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(71) Applicant: **SEKUR S.p.A.**
Piazzale Cadorna, 5
I-20123 Milan(IT)

(72) Inventor: **Cristiani, Andrea**
Via S. Severina, 25
I-00178 Roma(IT)
Inventor: **Genova, Baldassare**
Via A. Vertunni
I-00155 Roma(IT)

(74) Representative: **Giannesi, Pier Giovanni et al**
Pirelli S.p.A. Direzione Propietà Industriale,
Piazzale Cadorna 5
I-20123 Milano(IT)

(54) Panoramic protection mask for operating interventions in polluted environments.

(57) The described protection mask (1) comprises an annular lip (2) supporting a transparent screen (4) of toroidal form extending from the forehead of a user (3) to his chin. The screen (4) close to the user's mouth exhibits a preferably projecting middle portion (4c) having a connecting sleeve (5) provided with an inspiration opening (5b) and an expiration opening (5a) with which a single-acting valve (8) is associated, sealingly fastened thereto. A half-mask (6) is engaged to the inner part of the mask (1) and it sealingly acts by its perimetrical edge (6a) around the user's nose and mouth to bring them directly into communication with the expiration opening (5a). Two check valves (7) are associated with the half-mask (6) and are designed to enable the air transfer from the mask (1) inside to the half-mask (6) inside.

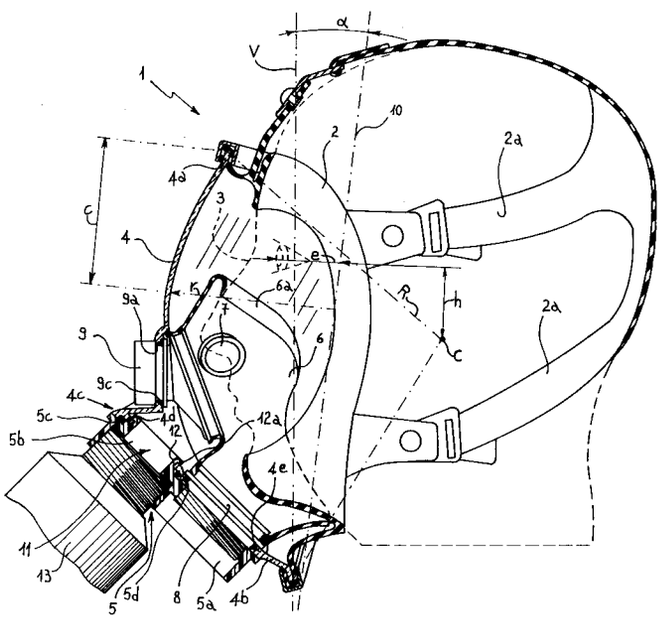

FIG. 1

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The present invention relates to a panoramic protection mask for operating interventions in polluted environments.

It is known that protection masks are widely used in case of natural disasters, industrial accidents or any situation in which it is necessary to ensure the user's survival even when highly toxic substances - be they in the form of gases, aerosol or powders - are present in the surrounding atmosphere.

The most common masks essentially comprise a rubber face-piece provided with a sealing lip arranged to act in abutment on the user's face, breathing means arranged to put the inner part of the mask into communication with an air supply and a transparent screen capable of permitting the user's vision.

The transparent screens can have different shapes and the most important ones are flat-shaped screens, screens in the form of a cylindrical sector defined by a single bending radius, and screens in the form of a truncated conical sector defined by a series of bending radii decreasing towards the lower screen portion.

Also provided are masks in which the transparent screen and face-piece are of one piece construction. a mask of the last mentioned type being for example the object of the US Patent No. 4,069,516.

In the above patent the mask mainly comprises an annular sealing lip arranged to act in contact relation on the user's face and carrying a transparent visual screen substantially of truncated conical form the major base edge of which is fastened to the lip whereas the minor base edge is such shaped as to be adapted to receive the breathing means as well as a possible transmitter.

Another type of protection mask having the screen and face-piece of one piece construction has been widely described in the European Patent No. 0 304 641.

Said mask is comprised of a visual screen provided with a perfectly transparent eye region and an opaque lower portion designed to receive the breathing means and a possible transmitter.

In addition this visual screen is so shaped that the transparent eye region is located as close as possible to the user's eyes.

It has been found that in order to ensure the maximum visual field in a mask simultaneously with the complete absence of optical distortions and, as much as possible, a uniform pressure on the user's face, one can resort to a screen having a substantially toroidal conformation completely embracing the user's face.

In accordance with the invention a panoramic protection mask for operating interventions in polluted environments is provided, of the type comprising an annular sealing lip arranged to exercise a tight seal around the user's face, a transparent screen sealingly connected to said annular lip by its outer perimeter, a connecting sleeve exhibiting an inspiration opening designed to bring an air supply into communication with the inside of the mask and an expiration opening, characterized in that said transparent screen has a substantially toroidal shape defined by an arc of a circle rotating through an angle of predetermined amplitude about a substantially vertical axis of rotation, said screen extending by its upper edge as far as the top of the user's forehead while the lower edge thereof extends as far as under the user's chin, the distance of said upper edge from said axis of rotation being greater than the distance therefrom of the lower edge, so that the screen can be given a downwardly tapering shape, said screen exhibiting a middle portion designed to sealingly engage the connecting sleeve and substantially positioned in register with the user's mouth.

It is to be noted that when the mask is worn by the user the axis of rotation of the transparent screen of toroidal form is substantially upright. In accordance with the present invention the thickness of the transparent screen is the greatest in the middle of its toroidal surface and gradually decreases towards the side portions thereof.

In keeping with a preferential aspect of the invention, the transparent screen is in the form of an isosceles triangle in which the base side is of substantially rectilinear configuration and defines the upper edge of the screen, whereas the oblique sides have a curvilinear extension, the three sides being joined to each other by wide-radius rounded portions.

Said transparent screen has one hole formed in the vicinity of the upper portion of said projecting middle portion and designed to sealingly receive a transmitter.

In accordance with the present invention said projecting middle portion has a second hole designed to be coupled to the inspiration opening of said connecting sleeve and a third hole designed to be coupled to the expiration opening of the sleeve.

It is to be noted that the axes of the first, second and third holes lie in the plane of symmetry of the transparent screen.

In particular said connecting sleeve is sealingly and removably engaged to said transparent screen by fastening means essentially consisting of a bayonet coupling.

Still in accordance with the present invention said bayonet coupling comprises a ring nut carried by the connecting sleeve coaxially with said inspiration opening and provided with at least a radially-extending engaging lug, said lug being designed to engage, through axial fitting, into a cor-

responding access housing formed on the perimetrical edge of said second opening and to be locked against said perimetrical edge following an angular rotation of the connecting sleeve about the axis of the inspiration opening.

Said ring nut in the embodiment under examination has four radially-extending engaging portions which are circumferentially distributed thereon according to angles of 90 degrees, said engaging portions being designed to engage into the second hole of said transparent screen.

It is to be noted that operatively engaged in said expiration opening is a single-acting valve previously fitted in said third hole of the transparent screen from the inside thereof.

Preferably the single-acting valve is operatively engaged in said expiration opening through threaded means.

Finally, also interposed between the inspiration opening and corresponding second hole and the expiration opening and corresponding third hole is at least a seal ring of elastomeric material.

Further features and advantages of the invention will become more apparent from the detailed description of a preferred embodiment of a panoramic protection mask for operating interventions in polluted environments given hereinafter by way of non-limiting example with reference to the accompanying drawings, in which:

- Fig. 1 is a transverse sectional view of a panoramic protection mask for operating interventions in polluted environments;
- Fig. 2 is a sectional side view of a toroidal transparent screen belonging to the protection mask shown in Fig. 1;
- Fig. 3 is a top view of the screen shown in Fig. 2;
- Fig. 4 is a front view of the screen;
- Fig. 5 is a diagram showing the amplitude of the visual field permitted by the mask in question.

Referring to the drawings and in particular to Fig. 1, a panoramic protection mask for operating interventions in polluted environments has been generally identified by reference numeral 1.

The protection mask 1 has a rubber annular lip 2 designed to act by contact on the user's face 3 due to a pulling action exerted thereon by a sling 2a provided around the user's head.

Fastened to the lip 2 by its outer perimeter is a transparent screen 4 of toroidal form defined by an arc of a circle rotating according to an angle of predetermined amplitude about a substantially vertical axis of rotation 10 (Figs, 1 and 2).

As viewed from Fig. 1, when the mask 1 is worn by a user 3 the transparent screen 4 thereof has its axis of rotation 10 inclined by an angle α the value of which is included between 5 degrees on and 25 degrees back relative to a vertical direction V.

In addition, said axis of rotation 10 appears to be in a rear position relative to the user's eyes by a value (e) ranging between 20 and 40 millimetres.

The screen 4 has an upper edge 4a located close to the top of the user's forehead and a lower edge 4b extending as far as under the user's chin.

As can be seen from Figs. 1 and 2, the transparent screen shown in section according to a vertical plane of symmetry is in the form of an arc of a circle the bending radius (R) of which is included between 100 and 200 millimetres.

It is to be pointed out that the centre (C) of the arc of the circle is disposed under the user's eyes by an amount (h) equal to or greater than 0 and smaller than 50 millimetres. As shown in Fig. 3, the toroidal transparent screen 4 is generated by the rotation of said circular segment about the axis of rotation 10 through an angle of rotation β ranging between 160 and 200 degrees.

The screen 4 has its maximum bending radius (r) defined in a plane perpendicular to said axis of rotation 10 having a value included between 75 and 108 millimetres (Fig. 2).

The distance (c) existing between the upper edge 4a and the screen 4 section having the maximum bending radius (r) is included between 0 and 80 millimetres.

It is also to be pointed out that the ratio between the bending radius (R) of said circular segment and the maximum bending radius (r) of the toroidal surface is greater than 1 and smaller than 2.5.

Still in fig. 2, the bending radius (a) of the upper edge 4a and the bending radius (b) of the lower edge 4b of the screen 4 as defined in the respective planes perpendicular to said axis of rotation 10 are included between 60 and 120 millimetres and 0 and 30 millimetres respectively.

The height (d) of the screen 4 is defined by the distance existing between the upper 4a and lower 4b edges thereof and is greater than 130 millimetres and smaller than 220 millimetres.

As clearly shown in Fig. 4, the transparent screen 4 has a downwardly tapering front configuration.

In greater detail, said screen 4 seen in front view has the shape of an isosceles triangle in which the base side is substantially rectilinear and defines the upper edge 4a, whereas the oblique sides have a curvilinear extension, the three sides being joined to each other by wide-radius rounded portions.

It is also to be pointed out that preferably the thickness of said transparent screen 4 is the greatest (S') in the middle of the toroidal surface for the

whole transversal section with a value of 3,3 mm and decreases (S") towards the side portions thereof to value of 2,2 mm, with tolerances of the cited values of ± 0,7 mm.

Referring to Fig. 2, a middle portion 4c of the screen 4 projects outwardly therefrom and is substantially positioned in register with the user's mouth.

Preferably the ratio between the overall surface of the transparent screen 4 and the surface of said screen taken up by said projecting middle portion 4c varies between 4 and 8.

In the embodiment shown in the drawings said transparent screen 4 is provided with one hole 9a formed in the vicinity of the upper portion of said middle projecting region 4c and arranged to sealingly receive a transmitter 9.

The necessary tight seal for said transmitter 9 is ensured by a spring ring 9c interposed between the transmitter and the perimeter of said first hole 9a.

In addition, the middle portion 4c is arranged to sealingly engage a connecting sleeve 5 provided with an inspiration opening 5b designed to communicate the inside of the mask with an air supply, and an expiration opening 5a.

As seen in the figures, the projecting middle portion 4c is provided with a second hole 4d fitted for connection with the inspiration opening 5b of the connecting sleeve 5 and a third hole 4e fitted for connection with the expiration opening 5a of said connecting sleeve.

It is also to be pointed out that the connecting sleeve 5 is removably and sealingly engaged with said second 4d and third 4e holes of the screen 4 by fastening means 11 consisting of a bayonet coupling.

The bayonet coupling comprises a ring nut 12 carried by the connecting sleeve 5 coaxially with said inspiration opening 5b and provided with at least a radially-extending engaging lug defining an undercut, said lug 12a being adapted to engage through axial fitting into a corresponding access housing 12b formed on the perimetrical edge of said second opening 4d and to become locked against said perimetrical edge following an angular rotation of the connecting sleeve 5 about the axis of the inspiration opening 5b.

In greater detail, in the embodiment shown the ring nut 12 belonging to the bayonet coupling 11 is provided with four engaging portions 12a distributed circumferentially thereabout according to angles of 90 degrees.

The configuration of the bayonet coupling is such that the ring nut 12 and the four portions 12a can be engaged in the second hole 4d the shape of which matches that of the above pieces.

Finally, in order to enable locking by bayonet coupling between the connecting piece 5 and the second hole 4d, the mating shape of said hole is axially rotated through an angle of about 45 degrees.

The tight seal between the connecting sleeve 11 and second hole 4d provided on the projecting portion 4c relies on a further seal ring 5c.

Finally, a filtering element 13 is clamped to the inspiration opening 5b of the connecting sleeve 5 so that the air inspired by the user from the surrounding atmosphere does not cause damages to his respiratory system.

At the inside of mask 1 sealingly engaged to the expiration opening 5a is a half-mask 6. The half-mask 6 has an end edge 6a designed to exert a sealing action around the user (3)'s nose and mouth.

At least a check valve 7 is associated with the half-mask 6 and it enables the air transfer from the inside of mask 1 to the inside of the half-mask 6.

Associated with the expiration opening 5a is a single-acting valve 8 arranged to enable the air expired by the user 3 to issue from the inside of the half-mask 6.

It is to be pointed out that, on assembling, the single-acting valve 8 is screwed to the expiration opening of the connecting sleeve 5 from the inside of the transparent screen 4 upon interposition of a spring seal ring 5d.

Note that the axes of the first hole 9a, second hole 4d and third hole 4e belong to the plane of symmetry of the transparent screen 4 in such a way that the mounting of the connecting sleeve 5, filter 13 and transmitter 9 do not restrain the width of the user's visual field as permitted by the transparent screen 4.

Due to the adoption of a toroidal transparent screen, the protection mask of the invention completely eliminates all distortion phenomena present in the masks of the known art.

In fact, the choice of a bending corresponding to the toroidal form enables the accomplishment of a screen capable of making the visual line of the user's eyes always cross the screen surface in a substantially perpendicular direction so as to minimize said distortions mainly due to optical refraction.

The extension of the toroidal surface of the screen over the user's whole face not only ensures an excellent image quality of the surrounding environment but also allows the user to take advantage of the greatest possible visual field.

In fact, as clearly shown in Fig. 5, the visual field permitted to the user by the mask in question, shown by dotted line K, coincides with the natural visual field of the user's eyes shown by dotted line K'. Said dotted lines K e K' have been lightly offset on the graph, for an easy reading.

In short, by the present masks all drawbacks resulting from the cylindrical screens involving important aberrations of astigmatism and the conical screens having very important aberrations due to the fact that the bending radius progressively decreases downwardly and the line of sight at the bottom becomes very oblique with respect to the screen surface, have been overcome.

In addition, the fact that the upper edge of the screen is spaced apart from the axis a greater distance than the lower edge, particularly in accordance with the cited values, ensures a downwardly tapering outline of the screen adapted to follow the configuration of the user's face with great accuracy, the use of elastic material corresponding to the seal ring being almost the same over the whole screen contour, which involves a sealing pressure on the user's face of substantially uniform value.

In addition, the downwardly tapering configuration of the toroidal screen enables the latter to follow the conformation of the human face so that face-pieces having a very reduced mass and even of one piece construction can be moulded.

Furthermore, the different components of the mask in question such as the screen, face-piece, connecting sleeve and others can be manufactured using very automatized moulding processes and their final assembling is quick and easy.

Finally, due to the removable and therefore interchangeable character of the connecting sleeve of the mask, different types of connecting sleeves and/or filtering elements can be used.

In fact, it is possible to make different types of connecting sleeves to be individually engaged on the projecting portion 4a and each suitable to make the mask adapted to be connected to a given type of breathable-air supply and/or a given operating typology.

For example in the embodiment shown in Fig. 1 the connecting sleeve 11 used gives the mask 1 an operating typology currently known as "under vacuum". In this case the air is taken from the surrounding atmosphere through the filter 13 by effect of the vacuum produced within the mask following the user's inspiratory action.

The single-acting outlet valve 8 will consist for example of a mere diaphragm adapted to be held against an appropriate seat to enable the air entry through the outlet opening 5a during the inspiratory movement, and move away from said seat to enable the air outflow during the expiratory step.

In a different embodiment the connecting sleeve can for example be arranged so as to enable the mask to operate in "overpressure" condition.

In this case a delivery duct is engaged to the inlet opening 5b from which the breathable air infed from an outer source comes, under a condition of positive pressure.

A delivery valve can be associated, in known manner, with this duct, which valve is designed to open the air passage towards the mask inside, when pressure in the mask goes under a predetermined value. The expiration valve is in turn provided, still in known manner, with a moving element, adjusted by a spring so as to enable the air outflow to the surrounding atmosphere when pressure within the mask exceeds the intended value.

The connecting sleeve can also be arranged so that the mask may be used with an oxygen closed-circuit breathing apparatus. In this case the expiration opening 5a will be closed to the surrounding atmosphere and connected to the inspiration opening 5b without any single-acting valve being interposed.

A connecting duct associated with a conventional oxygen breathing apparatus will be fitted in the inspiration opening 5b.

Both the air inspiration and expiration take place through the expiration opening 5a interconnected with the inspiration opening 5b and hence with said connecting duct.

Advantageously, the connecting threads or other connecting means provided on the different connecting sleeves can be made different from one another so as to prevent a wrong coupling, for example that an air supply system may be coupled to a connecting sleeve designed to be adopted in a supply system of another type.

Many modifications can be made to the invention as conceived without departing from the inventive idea characterizing it.

Claims

1. A panoramic protection mask for operating interventions in polluted environments, of the type comprising:

- an annular sealing lip (2) arranged to exercise a tight seal around the user (3)'s face;
- a transparent (4) screen sealingly connected to said annular lip (2) by its outer perimeter;
- a connecting sleeve (5) exhibiting an inspiration opening (5b) designed to bring an air supply into communication with the inside of the mask (1), and an expiration opening (5a),

characterized in that said transparent screen (4) has a substantially toroidal shape defined by an arc of a circle rotating through an angle of predetermined amplitude about a substantially vertical axis of rotation (10), said screen extending by its upper edge (4a) as far as the top of the user's forehead while the lower edge

(4b) thereof extends as far as under the user's chin, the distance of said upper edge from said axis of rotation being greater than the distance therefrom of the lower edge, said screen (4) exhibiting a middle portion (4c) designed to sealingly engage the connecting sleeve (5) and substantially positioned in register with the user's mouth.

2. A mask according to claim 1, characterized in that said middle portion (4c) of the connecting sleeve projects outwardly.

3. A mask according to claim 1, characterized in that when the mask (1) is worn by the user (3) the axis of rotation (10) of said transparent screen (4) of toroidal form is substantially upright.

4. A mask according to claim 1, characterized in that
the angle of inclination (α) of said axis of rotation (10) is included between 5 degrees on and 25 degrees back relative to a vertical direction (v).

5. A mask according to claim 1, characterized in that said axis of rotation (10) is in a rear position relative to the user's eyes by an amount included between 20 and 40 millimetres.

6. A mask according to claim 1, characterized in that said toroidal transparent screen (4) is generated by an arc of a circle the bending radius (R) of which ranges between 100 and 200 millimetres.

7. A mask according to claim 1, characterized in that the centre (C) of said arc of a circle is located under the user's eyes by an amount (h) included between 0 and 50 millimetres.

8. A mask according to claim 1, characterized in that said transparent screen (4) of toroidal form is generated by the rotation of said arc of a circle about the rotational axis (10) through an angle of rotation (β) included between 160 and 200 degrees.

9. A mask according to claim 1, characterized in that the maximum bending radius (r) of the toroidal transparent screen (4) defined in a plane perpendicular to said axis of rotation (10) is included between 75 and 108 millimetres.

10. A mask according to claim 9, characterized in that the ratio between the bending radius (R) of said arc of a circle and the maximum bending radius (r) defined in the plane perpendicular to said rotational axis (10) is greater than 1 and less than 2.5.

11. A mask according to claim 1, characterized in that the upper edge (4a) of the toroidal transparent screen (4) in a plane perpendicular to said rotational axis (10) exhibits a bending of radius (a) greater than 60 millimetres and smaller than 120 millimetres.

12. A mask according to claim 1 characterized in that the lower edge (4b) of the toroidal transparent screen (4) in a plane perpendicular to said rotational axis (10) exhibits a bending of radius (b) greater than or equal to 0 and lower than 30 millimetres.

13. A mask according to claim 1, characterized in that the distance (c) existing between the upper edge (4a) of the transparent screen (4) and the section thereof having said maximum bending radius (r) is included between 0 and 80 millimetres.

14. A mask according to claim 1, characterized in that the distance (d) existing between the upper (4a) and lower (4b) edges of the toroidal transparent screen (4) is included between 130 and 220 millimetres.

15. A mask according to claim 1, characterized in that the thickness of said transparent screen (4) is the greatest (s') in the middle of the toroidal surface and gradually decreases towards the side portions (s'') thereof.

16. A mask according to claim 1, characterized in that said transparent screen (4) is in the form of an isosceles triangle in which the base side defining the upper edge (4a) of the screen (4) is of substantially rectilinear configuration, whereas the oblique sides have a curvilinear extension, the three sides being joined to each other by wide-radius rounded portions.

17. A mask according to claim 1, characterized in that said transparent screen (4) has one hole (9c) formed in the vicinity of an upper portion of said projecting middle region (4c) and designed to sealingly receive a transmitter (9).

18. A mask according to claim 1, characterized in that said projecting middle portion (4c) has a second hole (4d) designed to be coupled to the inspiration opening (5b) through fastening means (11) carrying out the removable en-

gagement of said connecting sleeve (5), and a third hole (4e) designed to be coupled to the expiration opening (5a) of the sleeve.

19. A mask according to claims 17 and 18, characterized in that the axes of the first, second and third holes (9c, 4d and 4e) lie in the plane of symmetry of the transparent screen (4).

20. A mask according to claim 18, characterized in that said fastening means (11) essentially consists of a bayonet coupling.

21. A mask according to claim 20, characterized in that said bayonet coupling comprises a ring nut (12) carried by the connecting sleeve (5) coaxially with said inspiration opening (5b) and provided with at least a radially-extending engaging lug (12a) defining an undercut, said lug (12a) being designed to engage, through axial fitting, into a corresponding access housing (12b) formed on the perimetrical edge of said second hole (4d) and to be locked against said perimetrical edge following an angular rotation of the connecting sleeve (5) about the axis of the inspiration opening (5b).

22. A mask according to claim 21, characterized in that said ring nut (12) has four radially-extending engaging lugs (12a) which are circumferentially distributed thereon according to angles of 90 degrees.

23. A mask according to claim 18, characterized in that operatively engaged in said expiration opening (5a) is a single-acting valve (8) previously fitted in said third hole (4e) of the transparent screen from the inside thereof.

24. A mask according to claim 23, characterized in that said single-acting valve (8) is operatively engaged in said expiration opening (5e) through a threaded coupling.

25. A mask according to claim 18, characterized in that seal rings of elastomeric material (5c, 5d) are interposed between the inspiration opening (5b) and corresponding second hole (4d) and the expiration opening (5a) and corresponding third hole (4e).

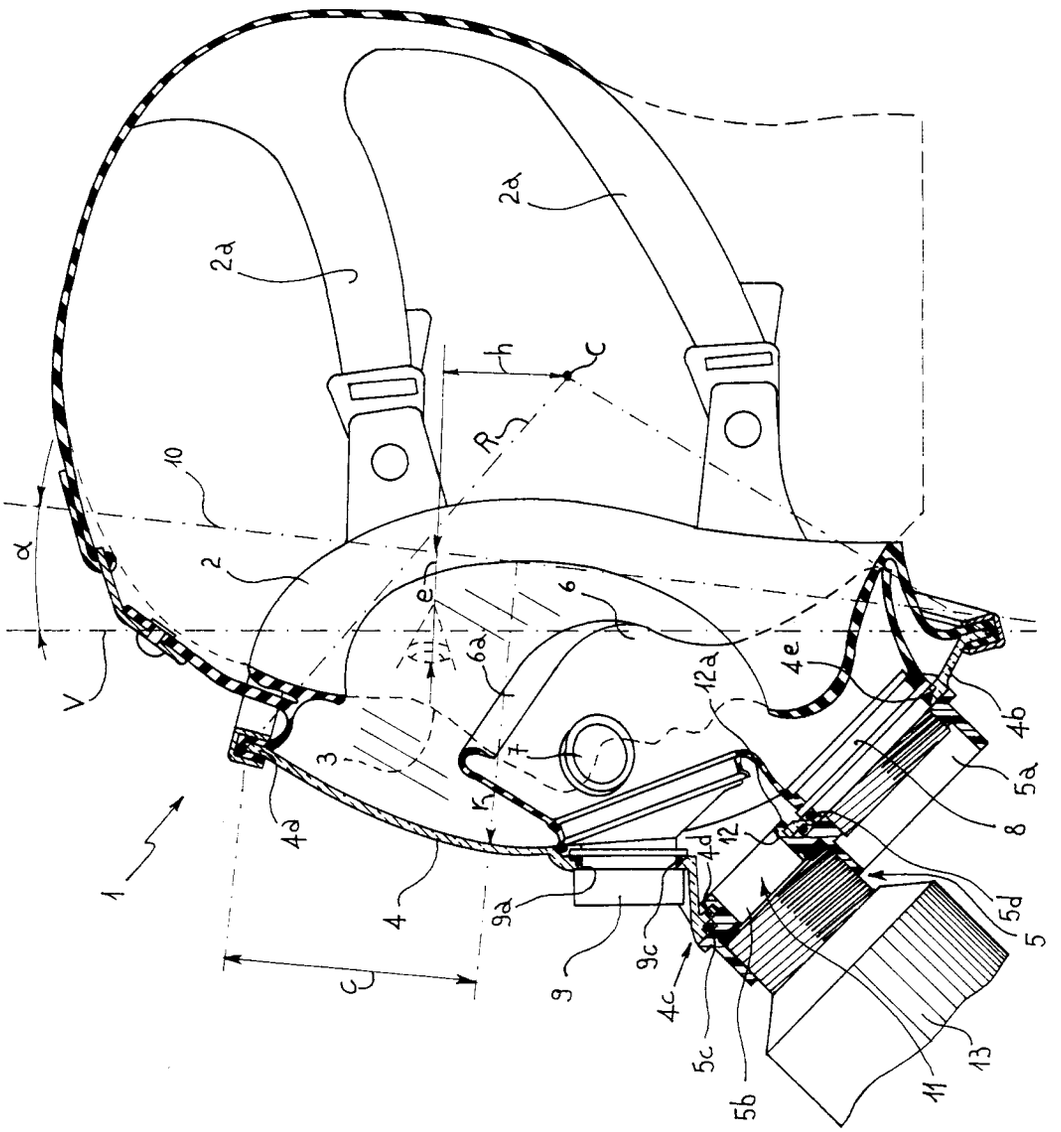
26. A mask according to claim 18, characterized in that a filtering element (13) is detachably mounted to said inspiration opening (5b), which filtering element enables the air to pass from the surrounding atmosphere to the inside of the mask (1) as a result of the vacuum produced in said mask, a single-acting valve (8) being associated with said expiration opening for enabling the air expired by the user (3) from the mask inside to be ejected.

27. A mask according to claim 18, characterized in that an air duct for delivering air under pressure to the mask inside is mounted to said inspiration opening (5b), a single-acting valve being associated with said expiration opening (5a) and being such adjusted that the ejection of air from the mask (1) is allowed when pressure within the mask exceeds a predetermined value.

28. A mask according to claim 18, characterized in that a connecting duct having a closed-circuit oxygen breathing apparatus is associated with said inspiration opening (5b), said expiration opening (5a) being hermetically isolated from the surrounding atmosphere and in fluid communication with the inspiration opening (5b).

29. A mask according to claim 1, characterized in that the ratio between the overall surface of the transparent screen (4) and the surface thereof taken up by said projecting middle portion (4c) is between 4 and 8.

FIG. 1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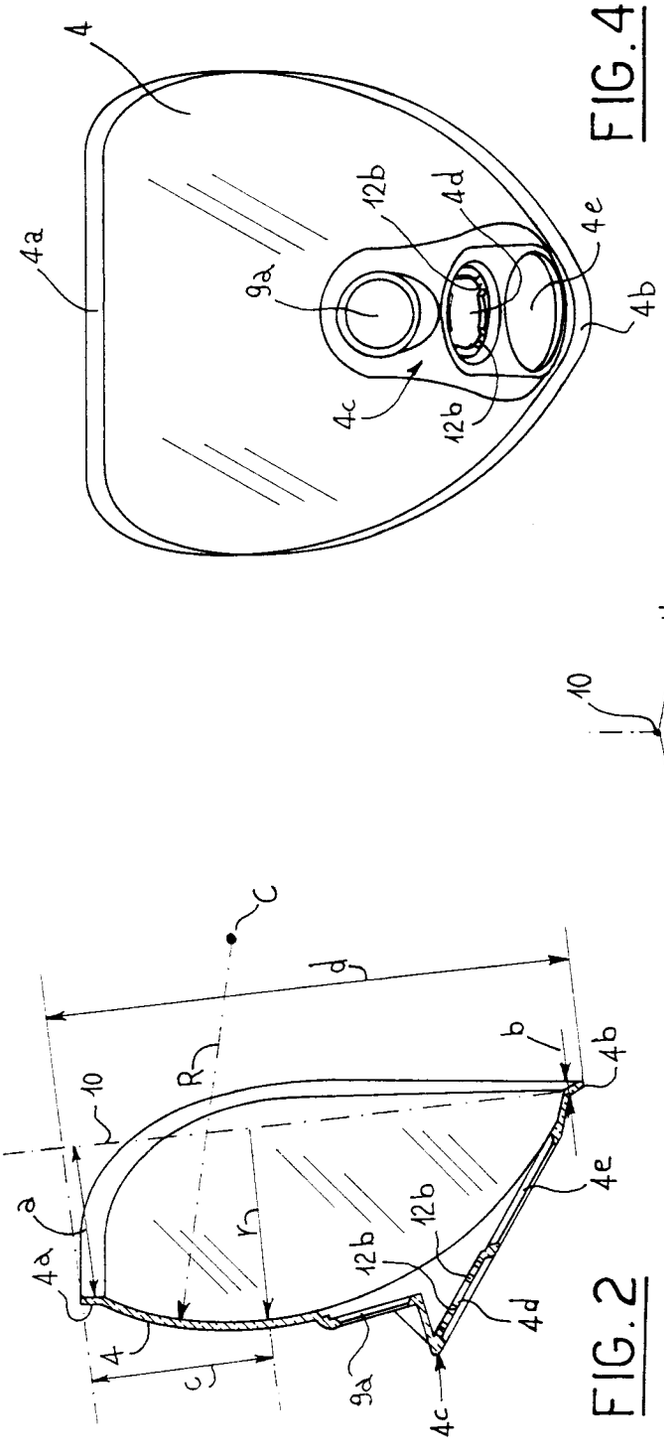


FIG. 4

FIG. 2

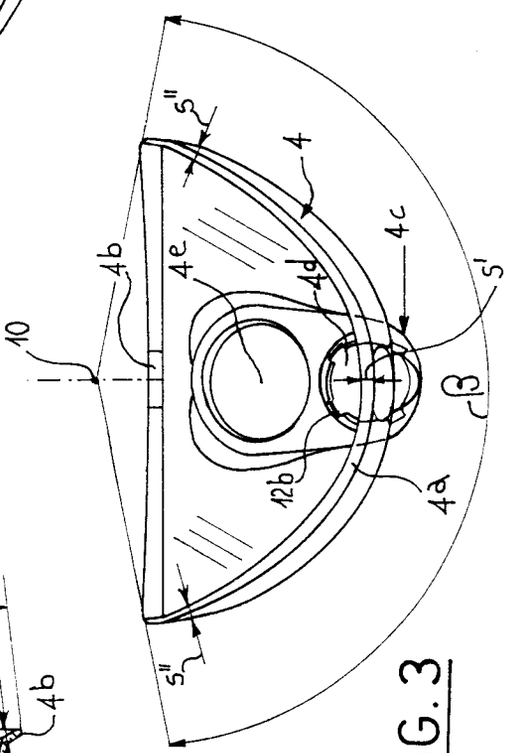
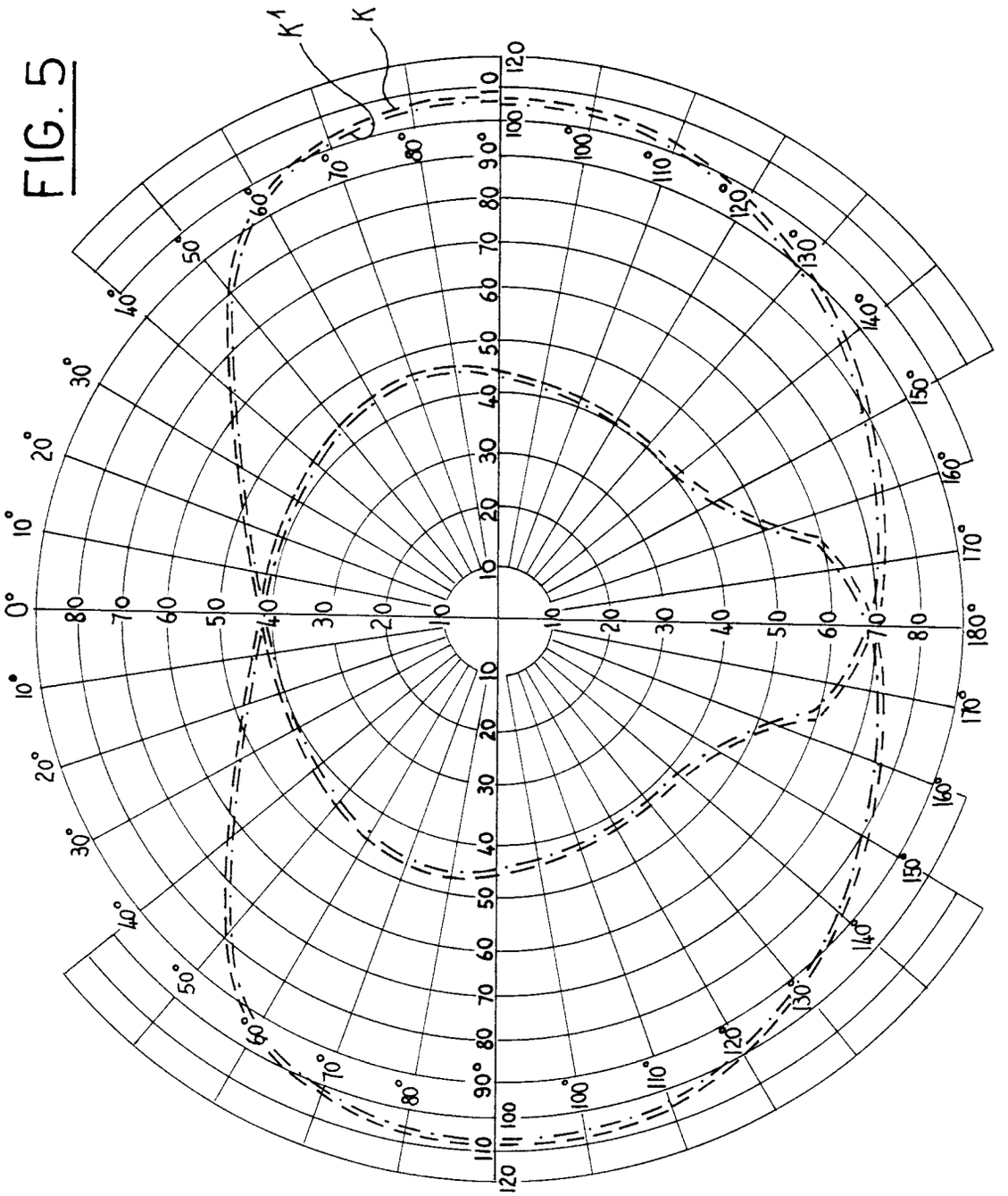


FIG. 3

FIG. 5



European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 10 6984

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.5)
A	US-A-4 595 003 (SHOEMAKER) * column 1, line 11 - line 14 * * column 3, line 16 - line 23; figure 1 *	1	A62B18/02
A	US-A-3 540 442 (HOLLOWAY) * abstract * * column 1, line 42 - line 52; figures *	1	
A	US-A-4 296 746 (SURGIKOS) * figures *	1	
A	US-A-3 545 436 (HOLLOWAY) * figures *	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

A62B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13 JULY 1992	WALVOORT B.W.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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