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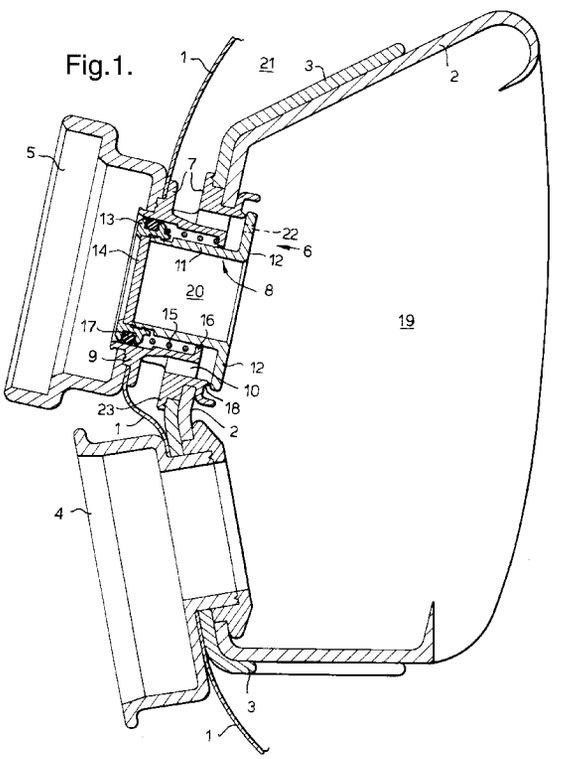
(54) Valve for breathing apparatus

(57) Breathing apparatus, particularly emergency escape breathing apparatus, comprising a hood (1) of flexible material for covering the user's head, an ori-nasal mask (2) mounted within the hood for covering the user's nose and mouth and a valve assembly (6) for controlling the supply of breathable gas from a supply (not shown) to the ori-nasal mask (2). The valve assembly includes a porous disc (14) which, in use, creates a pressure differential which acts to open a normally closed connection via a passage (10) between the interior of the hood (1) and the ori-nasal mask (2). This allows the user to obtain gas for breathing both direct from the supply via passage (20) and from the interior of the hood via passage (10). When however the pressure differential falls below a predetermined value, such as when the supply starts to run out, the pressure of a spring (15) overcomes the pressure differential and the passage (10) is cut off providing an immediate warning to the user that the supply is shortly to expire. Thereafter, breathing is solely from the supply or optionally in addition via restricted apertures (22) from the hood (1).

Fig.1.



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Description

This invention relates to breathing apparatus and in particular to emergency escape breathing apparatus.

Emergency escape breathing apparatus is intended primarily to provide a relatively short term supply of breathable gas to a user during retreat from an emergency situation. As will become clear however, the breathing apparatus of the present invention, while primarily intended for this purpose, also finds application in situations where a longer-term supply of breathable gas is needed.

The main components of emergency escape breathing apparatus are a hood, made of flexible material, which covers the head of the user, said hood having a transparent visor portion to allow the user to see out, a supply of breathable gas in the form of a small cylinder carried by the user, and means for supplying the gas from the cylinder to the hood. Typically the air supply will have a medium pressure in the range 2-10 bar.

With this type of breathing apparatus, the hood forming as it does a flexible bag over the head, acts as a reservoir for breathable gas and, in normal operation, the gas breathed by the user is partly taken direct from the cylinder, through the aforesaid gas supplying means, and partly from the reservoir formed by the hood.

A problem arises, however, if for any reason the gas supply pressure reduces, for example as the cylinder gas pressure reduces towards the end of the life of the cylinder. In these circumstances, carbon dioxide can build up in the hood due to the fact that there is not sufficient new incoming gas to flush out the carbon dioxide breathed out by the user. The user thus ends up breathing a gas which is increasingly contaminated with carbon dioxide and this may not always be apparent to the user until it is too late.

The present invention seeks to overcome this problem by making it immediately apparent to the user that the gas supply has reduced by either reducing that proportion of the gas supplied to the user from the reservoir formed by the hood as against that which is supplied to the user direct from the breathable gas supply, or allowing the user additionally to source air from the exterior.

In accordance with the invention there is provided breathing apparatus comprising a hood made of flexible material and intended to cover the head of a user, an ori-nasal mask attached to the inside of said hood for covering the nose and mouth of a user and means for supplying a breathable gas to said ori-nasal mask, said supplying means being characterised by a valve assembly which is operable to control the supply of gas to the ori-nasal mask, said valve assembly comprising a first passage through which gas from said supplying means may flow into said ori-nasal mask, said first passage incorporating a flow restrictor for creating a pressure differential between the input of said first passage and its output, a second passage through which gas may flow into and out of said ori-nasal mask, said second passage incorporating a valve for controlling the flow of gas through said second passage, and control means for controlling the operation of said valve in dependence upon the magnitude of said pressure differential.

Said second passage may connect the interior of the ori-nasal mask either to the interior of the hood, or to the exterior atmosphere, and this leads to two different modes of operation. Where the connection is to the interior of the hood, the operation of the valve assembly is as follows:-

1) When the supply of gas to the input of the first passage is at its normal, relatively high, pressure, the pressure differential across said flow restrictor is also relatively high and, in these circumstances, the control means acts to keep the second passage open so that the hood can fulfil its normal function of acting as a reservoir for the gas breathed by the user. During inhalation, gas is supplied to the ori-nasal mask partly direct from the breathable gas supply, through said first passage, and partly from the reservoir within the hood, through said second passage. During exhalation, a mixture of exhaled gas and new gas direct from the gas supply via the first passage is passed from the ori-nasal mask to the hood through said second passage to maintain the reservoir in the hood.

2) In the event that the supply of gas to the input of the first passage reduces, the pressure differential across the flow restrictor likewise reduces and, at some predetermined pressure, the control means acts to close the valve, thus reducing or even completely cutting off the supply to and from the hood. Thereafter, the air supply to the ori-nasal mask comes to a greater extent than before direct from the supply through said first passage. If the valve effects a complete closure of said second passage then, in the absence of other communication between the ori-nasal mask and the hood, the air supply to the user will thereafter be wholly from the air supply and will not have the benefit of the reservoir formed by the hood. The closing of the valve is readily sensed by the user who is thus warned of the reduction in the supply pressure.

When the second passage connects the ori-nasal mask to the exterior, the operation of the valve assembly is as follows:-

1) When the supply of gas to the input of the first passage is at its normal, relatively high, pressure, the pressure differential across said flow restrictor is also relatively high and, in these circumstances, the control means acts to keep the second passage closed. During inhalation, gas is supplied to the ori-nasal mask direct from the breathable gas supply, through said first passage.

2) In the event that the supply of gas to the input of the first passage reduces, the pressure differential across the flow restrictor likewise reduces and, at some predetermined pressure, the control means acts to open the valve, thus opening the second passage between the ori-nasal mask and the exterior. Thereafter, the gas supply to the ori-nasal mask comes partly direct from the reduced air supply through said first passage and partly from the exterior atmosphere via the second passage until the air supply stops and gas is supplied only from the exterior atmosphere. The closing of the valve may be readily sensed by the user, by restricting the gas breathed from the external atmosphere, so that the user is thus warned of the reduction in the supply pressure.

In order to maintain the air flow through the hood, means are also provided for venting the hood to atmosphere. There are various ways of doing this. For example, the neck of the hood may be left as a relatively loose fit so that excess gas simply leaks out, whilst still retaining the reservoir function of the hood. An alternative way is to fit a positive pressure exhalation valve in the hood so as to allow gas out but not in. In this case, the hood would be made a relatively sealing fit, thus defining an efficient reservoir within the hood. The exhalation valve can be placed in the hood material, or may be fitted direct in the ori-nasal mask. In this case the ori-nasal mask would also be made a relatively sealing fit. The direct fit is the better option since it can be positioned to remove as much as possible of the carbon dioxide laden exhaled breath and thus keeping the hood relatively clear of carbon dioxide. If the valve in the second passage is arranged to close completely, cutting off normal communication between the ori-nasal mask and the hood, then the exhalation valve will necessarily have to be positioned within the ori-nasal mask since otherwise there would be no vent for excess gas except around the edges of the ori-nasal mask.

The flow restrictor may take several forms, such as a single or multiple small holes in said second passage, or a tortuous route or, in the preferred embodiment, a porous membrane which is placed in the first passage.

In an embodiment, in which the second passage communicates with the interior of the hood, the first passage is defined within a first conduit which is movable between a first and a second position and is biassed into said first position by a spring means. By contrast the differential pressure due to the flow of gas through said restrictor acts in the opposite direction, namely in a direction tending to move the conduit to said second position. The first conduit is mechanically linked to the valve in said second passage in such a way that, when the conduit is in said first position, the valve is closed and, when the conduit is in the second position, the valve is open. It will be seen that, during operation of the valve assembly, the differential pressure acts in a direction against the spring means thus tending to keep the conduit in said second position, and keeping the valve in the second passage open. When the differential pressure drops below said predetermined level, the force of the spring means overcomes the force on the conduit due to the differential pressure and the conduit moves to said first position, thus closing the valve in the second passage.

In an embodiment said second passage is defined within a second conduit which extends from the interior of the ori-nasal mask either to the interior of the hood or to the exterior atmosphere and said valve includes a valve member which selectively closes off, either wholly or partially, said second passage. The valve member is mechanically linked to said first conduit and may indeed be actually attached to said first conduit so as to move therewith.

In a preferred embodiment, the first conduit is coaxially located within said second conduit, and said valve member takes the form of an annular flange formed on said first conduit and arranged to close, wholly or partially, the second passage which is located in the annular space between the first and second conduits. The aforesaid spring means is preferably located at a position exterior to the first conduit in the space between the first and second conduits.

In order that the invention may be better understood, two embodiments thereof will now be described by way of example only and with reference to the accompanying drawings in which:

Figure 1 is a side sectional view of a first embodiment of a breathing apparatus according to the invention; and

Figures 2 and 3 are views similar to Figure 1 but on a larger scale, and showing a second embodiment of the invention.

Referring firstly to Figure 1, the breathing apparatus is of the emergency escape type and comprises a hood 1 made of flexible impermeable material such as fabric reinforced polyurethane. The front part of the hood, including the part shown in the drawing, takes the form of a visor made of flexible transparent plastics material. In use, the hood is worn on the head of the user and has an elasticated neck to provide a reasonable seal at the user's neck, thus defining a relatively sealed space 21 within the hood which acts as a reservoir of breathable gas.

The hood is equipped with an ori-nasal mask 2 made of flexible plastics material or rubber which fits against the user's face, over the nose and mouth. The shape of the ori-nasal mask is maintained by an exo-skeleton 3 of rigid plastics material which, like the mask itself, is attached to the hood. An excess pressure exhalation valve is fitted to the exo-skeleton to vent excess gas within the ori-nasal mask to atmosphere. This valve, which is of conventional construction and is therefore not illustrated,

is fitted within a holder 4 attached to the exo-skeleton 3.

A supply of breathable gas is taken from a cylinder (not shown) which is worn by the user. Note however that the gas supply could be any compressed air source taken from a fixed or portable air cylinder, or from an air line. Typically the supply pressure will be in the range 2-10 bar.

Breathable gas is supplied to the user via a removable connector (not shown) which sealingly fits into a circular holder 5. This circular holder 5 is mounted on the exterior of a valve assembly 6 which is attached to the exo-skeleton 3. The valve assembly 6 controls the flow of gas from the supply to the interior 19 of the ori-nasal mask 2.

The valve assembly 6 is made primarily of two components: an outer component 7 and an inner component 8 which is mounted coaxially within the outer component 7 and is movable axially relative to the outer component. The outer component 7 itself comprises coaxially positioned inner and outer portions 9 and 23 respectively. The outer portion 23 is mounted on the exo-skeleton and the inner portion 9 is attached to the circular holder 5. Between the inner and outer portions 9,23 of the component 7 is an annular passage 10.

The inner component 8 comprises a cylindrical conduit 11 having, at its end within the interior 19 of the ori-nasal mask, a flange 12 of annular shape. The other (outer) end of the conduit 11 is fitted with a collar 13 which mounts a disc 14 of porous material. This disc may, for example, be a Porvair microporous filter made of sintered Vyton.

The conduit 11 is positioned primarily within the inner portion 23 of the outer component 7 and a helical spring 15, for example of stainless steel, is mounted between the two, as shown. This spring acts between a flange 16 formed on the inner portion 8 of the outer component 7, and said collar 13 to thus tend to bias the conduit 11 in an outwards direction (i.e. right to left in the drawing). The conduit 11 is located at its outer end by an O-ring seal 17 positioned in an outer circumferential slot formed in the collar 13, and at its inner end by engagement with the flange 16. Thus the conduit 11 is capable of executing an axial sliding movement, relative to the outer component 7. The collar 13 is removable, both for assembly purposes, and also to enable the disc 14 to be replaced.

Around the rim of the opening of the annular passage 10 into the interior 19 of the ori-nasal mask 2 is a triangular section ridge 18. As can be seen, the action of the spring 15 is such as to press the undersurface of the flange 12 onto the tip of the ridge 18 thus effecting a sealing connection and closing off the passage 10 from the interior 19 of the ori-nasal mask 2.

To use the breathing apparatus, the hood 1 is placed over the head, and the ori-nasal mask placed over the nose and mouth to give a reasonable sealing connection against the face around the edge. A source of breathable gas is supplied to the interior 19 of the ori-nasal mask via the above-referred to removable connector which is fitted into the holder 5. During use breathable gas passes through the porous disc 14 into the passage 20 defined by the conduit 11. The air thence passes along the passage 20 to the interior 19 of the ori-nasal mask 2 where it forms a component of the gas breathed by the user. In passing through the porous filter disc 14, the air creates a differential pressure across the disc as between the low pressure in the interior 19 of the ori-nasal mask and the relatively higher pressure of the incoming gas from the source. This differential pressure sets up a force in an inwards direction (i.e. left to right in the drawing) tending to oppose the spring 15. Provided that the differential pressure is sufficiently great, the conduit 11 is pushed in an inwards direction relative to the outer component 7 and thus causes the flange 12 to lift from its seating on the ridge 18 and open up a communication between the interior 19 of the ori-nasal mask 2 and the interior 21 of the hood 1 via the annular passage 10.

In normal operation, when the pressure to the left of the disc 14 is high enough to maintain sufficient differential pressure across the disc to keep the passage 10 open, the gas within the ori-nasal mask which is available for the user to breath is a mixture of air direct from the source, entering via passage 20, and gas from the reservoir formed by the interior 21 of the hood, entering via the passage 10. In these circumstances, the passage 10 remains open on both inhalation and exhalation. As already mentioned, on inhalation, the gases are drawn in to satisfy the user's demand from both the source and the reservoir formed by the hood; on exhalation, the flow of air from the source via the passage 20 continues, but the flow through the passage 10 reverses, allowing gas to return to the interior 21 of the hood to keep the reservoir topped up. During all of this process, excess gas is vented to atmosphere via the exhalation valve.

In the event that the air supply pressure reduces, the pressure at the left hand side of porous disc 14 reduces and this in turn causes a reduction of the differential pressure across the disc 14. At a predetermined differential pressure, determined by the strength of spring 15, the flange 12 of conduit 11 will become pressed against the tip of ridge 18 and the connection between the interior 19 of the ori-nasal mask and the interior 21 of the hood will thus be closed off. This situation is detected immediately by the user since the reservoir formed by the hood is no longer available. In these circumstances the sole gas supply is direct from the source via the passage 20 and the characteristics of the apparatus, as perceived by the user, change markedly, and thus provide a clear warning of possible imminent failure of the supply. Furthermore, whilst the passage 10 is cut off, and provided the air supply does not expire completely, a build-up of carbon dioxide within the interior 19 of the ori-nasal mask cannot occur, since exhaled gas will be flushed out by the incoming air, via the exhalation valve.

In an alternative embodiment of the invention a plurality of spaced holes (one shown dotted under reference

22) are formed through the flange 12 so that, even when the flange lies against the tip of the ridge 18, there is a limited communication between the interior 19 of the ori-nasal mask 2 and the interior 21 of the hood. These holes have no effect during normal operation but, when the pressure falls to an extent to cause the flange 12 to move against the ridge 18, the user can obtain a limited quantity of gas from the reservoir, thus making the effort of breathing more comfortable during this period. However, the difference in breathing characteristics is still sufficient to give the user clear warning of the possible imminent failure of the supply.

A second embodiment of the invention is shown in Figures 2 and 3. Since the construction is very similar, detailed description will not be given; reference numerals from Figure 1 are used for corresponding parts, where appropriate.

There are two principal differences in construction:

1) The valve assembly 6 is carried on the hood 1, as before, but is attached to the material of the hood by the outer portion 23 of the component 7 instead of by the inner component 9, as before. The result of this is that the annular passage 10 exits to atmosphere, instead of to the interior 21 of the hood, as before. Other means (not shown) may be provided for effecting communication between the interior 21 of the hood and the interior 19 of the ori-nasal mask, these means effecting a permanent or semi-permanent connection, as desired. This will be discussed in more detail below.

2) The outer portion 23 of the component 7 is extended inwards into the interior 19 of the ori-nasal mask by a cylindrical portion 24. At its innermost end, the portion 24 is formed with an inwardly extending flange 25 which carries a triangular section ridge 26. In the position of the conduit 11 shown in Figure 3, the top surface of the flange 12 presses against the tip of the ridge 26, thus effecting a sealing connection. The ridge 26 replaces the ridge 18 of the previous embodiment, which latter is omitted. Instead, in the position of the conduit 11 shown in Figure 2, there is a two-way communication between the interior 19 of the ori-nasal mask and the exterior via the passage 10, as indicated by the two-headed arrow A.

In use, the valve assembly 6 acts in the same way as described above, but with a different result.

In normal operation, when the pressure to the left of disc 14 is high enough to maintain sufficient pressure across the disc, the differential pressure across the disc keeps the flange 12 in contact with the ridge 26, as shown in Figure 3. During this time, air is supplied to the interior 19 of the ori-nasal mask 2 through the passage 20 from the source of breathable gas. The passage 10 is closed. To enable the interior 21 of the hood to act, as before, as a reservoir, gas may additionally be supplied to the ori-nasal mask from the interior 21 of the hood through a communication means (not shown) between the interior 19 of the ori-nasal mask and the interior 21 of the hood. This communication means, if provided, may be permanent - for example, one or more holes between the ori-nasal mask and the interior of the hood, or may be switched on or off in dependence upon the state of the valve assembly 6.

In the event that the air supply pressure reduces, the pressure at the left hand side of the porous disc 14 reduces and this in turn causes a reduction of the differential pressure across the disc 14. At some point, the pressure of spring 15 will overcome the differential pressure, and the conduit 11 will move leftwards to the position shown in Figure 2. In this position, the passage 10 is open, and the user is able to source gas both from the breathable air source via passage 20, and from the surrounding atmosphere via passage 10. Hopefully by this time the user will have had time to move to a safer environment. The change of circumstances is, however, signalled to the user who is thus warned to get to safety as soon as possible so that the breathing apparatus can be removed altogether.

In the event that a communication is provided between the ori-nasal mask and the interior 21 of the hood, it may be arranged that, in the position of valve assembly 6 shown in Figure 2, the communication is cut off to prevent the user trying to breath increasingly stale gas from the interior of the hood.

Claims

1. Breathing apparatus comprising a hood made of flexible material and intended to cover the head of a user, an ori-nasal mask attached to the inside of said hood for covering the nose and mouth of a user and means for supplying a breathable gas to said ori-nasal mask, said supplying means being characterised by a valve assembly which is operable to control the supply of gas to the ori-nasal mask, said valve assembly comprising a first passage through which gas from said supplying means may flow into said ori-nasal mask, said first passage incorporating a flow restrictor for creating a pressure differential between the input of said first passage and its output, a second passage through which gas may flow into and out of said ori-nasal mask, said second passage incorporating a valve for controlling the flow of gas through said second passage, and control means for controlling the operation of said valve in dependence upon the magnitude of said pressure differential.

2. Breathing apparatus as claimed in claim 1 wherein said valve assembly comprises a first component in which is formed said first passage and a second

component in which is formed said second passage, said components being movable in relation to one another from a first position in which said valve is open to a second position in which said valve is closed.

3. Breathing apparatus as claimed in claim 2 including spring means acting between said first and second components to bias said components into one of said first or second positions.

4. Breathing apparatus as claimed in claim 3 in which the flow restrictor is positioned such that said pressure differential acts in opposition to the pressure of said spring.

5. Breathing apparatus as claimed in any one of the preceding claims wherein said flow restrictor comprises a disc of porous material mounted in said first passage.

6. Breathing apparatus as claimed in any one of the preceding claims wherein the second passage communicates with the interior of the hood.

7. Breathing apparatus as claimed in claim 6 wherein, when the pressure differential created by said flow restrictor is above a predetermined value, said valve is open to allow flow of gas from the interior of the hood to the ori-nasal mask and vice versa and, when the pressure differential is below said predetermined value, said valve is closed.

8. Breathing apparatus as claimed in either one of claims 3 or 4 and claim 7 wherein said spring means is operable to bias said components into said second position.

9. Breathing apparatus as claimed in any one of claims 6 to 8 further comprising bypass means for bypassing said valve to give a limited communication between the interior of the hood and the ori-nasal mask, even when the valve is closed.

10. Breathing apparatus as claimed in any one of claims 1 to 5 wherein the second passage communicates with the exterior.

11. Breathing apparatus as claimed in claim 10 wherein, when the pressure differential created by said flow restrictor is above a predetermined value, said valve is closed to prevent passage of gas from the exterior to the ori-nasal mask and, when the pressure differential is below said predetermined value, said valve is open to allow flow of gas from the exterior to the ori-nasal mask and vice-versa.

12. Breathing apparatus as claimed in either one of claims 3 or 4 and claim 11 wherein said spring means is operable to bias said components into said first position.

Fig.1.

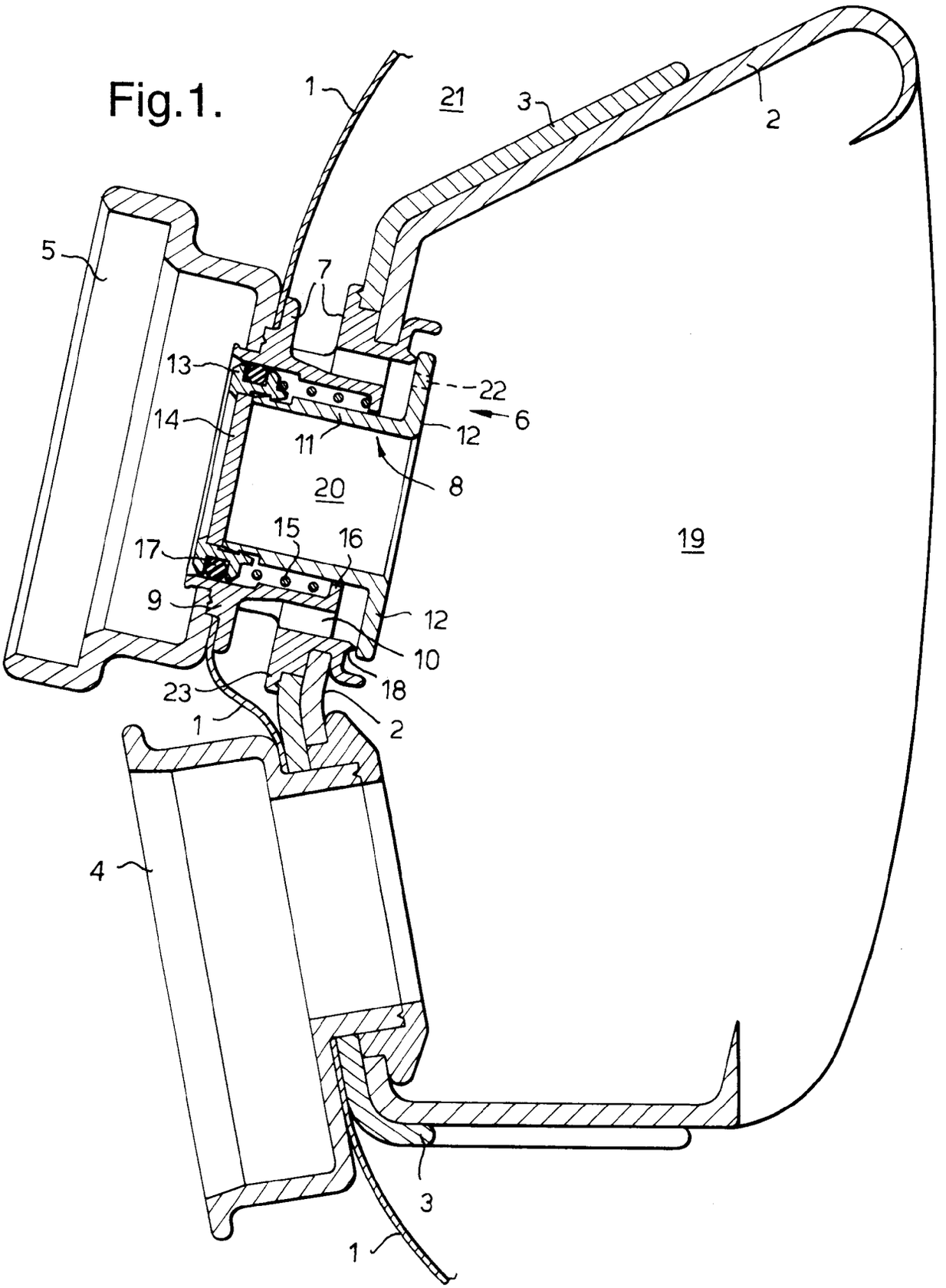


Fig.2.

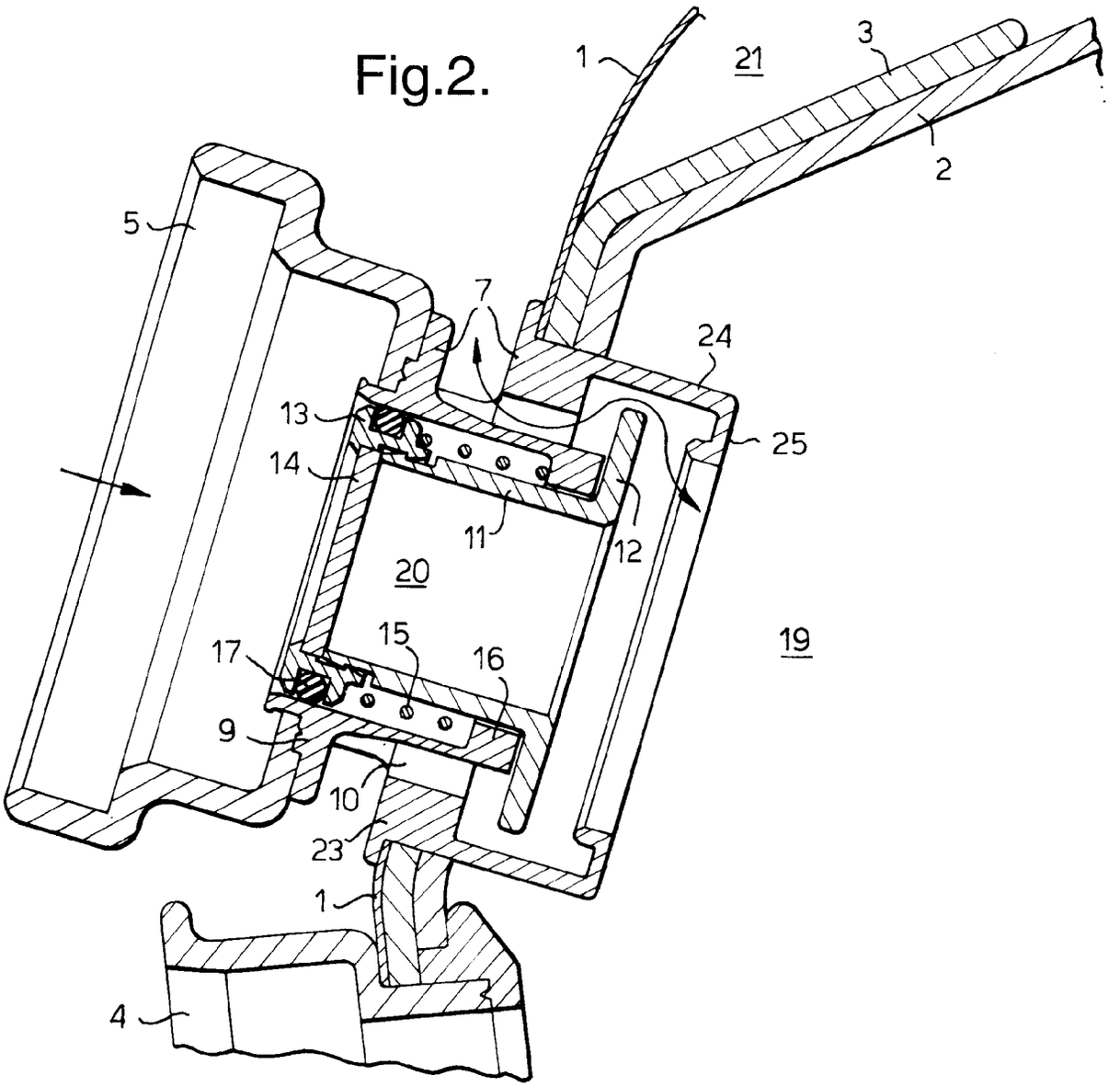
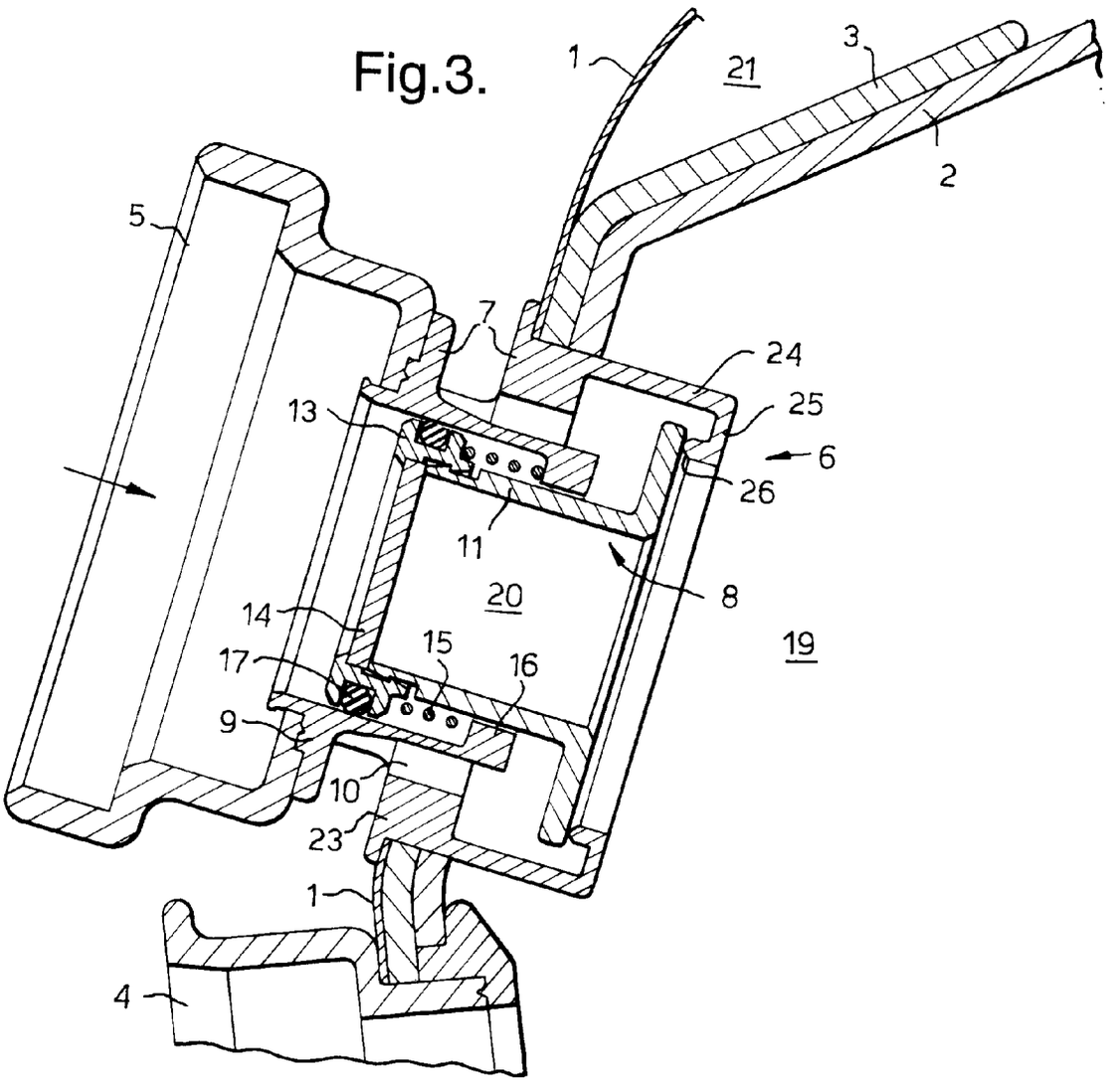


Fig.3.



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EUROPEAN SEARCH REPORT

Application Number
EP 95 30 6695

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	EP-A-0 470 791 (SABRE SAFETY LTD) * column 5, line 16 - column 9, line 35; figures 1-4 *	1	A62B9/02 A62B18/10
A	FR-A-2 649 016 (DRÄGERWERK) * page 4, line 19 - page 5, line 26; figures 1,2 *	1	
A	EP-A-0 130 283 (AUERGESELLSCHAFT) * page 2, paragraph 2 - page 3, paragraph 1 *	1	
A	GB-A-2 244 433 (CAMBERLEY RUBBER MOUNTINGS LTD) * page 7, line 19 - page 16, line 26; figures *	1	
A	US-A-4 007 758 (GRAY) * column 1, line 64 - column 3, line 62; figures 1-5 *	1	
A	US-A-2 966 917 (BLOOM) * column 1, line 64 - column 3, line 36; figures 1,2 *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.6) A62B
A	GB-A-2 143 137 (FIGGIE INTERNATIONAL INC) * page 1, line 105 - page 3, line 72; figures 1-5 *	1	
A	EP-A-0 325 959 (BILSOM SENTRY LTD) * column 2, line 24 - column 6, line 38; figures 1,2 *	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	22 December 1995	Triantaphillou, P

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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