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(54) REGULATING MEMBRANE FOR THE SECOND-STAGE REGULATOR OF TWO STAGE UNDERWATER BREATHING APPARATUSES

(57) A regulating membrane for a second stage regulator of two-stage underwater breathing apparatuses, comprising a continuous flexible side wall, tapered from the peripheral edge towards the top in which a rigid plate is centrally provided, coaxial to said flexible wall, said flexible side wall being provided with at least one continuous or discontinuous lateral reinforcing element, possibly protruding outwardly and/or inwardly from said membrane, to support and guide the collapsing movements of said plate with respect to the membrane.

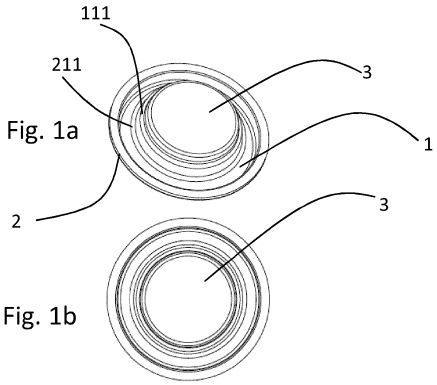

Fig. 1a

Fig. 1b

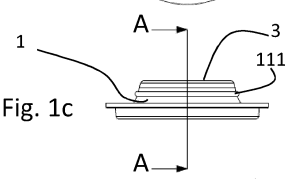

Fig. 1c

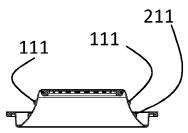

Fig. 1e

A-A

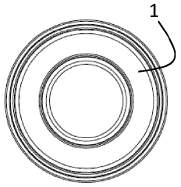

Fig. 1d

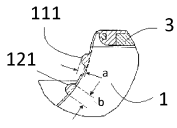

Fig. 1f

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Description

[0001] The present invention relates to underwater breathing apparatuses, and in particular to two-stage underwater breathing apparatuses; more particularly, it relates to a regulating membrane for the second dispensing stage of such apparatuses.

[0002] At the state of the art, the second dispensing stage of a two-stage breathing apparatus comprises a container body containing a flexible membrane centrally provided with a rigid or semi-rigid plate, a membrane which on the one hand communicates with the external environment, and on the other hand contributes to defining a chamber provided with the aspiration duct of the respirable mixture by the diver, and being in communication by means of a valve with the supply of the breathable mixture from the first reducer stage, being provided means of activation of the valve mechanically coupled to said membrane, generally consisting of a lever in contact with the plate at the center of the membrane, whose peripheral edge is clamped between the two parts of the container body.

[0003] Operationally, in the absence of a breathing act by the diver using the second stage breathing apparatus and in stable conditions, the inside of the regulator is at ambient pressure, i.e. the pressure inside said second stage is equal to the pressure outside, i.e. the inside of the second stage is at a pressure equal to the pressure outside; the membrane is designed to react to the depression caused by the inspiratory act, therefore when the diver inhales, the membrane reacts to the depression which alters the aforementioned equilibrium and makes a movement which activates the plate which lowers on the lever, which causes a retraction of the valve and consequently the breathable mixture inside the regulator is delivered. At the end of the inspiratory act, the membrane temporarily activates the regulator again to deliver gas until the pressure equilibrium described above is reached.

[0004] It is therefore evident that the mechanical and morphological characteristics of the membrane influence the reaction time of the valve with respect to the inspiratory act, and therefore the efficiency and comfort of the regulator.

[0005] In particular, elastomeric membranes tapered from the periphery towards the central plate are generally used, and these membranes often have a hyperboloid profile, with the axis of symmetry corresponding to the central axis of the plate.

[0006] These membranes tend, to the action of the depression generated by the respiratory act and because of the asymmetry of the movement of the lever with respect to the membrane itself, to collapse in a not entirely uniform way, because of the same flexibility that is required of them to perform their function. This drawback can actually affect the opening movement of the valve, and therefore reduce the efficiency and comfort of the dispenser.

[0007] Moreover, the membranes known to the state of the art may present difficulties during assembly and/or maintenance operations of the second stage to which they belong, since their characteristics of elasticity or limited rigidity may give rise to incorrect positioning between the installation seat and the retaining organs, the latter being commonly composed of a cover which is screwed into said seat by rotation, coming into contact with the membrane/membrane to which part of the rotational motion of screwing and/or unscrewing is transferred, with the risk of undesirable deformation or, at the limit, damage to part of the membrane/membrane, negatively affecting the control of the valve during the operation of the second stage.

[0008] Thus, the purpose of the present invention is to provide a regulating membrane for the second stage dispenser of two-stage controlled collapse underwater breathing apparatuses, which is capable of overcoming the drawbacks to the state of the art, providing improved uniformity of dispensing valve actuation, and thus improved regulation of the pressure of the dispensed mixture.

[0009] A further purpose of the present invention is to provide a regulating membrane for the second stage dispenser of two-stage apparatuses that provides a simpler, safer and more effective assembly and maintenance phase of the second stage to which the membrane belongs.

[0010] It is therefore an object of the present invention to provide a regulating membrane for the second stage dispenser of two-stage underwater breathing apparatuses, comprising a continuous flexible side wall, tapered from the peripheral edge towards the top in which a rigid or semi-rigid plate is centrally provided, coaxial to said flexible side wall; said flexible side wall is provided with at least one lateral reinforcing element preferably but not necessarily continuous along a known path, preferably projecting outwardly and/or also inwardly.

[0011] According to an embodiment, the reinforcing element(s) are made in the form of thickening of the flexible side wall, which thickening is located at said reinforcing element.

[0012] According to an embodiment which may be provided in combination with one or more of the preceding embodiments, said reinforcing element(s) may be in the form of one or more continuous or discontinuous ribs or ribs.

[0013] According to yet another feature which may be provided in any combination or alternatively with one or more of the other features, said at least one rib may be arranged in a plane parallel to said plate. The lateral reinforcing members may be one or more, and may be arranged so as to divide the flexible sidewall into segments equivalent to each other in height. According to an alternative embodiment, the lateral reinforcing elements may be arranged in such a way as not to divide the lateral wall into non-uniform segments.

[0014] Other embodiments realizable in combination

with or as an alternative to the embodiments disclosed herein contemplate the lateral reinforcing elements being made of piece with the flexible side wall or of piece with the entire membrane body.

[0015] The present invention does not place any constraints on the mutual characteristics of the lateral reinforcing elements, in the case of embodiments with two or more of said elements. Accordingly, embodiments may be contemplated where, for example, the cross-section and/or plastic and/or elastic characteristics are different between two or more elements applied to the same flexible side wall.

[0016] The flexible side wall is preferably a hyperboloid; the material with which said wall is made is an elastomeric polymer at a degree of hardness between 20 and 80 Shore A, and preferably 40 Shore A. The elastomeric polymer may be a liquid silicone rubber (LSR).

[0017] In a preferred embodiment, said lateral reinforcing elements have a semi-toroidal profile; the reinforcement has a thickness at least twice that of the flexible side wall, and exhibits a width at the base greater than said thickness.

[0018] In a different embodiment, said lateral reinforcing elements are made in the form of one or more segments arranged in the manner of helical ribs applied to the side wall preferably, but not necessarily, along a path beginning at the base of the wall and ending at the opposite end of the pa-net or in the vicinity of the plate. The invention does not limit the shape, absolute arrangement, mutual disposition, numerosity and material of the lateral reinforcing elements.

[0019] Preferably, but not necessarily, the helical ribs are arranged in an upward path from the base of the membrane toward the plate according to a clockwise rotation about an axis orthogonal to the plane of the plate and oriented in the direction from the base of the membrane to the plate. In this way, the rotational movement imparted to the membrane as a result of screwing a cap or other protective covering of the membrane to the body of the second stage results in a stretching of the ribs that prevents unwanted bending of the lateral surface of the membrane.

[0020] One embodiment that may be combined with the preceding embodiments involves arranging the ribs along one or more planes passing through the axis of symmetry of the membrane. Consequently, the individual ribs or lateral reinforcements are located along a radial path that follows the convex profile of the side wall. As before, this variant is freely combinable with the realization of lateral reinforcing elements in various numerosities, materials, sizes, segmentation freely chosen by the branch engineer according to the desired stiffness and controlled collapse characteristics obtainable from the present invention.

[0021] A further embodiment contemplates that the lateral reinforcing elements comprise risers, preferably of semi-ellipsoidal shape and even more preferably of substantially hemispherical shape. Such prominences may be applied to the inner and/or outer surface of the side wall, or be made of piece with the wall itself, according to any arrangement.

[0022] It has been found that the arrangement according to a quincuncial succession solves very well the technical problem of the controlled collapse of the membrane; however, different formations of rises, even not necessarily of identical shape and/or reciprocal size, fall within the same inventive concept presented herein. By way of non-limiting example, there is provided the staggered arrangement of a predetermined number of risers along one or more annular bands of the side wall, wherein the characteristics of the individual risers may be reciprocally varied between one or more of said annular bands.

[0023] Further advantages and features of the membrane according to the present invention will become apparent from the following detailed description of a preferred embodiment of the same embodiment, for illustrative and non-limiting purposes, with reference to the accompanying drawing plates, wherein:

- figures 1a, 1b, 1c, 1d show perspective, top, side and bottom plan views, respectively, of a first embodiment of the membrane according to the present invention;
- figure 1e is a longitudinal sectional view of the membrane of the same executive form as in the previous figures;
- figure 1f shows an enlarged detail of figure 1e.
- Figures 2a, 2b, 2c, 2d show, respectively, perspective, top, side and bottom plan views of a second embodiment of the membrane according to the present invention;
- figure 2e is a longitudinal cross-sectional view of the membrane of the form executed in the precede figures;
- figure 2f shows an enlarged detail of figure 2e.
- Figures 3a, 3b, 3c, 3d show, respectively, three-dimensional perspective, top plan, side plan and bottom plan views of a third embodiment of the membrane according to the present invention;
- Figure 3e is a longitudinal cross-sectional view of the membrane of the embodiment of the prior art;
- Figure 3f shows an enlarged detail of Figure 3e.

[0024] A perspective and plan view from above of a first executive form of a membrane according to the present invention is shown in figures 1a and 1b; by 1 is designated the continuous side wall of the membrane, which membrane has a peripheral edge 2, made of piece with the same in flexible material. At the center of the membrane a plate 3 made of rigid or semi-rigid material is positioned, coupled to the side wall 1 in a manner known in and of itself, and better visible in the figures further described. On the side wall 1 there are two reinforcing elements 111 and 211 in an annular position with respect to the side wall and projecting outwardly. The executive form described herein therefore contemplates

a membrane provided with two reinforcing elements, external to the membrane with reference to the position of the valve control lever, continuous and cooperating with the entire annular band constituting the side wall of a membrane provided with rotational symmetry around an axis orthogonal to the plate of substantially circular conformation 3 and passing through it. It is reiterated herein that this specific form is illustrative and not limiting of other possible variants falling within the same inventive concept of the present invention. By way of example, alternative implementations may include one or more of two annular reinforcing elements, also positioned internally to the membrane and/or comprising different material and/or section and/or segmentation.

[0025] Figure 1c shows a side view of the membrane from a position external to the membrane itself and thus where the side edge 2 covers the view of the reinforcement 211 while the annular reinforcement 111 is visible and it is noticeable how it is arranged parallel to the plate 3. From the comparison with figure 1d, which depicts the entire membrane as seen from below, that is, from inside the chamber where the control lever of the valve of the second regulator stage is housed, it is observed that there are no reinforcing elements arranged on the inside of the side wall 1, since the present executive form contemplates them in the external surface as visible in the previous figures. However, further variations may provide for one or more reinforcing elements also or only on the said interior of side wall 1.

[0026] Figure 1e is a longitudinal section of the membrane referred to in the previous figures according to the geometric plane passing through segment A-A; equal parts correspond to equal numerals. The figure highlights the fact that both ribs 111 and 211 exhibit a semi-toroidal cross-section, lie in planes parallel to the plane of the plate 3, and protrude outwardly in relief from the side wall 1. It can also be seen that the side wall 1 itself is subdivided by the reinforcing elements 111, 211 into three segments substantially equal to each other in height. The side wall 1 of the membrane exhibits a hyperboloid shape.

[0027] As shown in Figure 1e, the sidewall reinforcing members 111, 211 are arranged in planes parallel to that of the plate 3, and these planes subdivide the wall into three portions substantially equal to each other in height.

[0028] Figure If, in which similarly equal portions correspond to equal numerals, particularly shows that the width b at the base of the reinforcing elements is greater than the thickness a of the reinforcing elements themselves. In turn, the thickness of the reinforcing elements is greater than the thickness of the side wall.

[0029] Figures 2a-2e present a second embodiment of the present invention, illustrated in views similar to the previous one and in which references to common parts have been reused. It is evident that there is a plurality of equivalent lateral reinforcing elements, three of which are indicated with 121, 221, 321, having a substantially long-linear shape and predetermined length running from the base of the side wall towards the top thereof where the plate 3 is connected. The lateral reinforcing elements of the form shown herein are continuous, equally distributed and arranged in the guise of ribs on the side wall 1 along a reinforcing path articulated according to a helical curve wrapped around a portion of the side wall, which helical curve presents a known angle of wrap and develops coaxially to the plate.

[0030] Figure 2e shows a longitudinal section along the plane passing through segment A-A, from which representation one can see the presence of three reinforcing elements 121, 221, 321 present on the external surface of the side wall and intercepted by the sectional plane at different heights of side wall 1. The inclination of the elements with respect to the horizontal plane of the plate is arbitrary and, advantageously, occurs according to an angle α greater than 0° decimal and less than 90° decimal so as to avoid incorrect positioning of the membrane and/or deformation of the side wall during installation of the same membrane within the second dispenser stage to which it belongs. In this context, the membrane retaining members to the main body of the second dispensing stage, which are commonly composed of a cover that is rotatably screwed into said seat, may come into partial contact with the membrane to which part of the rotational motion of screwing and/or unscrewing is transferred, with the risk of undesirably deforming or even damaging part of the membrane negatively affecting valve control during second stage operation.

[0031] As discussed above, the scope of the present invention extends to several other variants which may differ, by way of non-limiting example, in terms of the numerosity of elements, the surface area of the wall on which they are positioned, the physical and constructional characteristics of the elements, and the shape and coverage of the positioning path.

[0032] Figures 3a-3f show a third embodiment of the invention, in which the lateral reinforcing elements are declined in the form substantially referable to a hemisphere 131 or more generically of an ellipsoidal dome, whose dimensions are one or two orders of magnitude smaller than the overall dimension of the membrane (detail in figure 3f). A plurality of such elements 131 is visible along the side wall 1 wherein, in this exemplary and non-limiting form, they are positioned along three circumferences coaxial to the axis of the membrane and mutually offset such that each element 231 of the intermediate circumference results in an intermediate position between two consecutive elements 131 of the upper circumference and/or between two consecutive elements 331 of the lower circumference.

[0033] The operation of the membrane according to the present invention will be apparent from the following. As mentioned above, in numerous respiratory devices widespread on the market, the second dispensing stage includes a membrane that reacts both to the pressure exerted by the environment and to the depression realized by the inspiratory act.

[0034] This flexible membrane is usually shaped like the membrane in the attached figures, i.e., tapered towards a flat wall of rigid material. The side wall, on the other hand, must be flexible, and preferably the membrane is made as a whole by overmolding an elastomeric material onto the rigid thermoplastic polymer plate. The elastomeric material is chosen with a hardness between 20 and 80 Shore A, and preferably 40 Shore A. The elastomeric polymer may be a liquid silicone rubber (LSR) .

[0035] In order for the side wall to react to the depression following inhalation by the user in an orderly manner, side reinforcements 111, 121, 131 have been introduced which allow for "bellows" folding of the side wall so that the action of the plate 3 on the lever that controls the valve opening is smoother.

[0036] The side reinforcing elements are made of piece with the side wall, but could be similarly applied later on the same. The reinforcing elements are formed, in the illustrated example, with a width at the base greater than the thickness, which in turn is greater than the thickness of the side wall. This solution appears to be optimal in order to confer the appropriate rigidity to the side wall without, on the other hand, introducing modifications that could hinder or compromise the regular functioning of the membrane.

[0037] The control membrane designed in this way has an improved reliability and functional efficiency compared to the state of the art, without having introduced particularly complex or costly structural changes.

Claims

1. A regulating membrane for a second stage regulator of two-stage underwater breathing apparatuses, comprising a continuous flexible side wall (1) tapered from the peripheral edge (2) toward the top in which a rigid or semi-rigid plate (3) is centrally provided, coaxial to said flexible side wall, **characterized in that** said flexible side wall (1) is provided with at least one continuous or discontinuous lateral reinforcing member (111; 121 ; 131), which may protrude outwardly and/or inwardly.

2. Membrane according to claim 1, wherein said at least one lateral reinforcing element (111, 211) is arranged in a plane substantially parallel to said plate (3) and subdivides said lateral wall (1) into annular bands of various heights, also not equivalent to each other.

3. Membrane according to claim 1 wherein said at least one lateral reinforcing element (121) has a substantially loglinear shape of predetermined length and is disposed in a rib-like manner on said lateral wall (1) along a reinforcing path articulating from a zone in proximity to the peripheral edge (2) to a zone in proximity to the plate (3).

4. Membrane according to claim 3 wherein said reinforcing path runs along a helical curve wrapped around at least part of said side wall (1), said helical curve having a known angle of wrap (α) greater than 0 decimal degrees and less than 180 decimal degrees and preferably less than 90 decimal degrees, said helical curve running coaxially to the plate.

5. Membrane according to claim 1 wherein said at least one lateral reinforcing element (131, 231, 331) comprises a plurality of risers, preferably of semi-ellipsoidal shape and even more preferably of substantially hemispherical shape, distributed on said lateral surface (1) according to a known distribution and preferably comprising repetition of mutually staggered risers along one or more annular bands of the lateral wall (1) .

6. Membrane according to one or more of the preceding claims, wherein said at least one lateral reinforcement (111; 121; 131) is made of piece with said flexible side wall (1) of the membrane.

7. Membrane according to any one of the preceding claims, wherein said flexible side wall (1) is a hyperboloid.

8. Membrane according to any one of the preceding claims, **characterized in that** the material with which said side wall (1) is made is an elastomeric polymer at a hardness degree between 20 and 80 Shore A, and preferably 40 Shore A, said elastomeric polymer being preferably a liquid silicone rubber (LSR).

9. Membrane according to any one of the preceding claims, wherein said lateral reinforcing element(111; 121; 131) has a thickness (a) greater than that of the flexible side wall (1), and has a width at the base (b) greater than said thickness (a).

10. Membrane according to any one of the preceding claims 1 to 8, wherein said at least one side reinforcing element has a semi-toroidal profile.

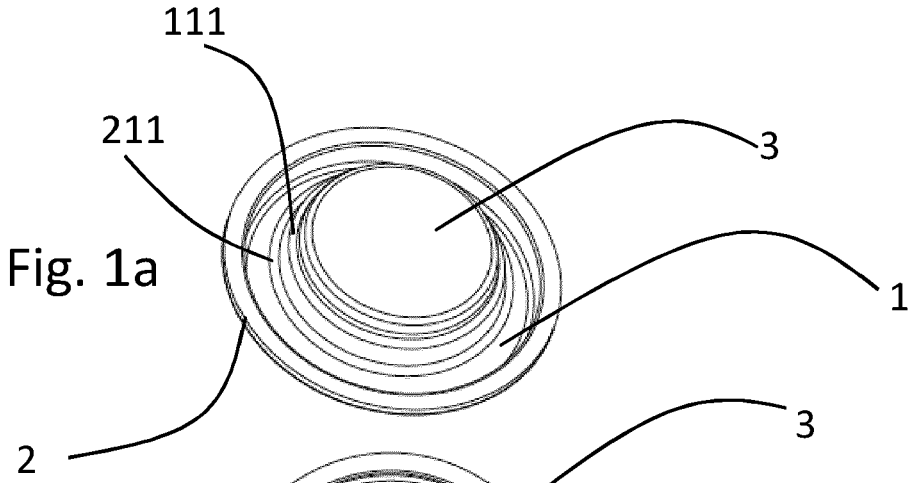


Fig. 1a

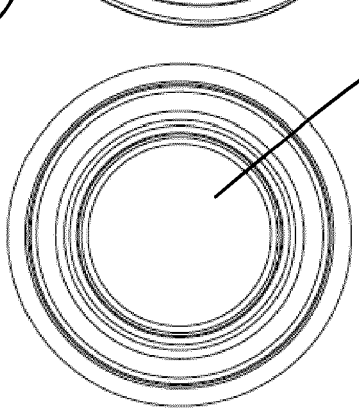


Fig. 1b

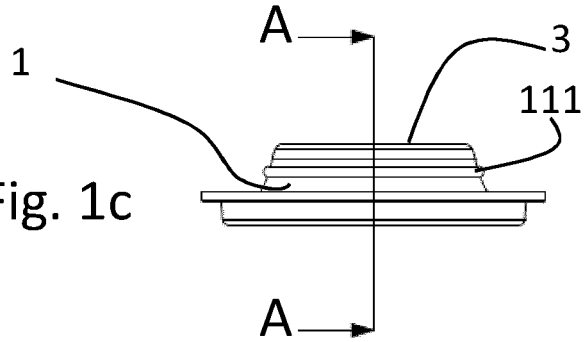
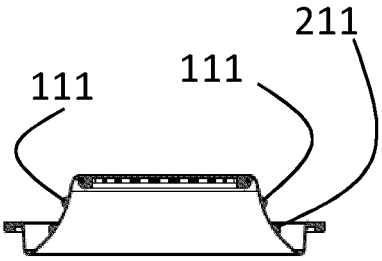


Fig. 1c



A-A

Fig. 1e

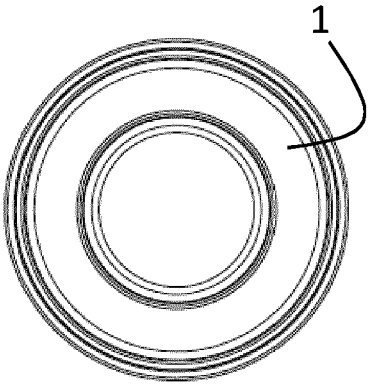


Fig. 1d

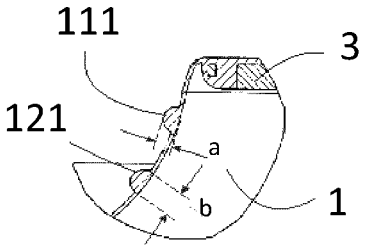


Fig. 1f

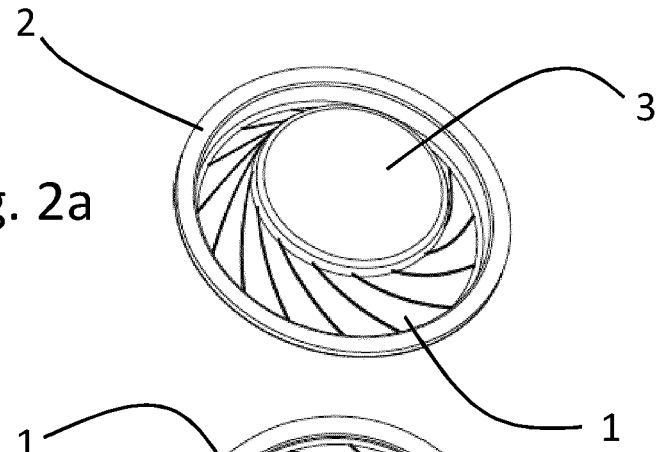


Fig. 2a

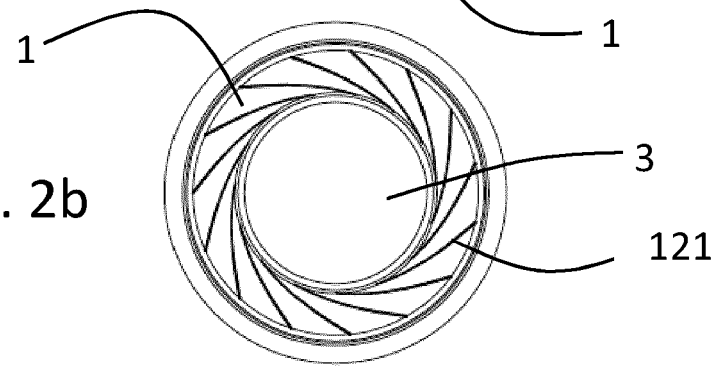


Fig. 2b

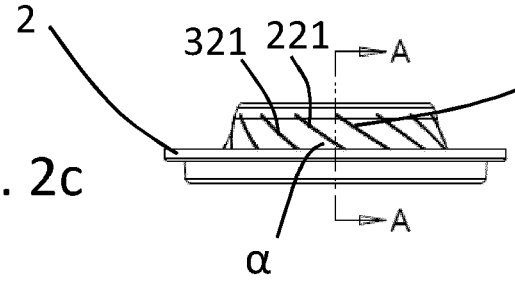


Fig. 2c

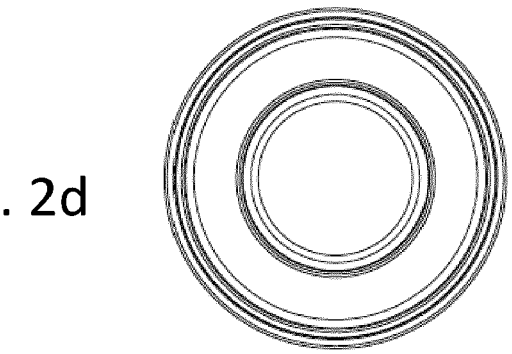


Fig. 2d

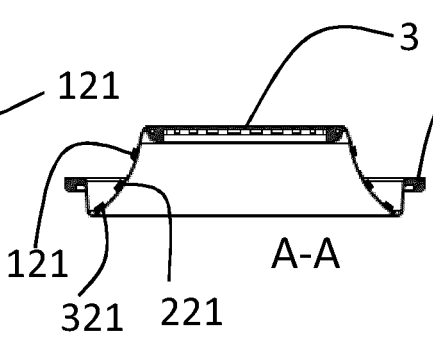


Fig. 2e

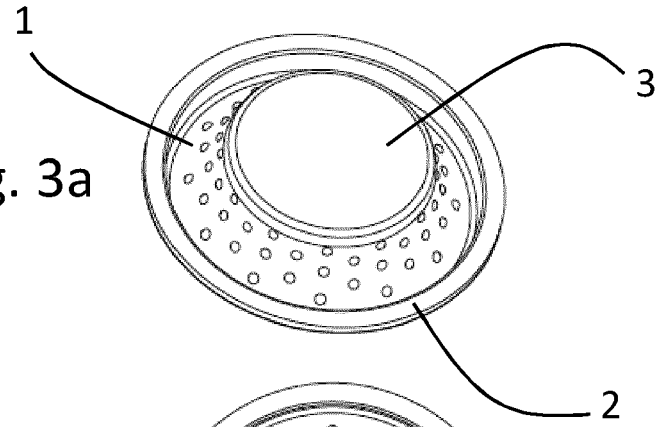


Fig. 3a

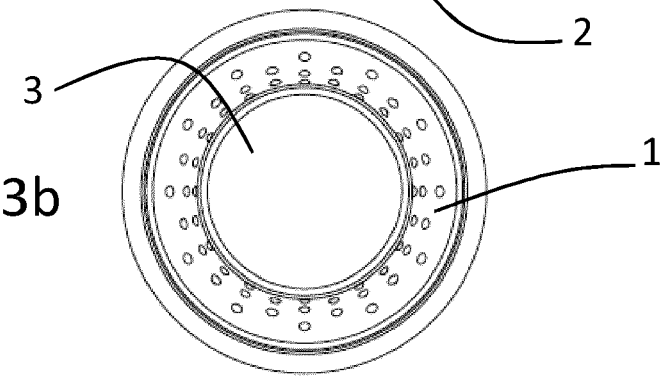


Fig. 3b

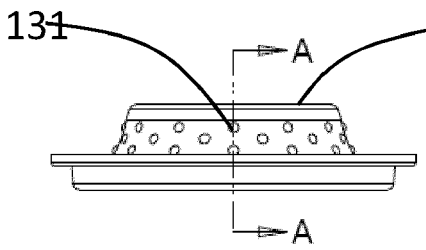


Fig. 3c

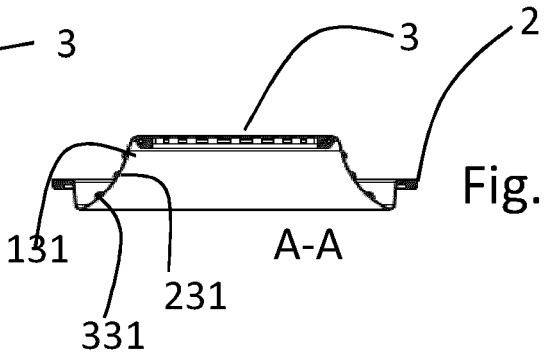


Fig. 3e

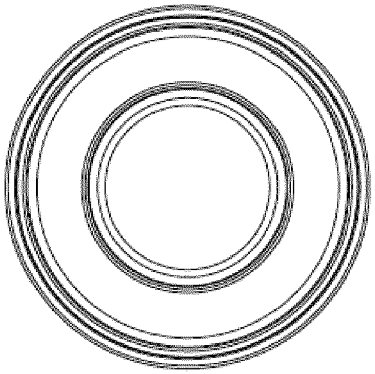


Fig. 3d

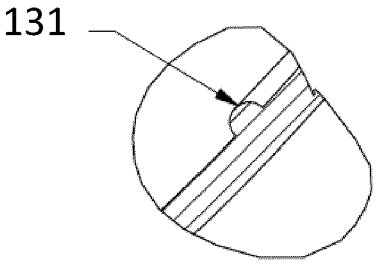


Fig. 3f

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EUROPEAN SEARCH REPORT

Application Number
EP 21 16 1707

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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