one aspect of the present invention.

Thus, in one embodiment of the invention, the full mask contains in its wall a leakage compensation means which has, in a housing, a bellows which moves in response to the pressure in the space against a spring supported on the bottom of the housing. A superatmospheric pressure, which is necessary to prevent the penetration of the surrounding atmosphere, which might possibly be poisonous, into the mask, can be maintained for a long time in the space in spite of the pressure of small leaks. Such leaks are especially likely to occur from the half mask. When the mask is used in a closed circulatory system, the leakage compensation prevents a great loss of respiratory air from the circulatory system. Even a small bellows with a volume of approximately 20 cm^3, can compensate for leaks of approximately 1% of the respiratory air turnover. The following data may be taken as an example. 1% leaks result in a leakage loss of 0.3 l/min with a respiratory air turnover of 30 l/min. With 15 breaths/min this results in a volume discharge/breath of 20 cm^3. Elasticities of the full mask support the volume of the bellows.

The leakage compensation means further presents the possibility, when fitting the mask for use, of controlling the tight fit onto the face. Previously, this was done by closing a mask connection with the ball of the thumb and then generating a low pressure through suction. This method of testing has the disadvantage, however, that the wearer of the mask generates a low pressure, which is nevertheless too high, which causes the mask to be sucked too strongly against the face. With the leakage compensation means a safer testing method may be adopted. The wearer of the mask expires into the mask while the mask connection is kept shut. As a result, the bellows is moved against the force of the spring. If the wearer of the mask does not expire further, the bellows will return into the original position in the case of leaks. This test for sealing has the advantage that it is carried out in respect of the surrounding atmosphere with the pressure difference as occurs in practical operation. It is therefore advantageous to observe the leakage compensation means while monitoring the tightness of fit of the mask.

For a better understanding of the present invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawing which shows a section through a respiratory mask according to an embodiment of the present invention.

The protective breathing mask consists of a full mask 1 having a mask body 2, a viewing window 3 and an outer sealing frame 4 in which there is arranged an internal half mask 5. This is directly connected via a connecting pipe 6 to a protective respiratory apparatus with closed circulation, the pipe 6 allowing both inspiration, as indicated by arrow 7, and expiration, as indicated by arrow 8, to take place.

The mask body 2 is provided with leakage compensation means 9 in the form of a covering 10; a variable volume chamber in the form of bellows 11; and a spring 12. A base 13 of the covering 10 serves as an abutment for the spring 12.

The internal half mask 5 is provided in its wall with a check valve 14 which opens and closes easily. It opens in the direction of a space formed between the half mask 5 and the full mask 1, the mask interspace 15. During inspiration the check valve 14 closes, dependent on the low pressure in the interior space 16 of the internal half mask 5. During expiration a slight excess pressure develops as a result of the resistance of the connected protective respiratory apparatus with closed circulation. This causes the check valve 14 to open so that a portion of the expiratory air can flow into the mask interspace 15. An excess pressure is thereby built up in the interspace 15 during expiration as in the interior space 16 of the internal half mask 5. At the end of the expiration phase the check valve 14 closes again. As a result of the excess pressure in the mask interspace 15 the bellows 11 of the leakage compensation means 9 is compressed against the action of spring 12.

With good sealing of the full mask 1 and of the internal half mask 5, the excess pressure is maintained in the mask interspace 15 during the inspiration phase. In the case of a slight leak, the bellows 11 expands again under the action of the spring 12, as the pressure falls, thereby compensating the volume of the mask interspace 15 so that an excess pressure is maintained here until the next expiration phase.

The protective respiratory mask when used with a protective respiratory apparatus with a closed circulatory system, affords a low superatmospheric pressure at the sealing line of the mask with the face; and there is no flow through the mask interspace 15 even when there are leakages, which cannot always be prevented, at the seals of both masks.

CLAIMS

1. A protective respiratory mask comprising a full mask and a half mask received by the full mask which masks define between them a space for respiratory gas, and are provided with a passageway to allow gas to flow to and from a wearer, wherein the half mask is provided with a one-way valve which allows gas to flow from the interior of the half mask to said space to tend to maintain, in use of the mask, a superatmospheric pressure in said space, and wherein the full mask is provided with a variable volume chamber,

whose volume varies in response to the pressure in said space against the action of biasing means for decreasing the volume of said space in response to a decrease in gas pressure in said space and vice versa.

2. A protective respiratory mask as claimed in claim 1, wherein said variable volume chamber houses said biasing means and wherein the volume of the variable volume chamber decreases in response to an increase in gas pressure in said space.

3. A protective respiratory mask as claimed in claim 1, wherein the interior of said variable volume chamber is in communication with said space, and said biasing means acts against the exterior of the variable volume chamber so that the volume of the variable volume chamber increases in response to an increase in gas pressure in said space.

4. A protective respiratory mask as claimed in any preceding claim, wherein the full mask is provided with a transparent region to allow vision of the wearer.

5. A protective respiratory mask as claimed in any preceding claim wherein said variable volume chamber is housed in a housing disposed in a wall partially defining the full mask, the interior of the housing being in communication with said space, and the housing being provided with a rigid wall to which said biasing means is attached.

6. A protective respiratory mask as claimed in claims 4 and 5 wherein the housing is arranged in a front wall of the full mask in the field of vision of the wearer.

7. A protective respiratory mask as claimed in claim 4 or 5, wherein the housing is made at least partially of a transparent material.

8. A protective respiratory mask as claimed in claim 7, when appendant to claim 4, wherein at least a part of said housing forms a part of said transparent region.

9. A protective respiratory mask as claimed in any preceding claim, wherein said variable volume chamber comprises a bellows.

10. A protective respiratory mask as claimed in any preceding claim, wherein said biasing means comprises a spring.

11. A protective respiratory mask substantially as hereinbefore described with reference to, and as shown in, the accompanying drawing.

12. A protective respiratory apparatus comprising a closed circulatory system including a protective respiratory mask as claimed in any preceding claim.

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