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(54) **MEDICAL FACE MASK WITH SEALING STRIP**

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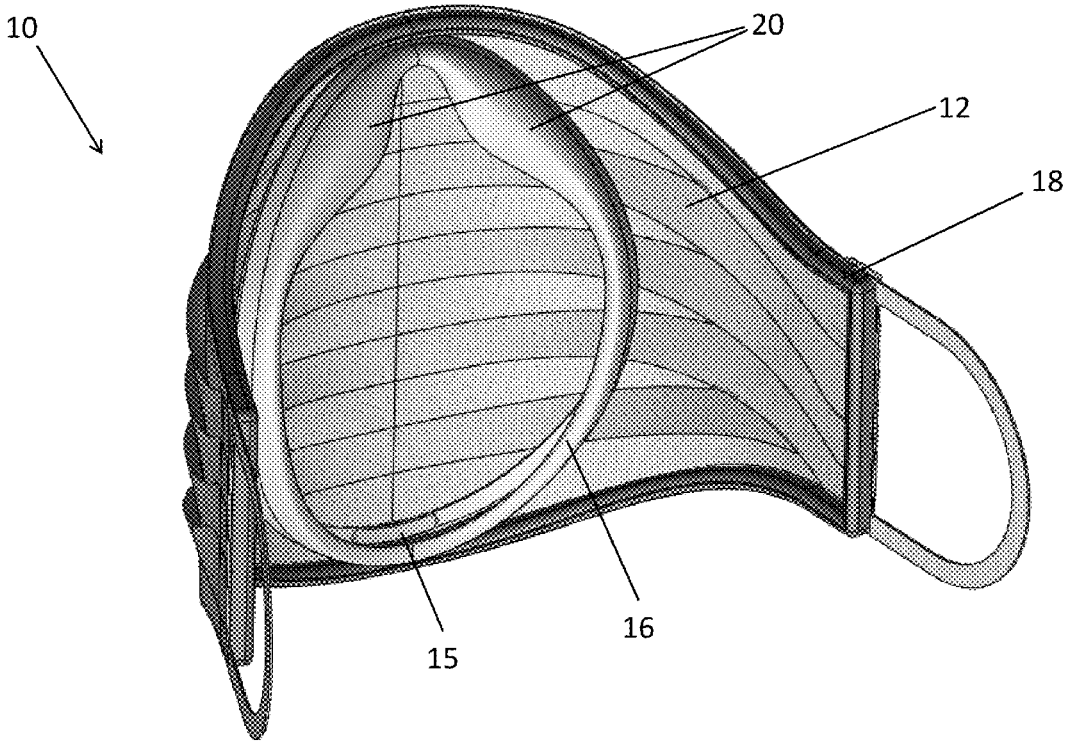
(57) **ABSTRACT**

The present invention relates to a face mask for filtering contaminants from the air that is suitable for medical applications. The face mask includes an air-permeable body having an inner surface, wherein the body is sized to cover the nose and mouth of a subject when worn by the subject, an inner seal connected to said inner surface of said body, wherein said inner seal is sized to form a perimeter around a wearer's nostrils and mouth, at least one strap connected to said body for securing said face mask to said subject's face, and a deflector layer connected to the inner surface of said body, wherein the deflector redirects at least a portion of the exhaled air down into the lower regions of the air-permeable body.



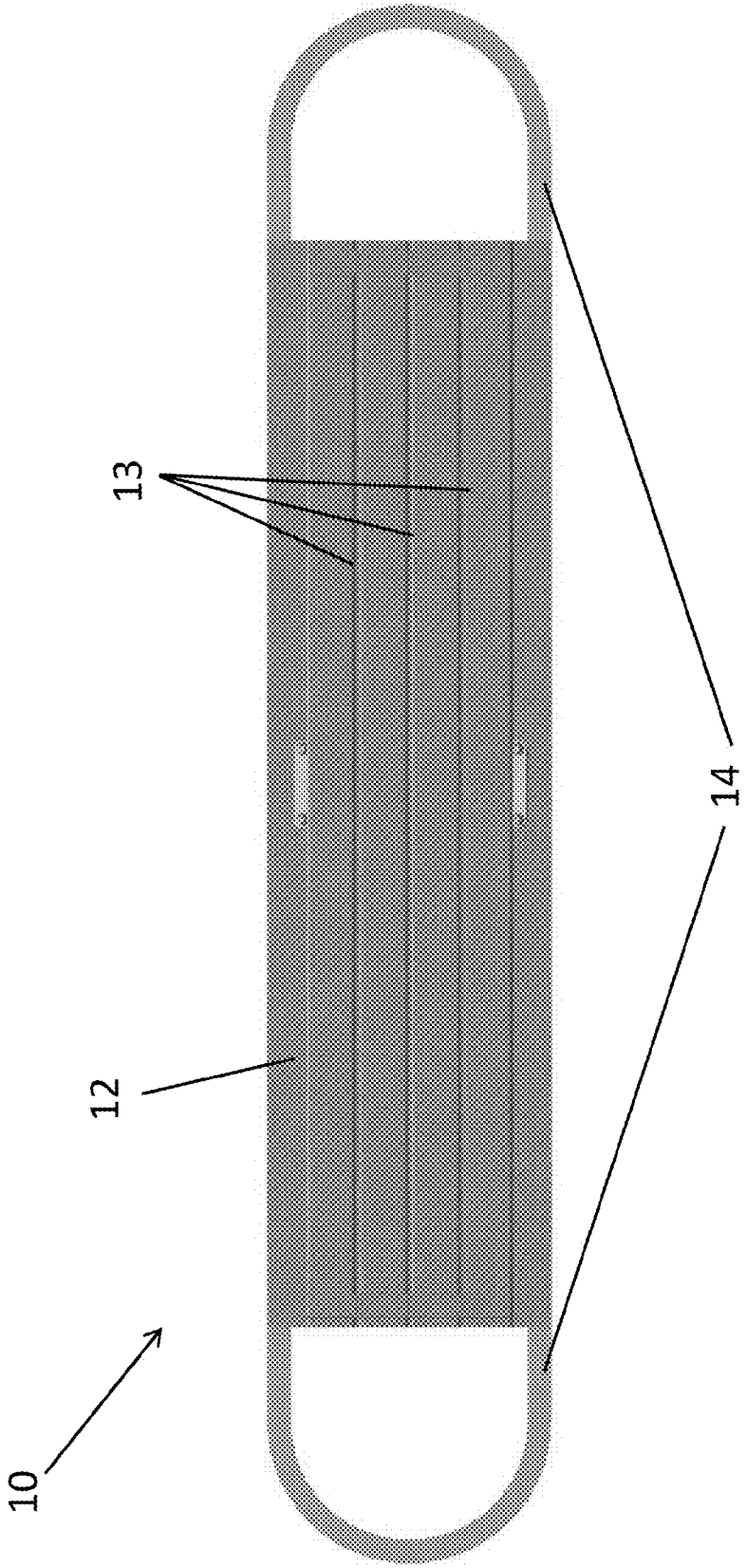


Figure 1

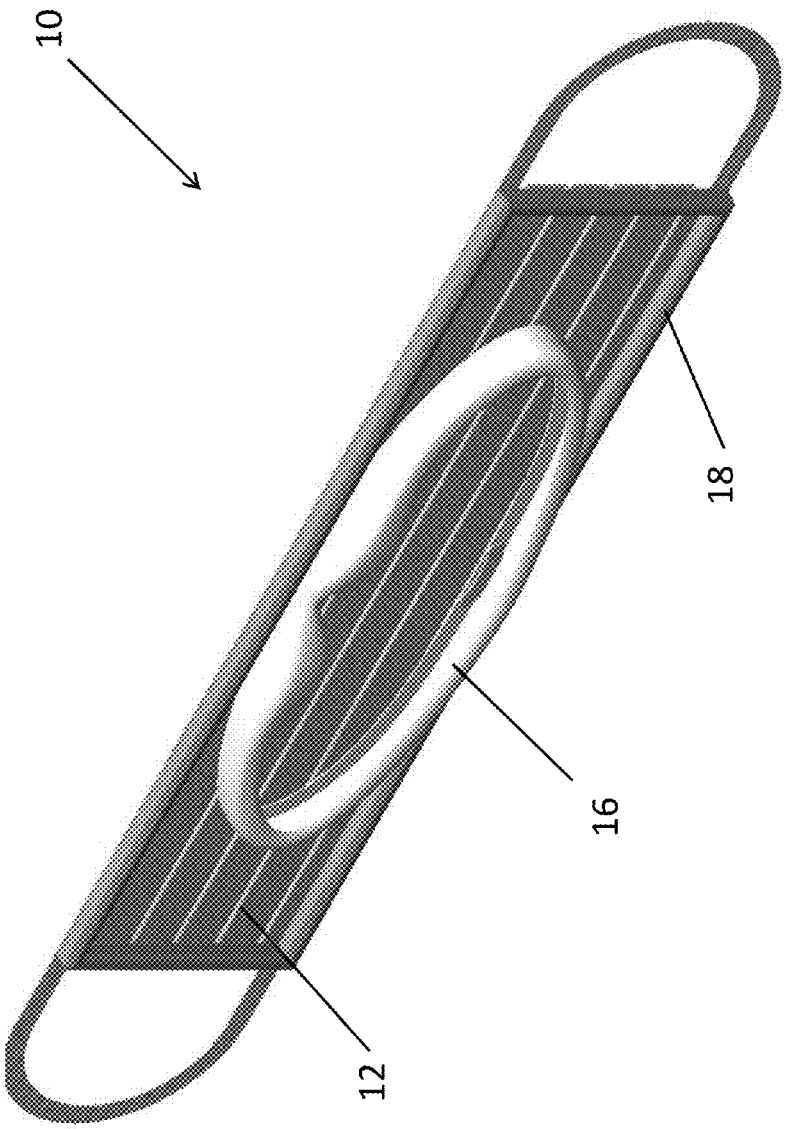


Figure 2

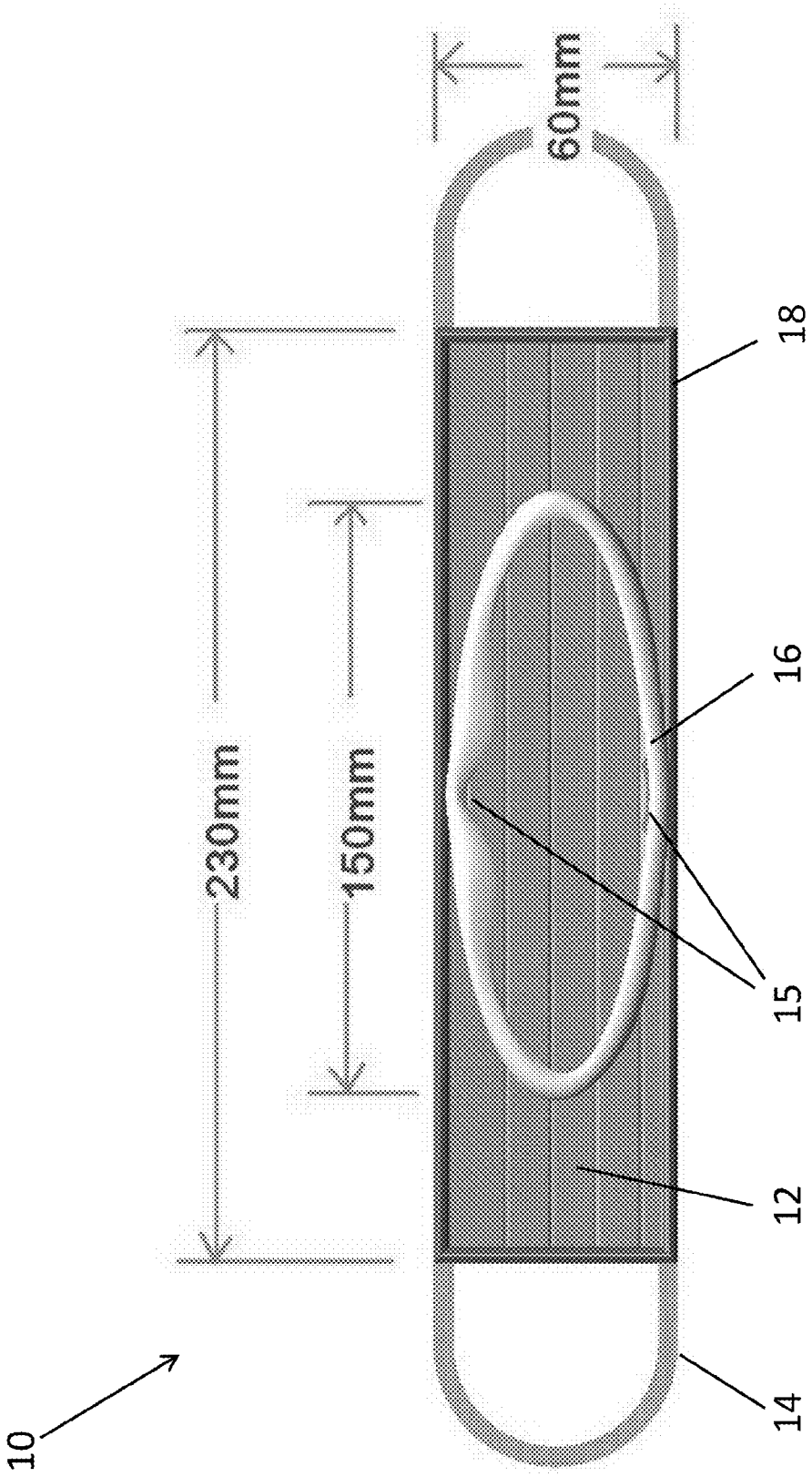


Figure 3

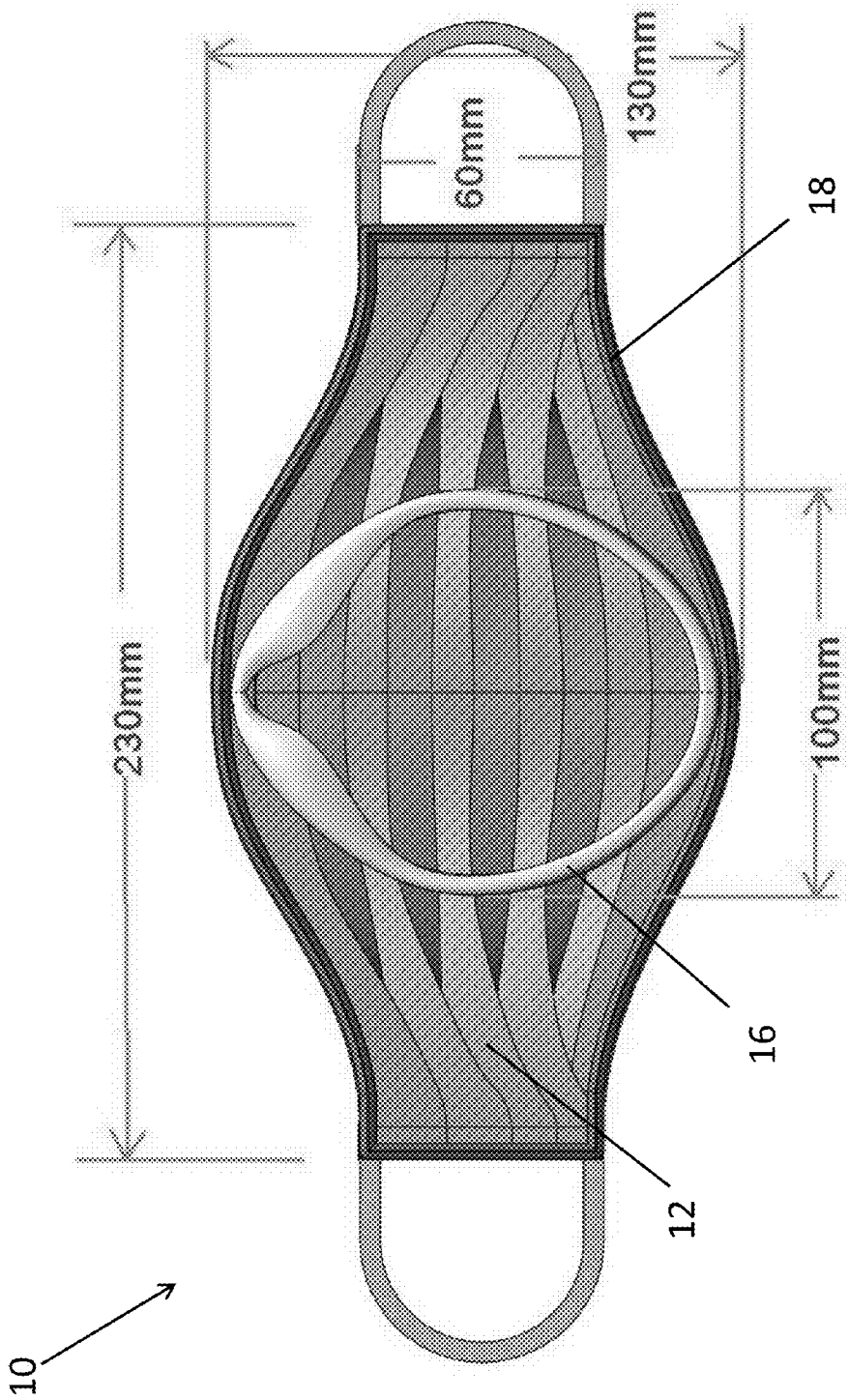


Figure 4

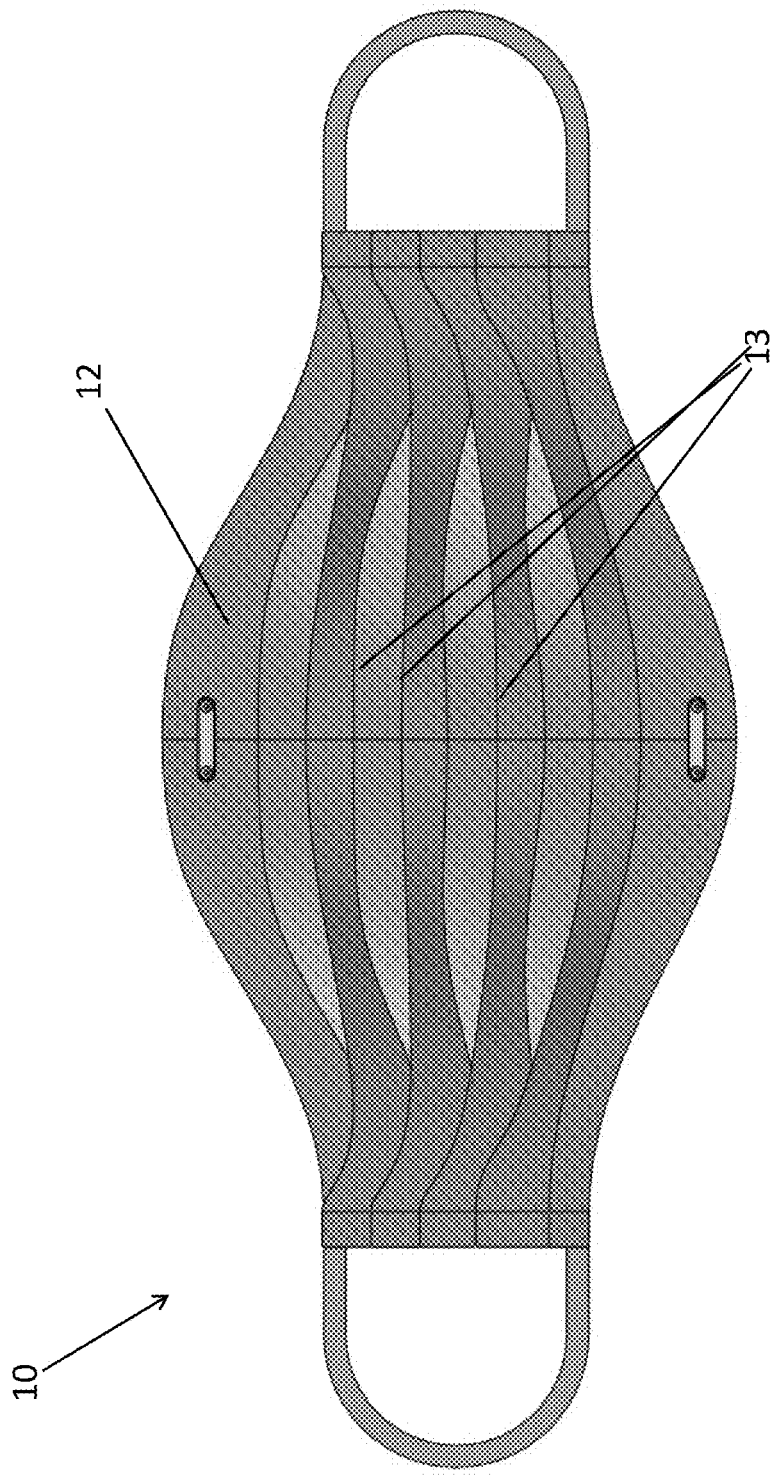


Figure 5

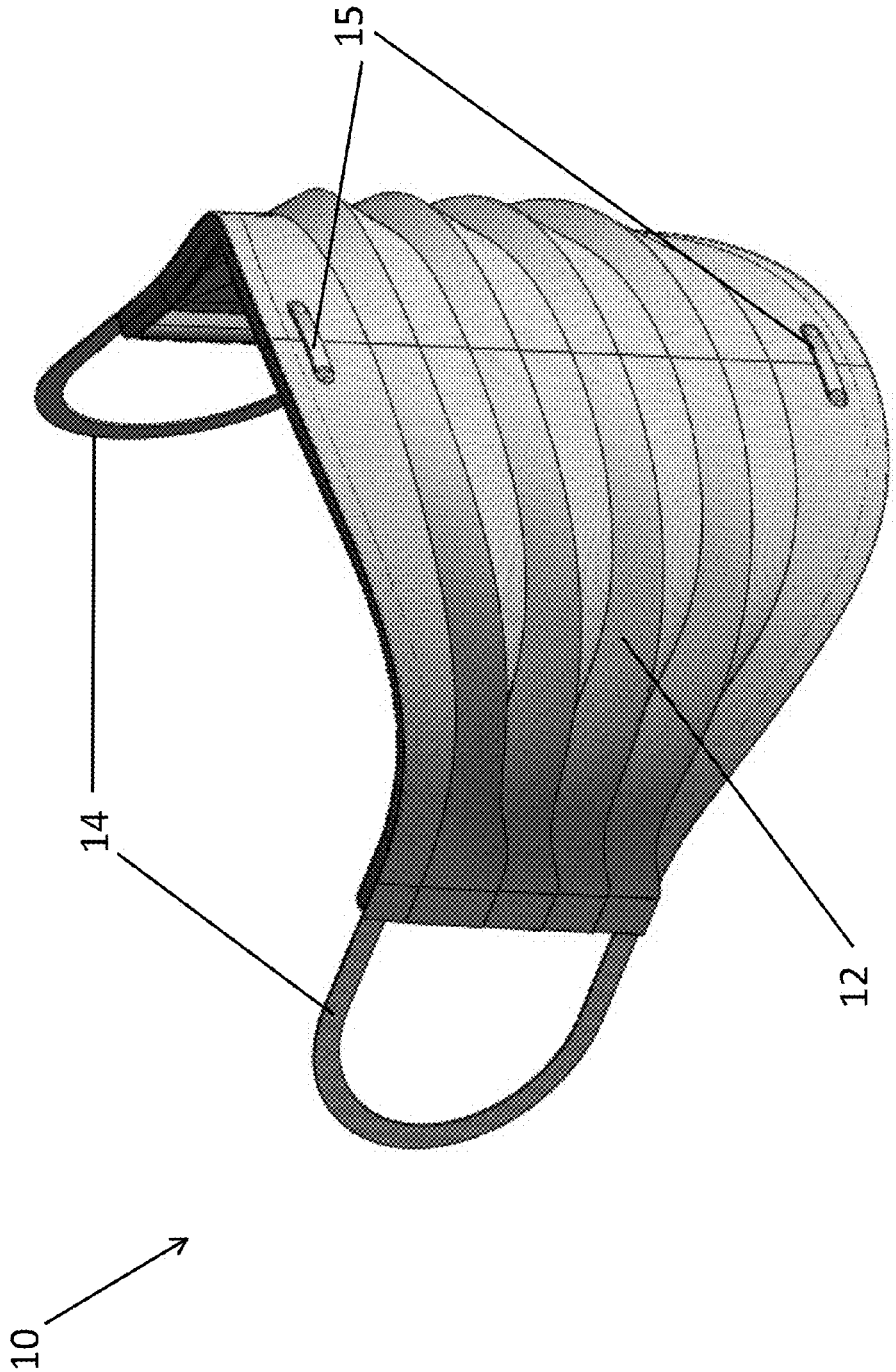


Figure 6

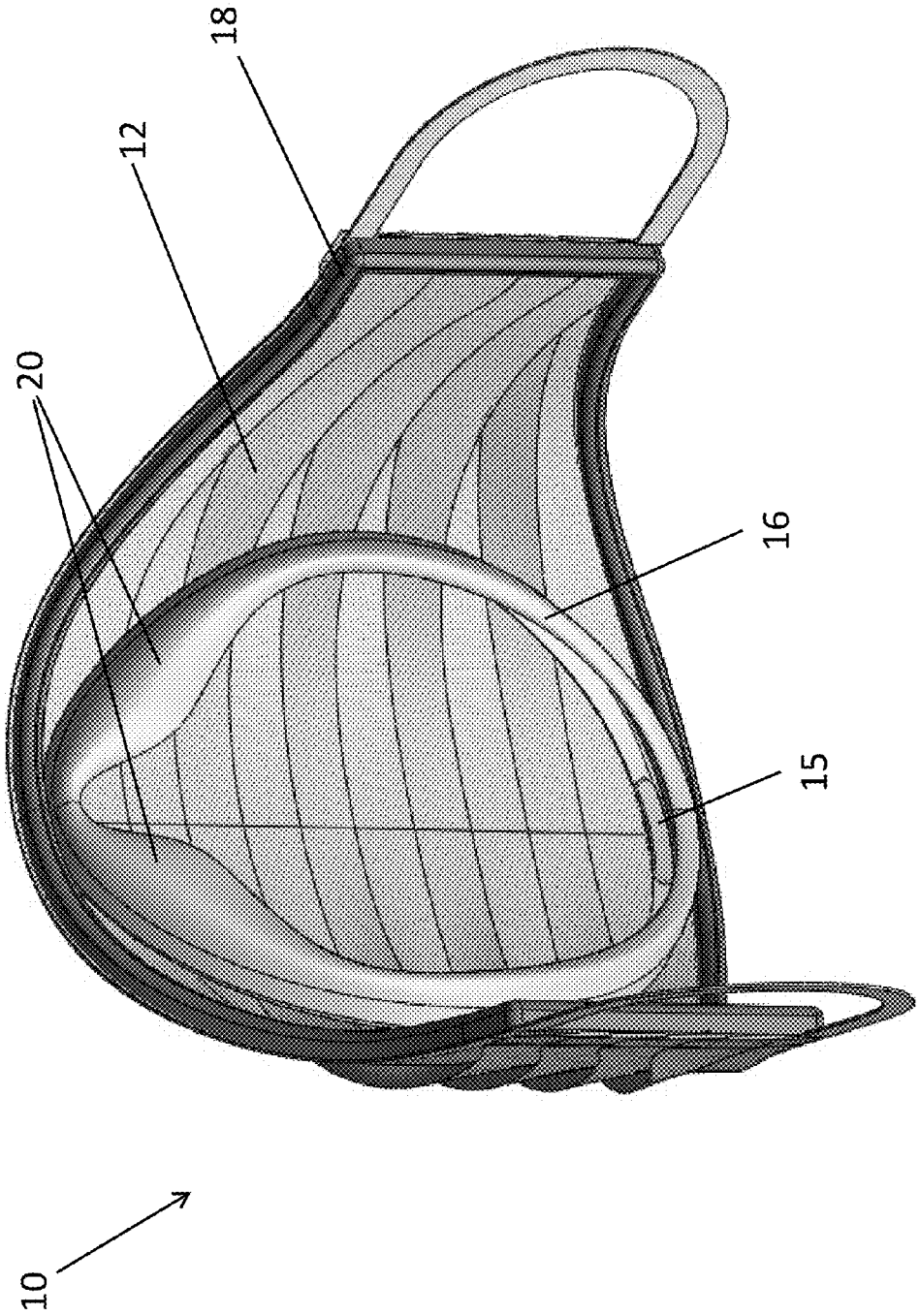


Figure 7

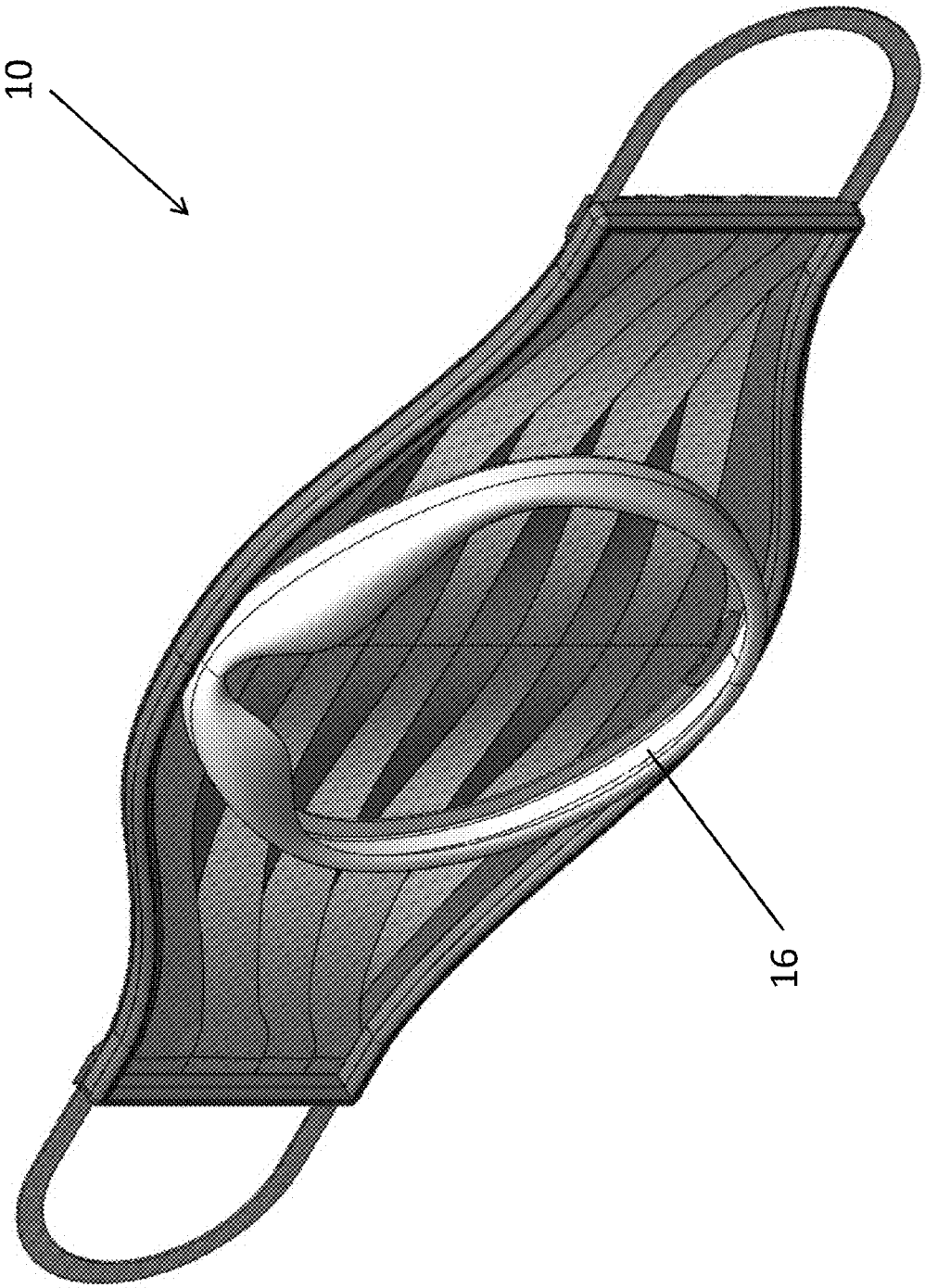


Figure 8

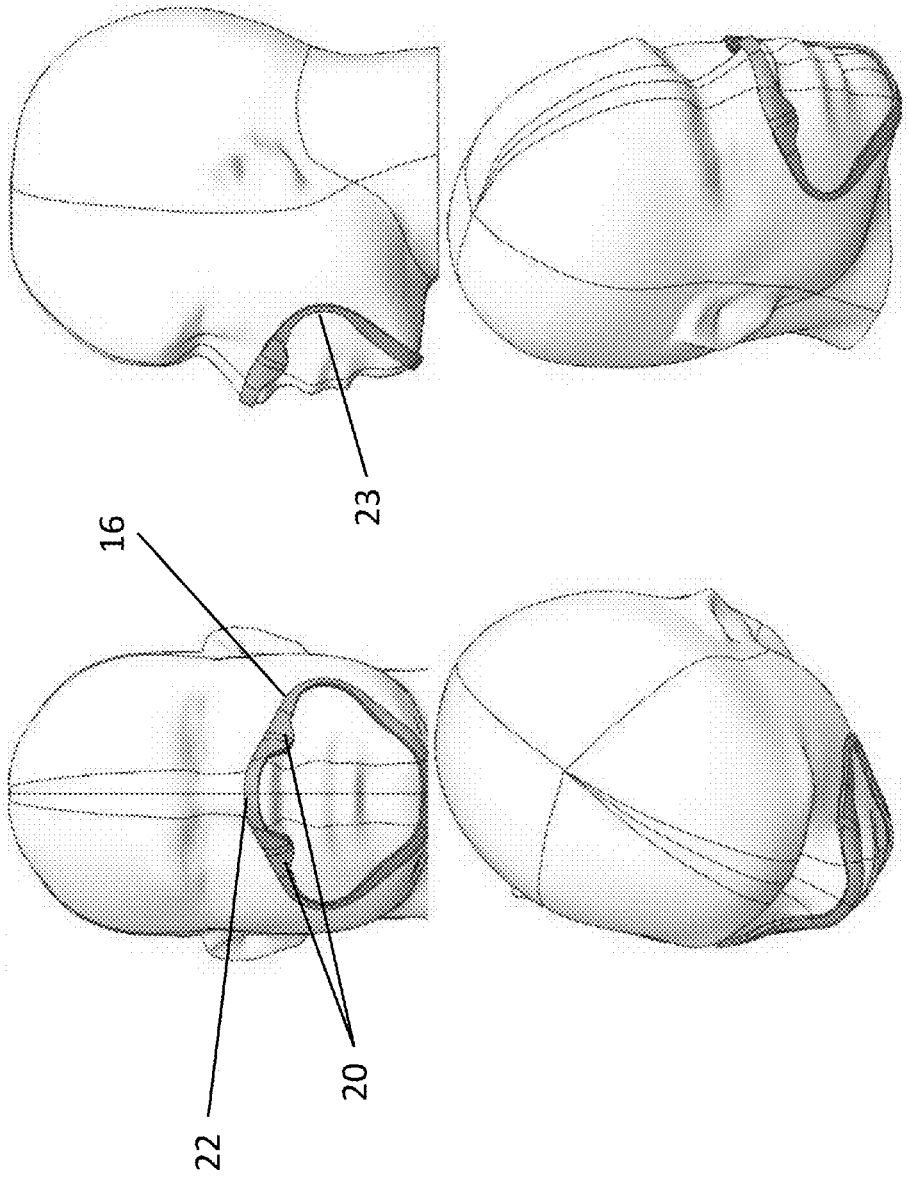


Figure 9

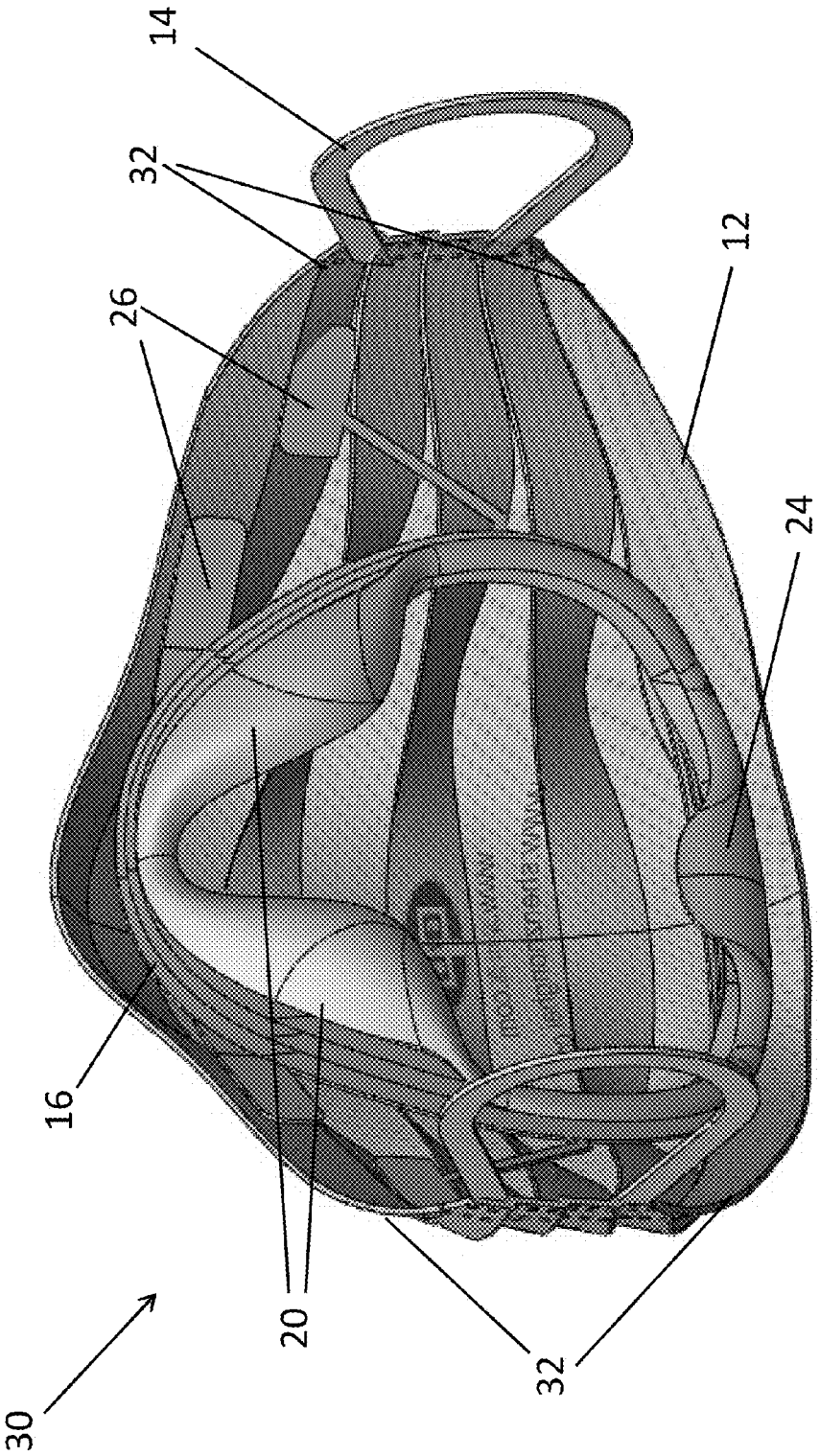


Figure 10

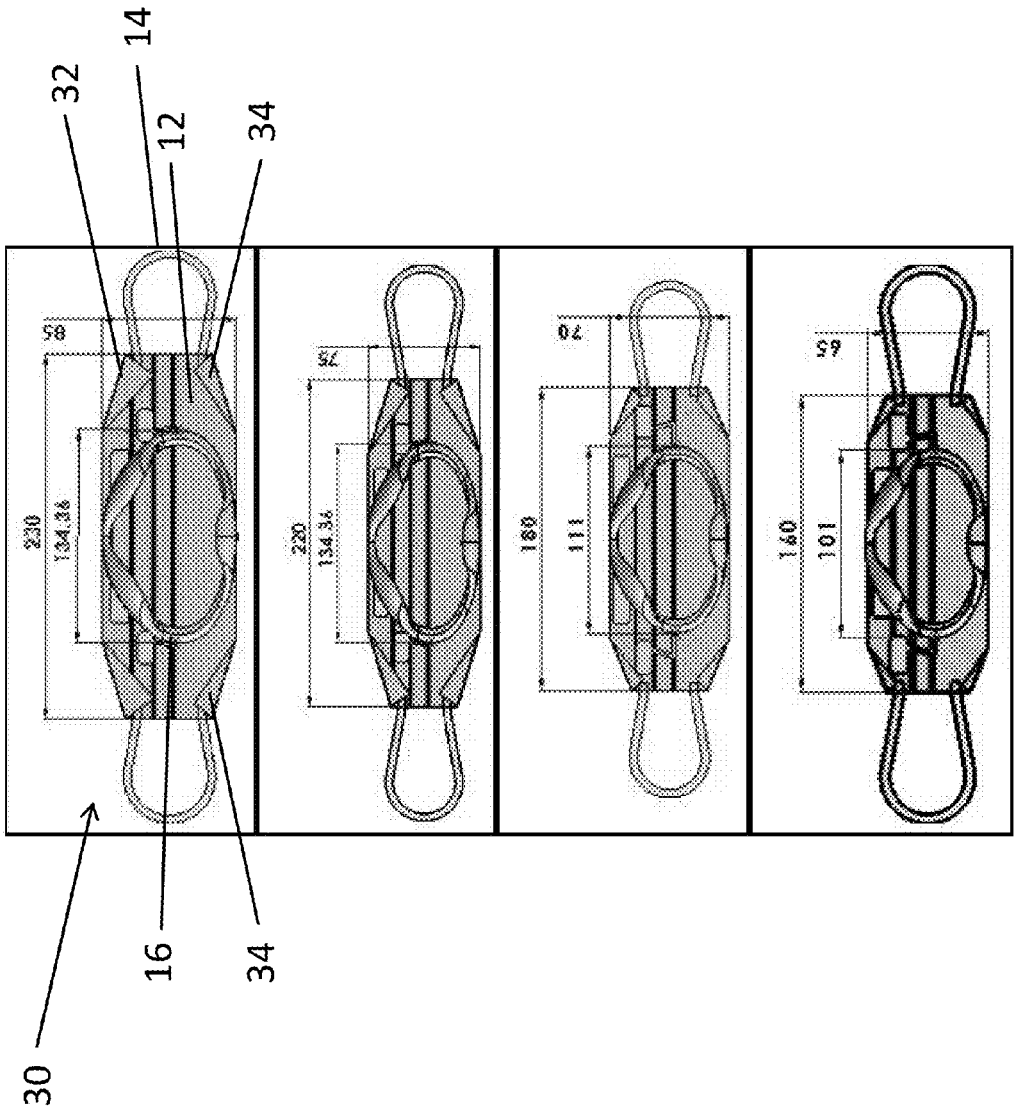


Figure 11

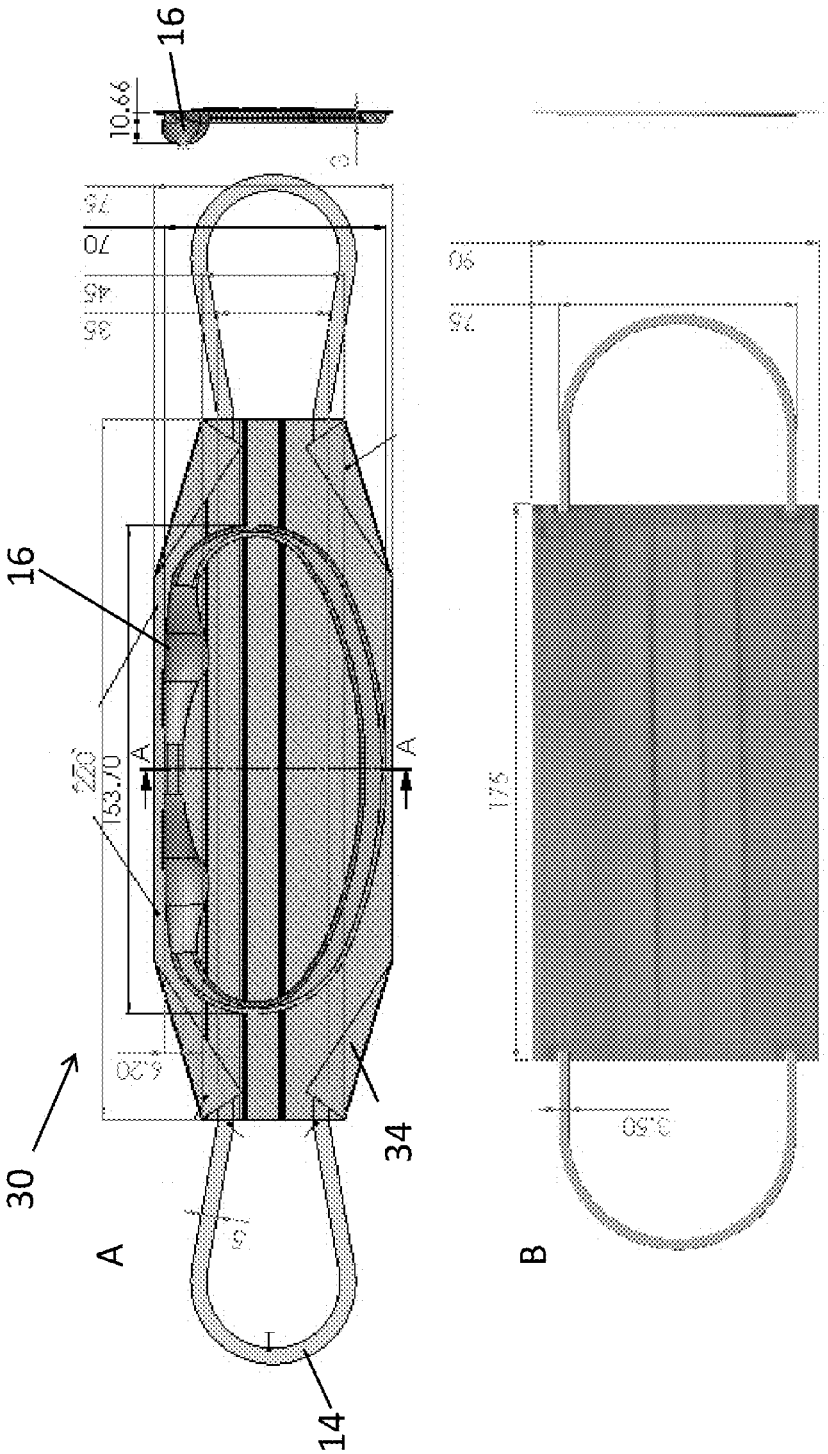


Figure 12

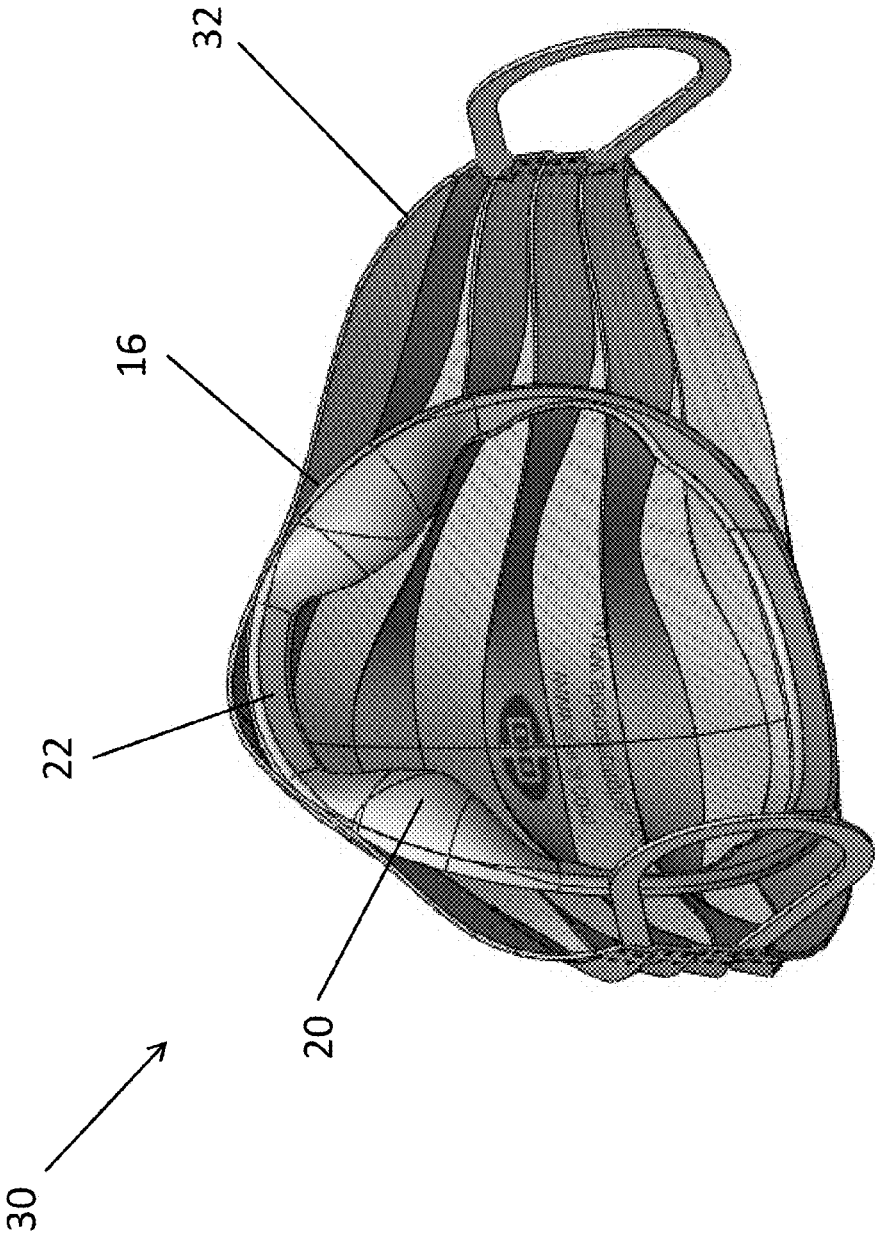


Figure 13

Figure 14

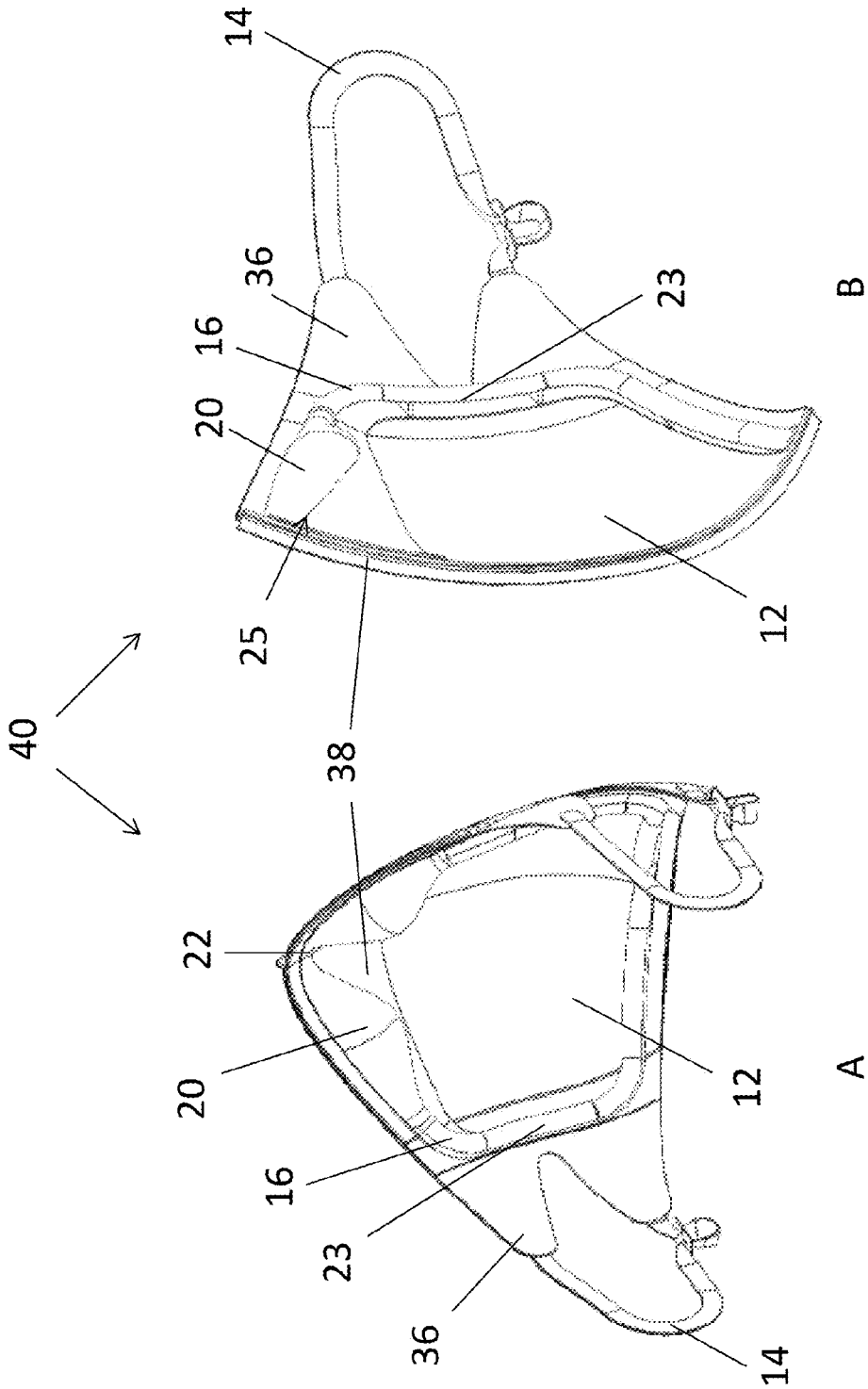


Figure 15

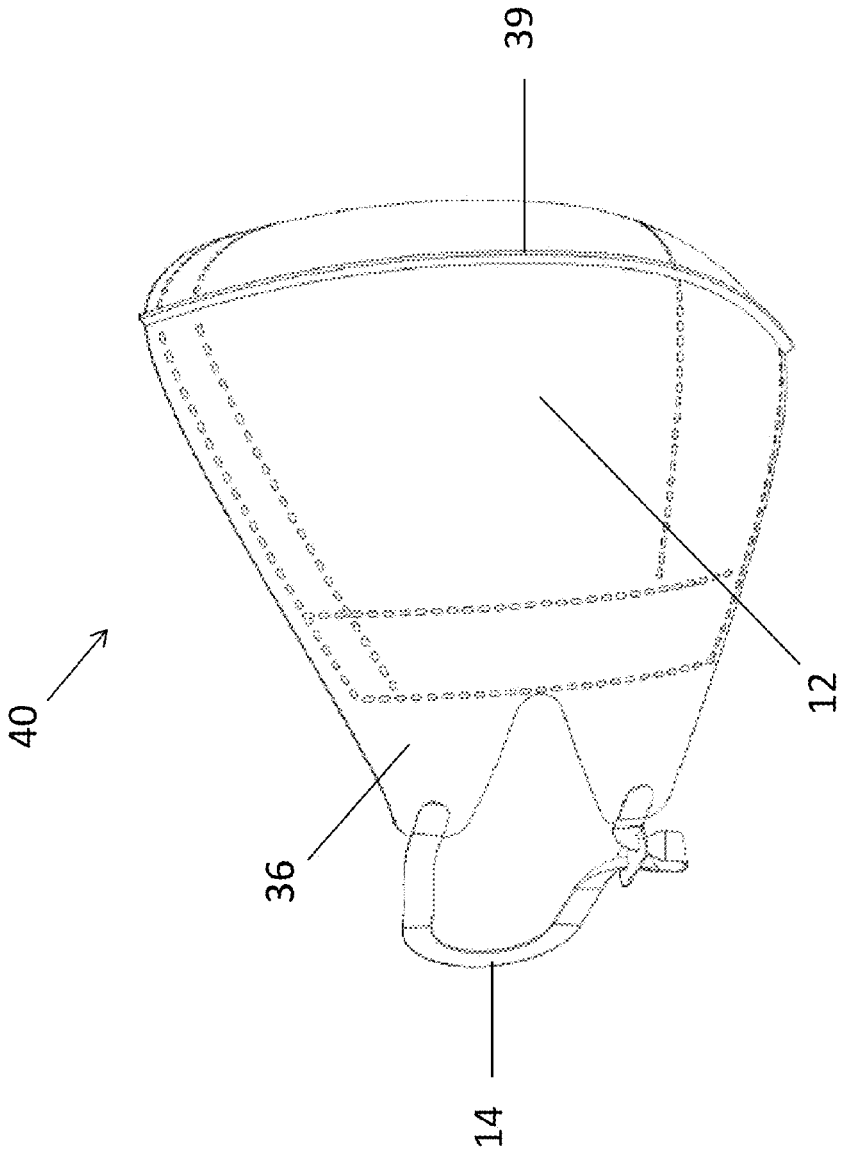


Figure 15

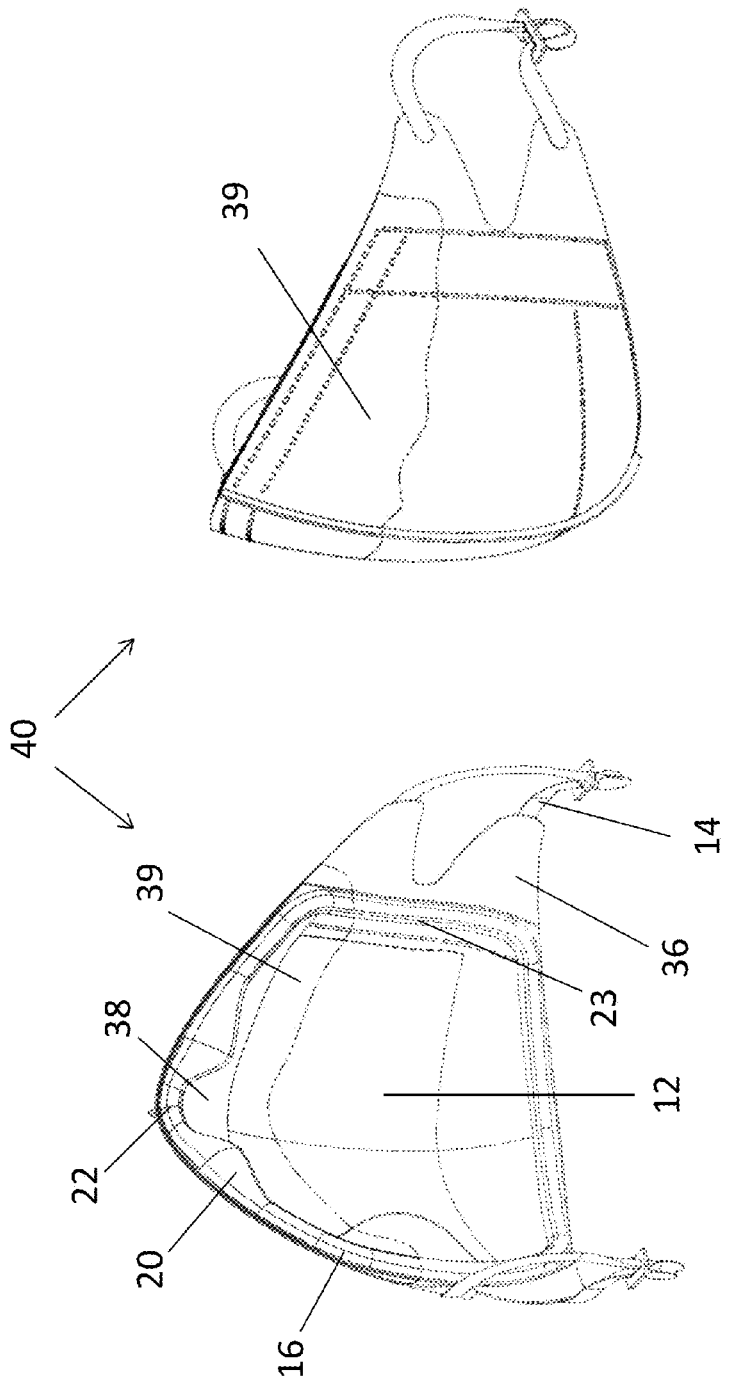


Figure 16

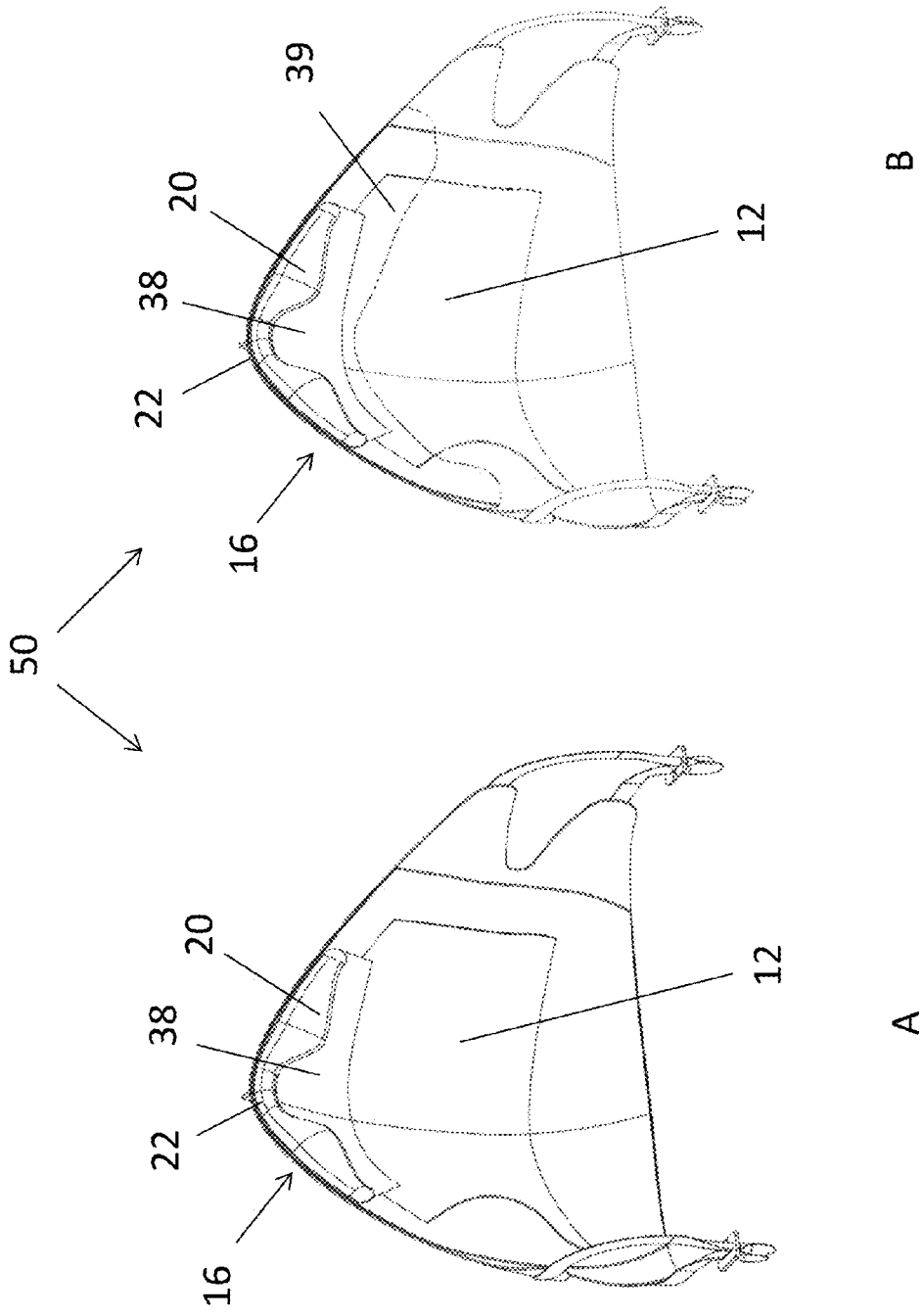


Figure 17

MEDICAL FACE MASK WITH SEALING STRIP

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority under 35 U.S.C. 119(e) to U.S. Provisional Patent Application No. 61/819,969 filed May 6, 2013, which is incorporated by reference herein in its entirety. The present application is also a continuation-in-part of U.S. application Ser. No. 13/933,821 filed Jul. 2, 2013, which claims priority under 35 U.S.C. 119(e) to U.S. Provisional Patent Application No. 61/819,969 filed May 6, 2013, the entire disclosures of which are each incorporated by reference herein in their entirety.

BACKGROUND OF THE INVENTION

[0002] Face masks are often used as personal protective equipment in a variety of situations, such as during medical treatment or in dusty environments. Medical personnel, such as nurses and surgeons, often need to wear face masks when providing care to a patient. Such face masks are generally designed to filter airborne contaminants from the air being inhaled by the user in order to protect the user from inhaling pathogens and other contaminants, while also protecting people near the user from inhaling contaminants exhaled by the user. Such airborne contaminants may include aerosolized saliva, bacteria, viruses, dust, or any other type of particle that can be suspended in air.

[0003] Face masks currently available are typically produced with one of two types of protection. Both types of masks are made by a variety of different manufacturers. The type of mask with the highest level of protection is the N95 mask, which refers to an efficiency rating determined by the National Institute for Occupational Safety and Health (NIOSH). The "N95" designation corresponds to a mask that blocks about 95% of particles that are 0.3 microns or larger. With testing for proper fit, these masks can provide good protection against inhaling harmful particles.

[0004] On the other hand, the type of mask used most frequently in healthcare environments is the "surgical" or "procedure" mask. The surgical masks presently available do not provide a complete seal with the user's face, resulting in a lower filtering capability compared to N95 masks. However, these surgical masks are significantly less expensive than N95 masks. These surgical masks are typically constructed from a flat, pleated filter material that spreads when the mask is worn. When the mask is secured to the user's face, gaps between the filter material and the wearer's face can occur. While these masks may protect the wearer from particles impacting directly against the mask, they offer little or no protection from contaminants suspended in air that can pass around the edges of the mask into the wearer's lungs.

[0005] Further, it is well recognized that one of the biggest problems for wearers of current surgical masks is the unwanted flow of moist, exhaled breath up the inner surface of the face of the mask, exiting towards their eyes. This exhaled breath can irritate the wearer's eyes, and if the wearer is also wearing glasses, significant fogging can occur. While anti-fogging strips are available for placement onto typical surgical masks, they unfortunately reduce the surface area for air to exit the mask, driving even more exhaled air out towards the eyes.

[0006] Thus, there is a continuing need in the art for a surgical face mask that provides an improved seal with the user's face, and prevents or significantly reduces exhaled breath from escaping out the top region of the mask toward the wearer's eyes. The present invention addresses this unmet need in the art.

SUMMARY OF THE INVENTION

[0007] The present invention relates to a face mask for filtering contaminants from air. The mask includes an air-permeable body having an inner surface, wherein the body is sized to cover the nose and mouth of a subject when worn by the subject, an inner seal connected to the inner surface of the body, wherein the inner seal is sized to form a perimeter around a wearer's nostrils and mouth, at least one strap connected to the body for securing the face mask to the subject's face, and a deflector layer connected to the inner surface of the body, wherein the deflector redirects at least a portion of the exhaled air down into the lower regions of the air-permeable body. In one embodiment, the inner seal is configured to form a seal around the subject's nose and mouth when worn by the subject. In another embodiment, the inner seal includes at least one leaflet for conforming a portion of the inner seal to the subject's nose. In another embodiment, the inner seal comprises silicone. In another embodiment, the at least one strap is connected to two or more extensions protruding from the side of the face mask. In another embodiment, the air-permeable body is slightly rigid. In another embodiment, an exterior surface of the air-permeable body includes at least one ridge to provide the slight rigidity. In another embodiment, the deflector layer is air-impermeable. In another embodiment, the deflector is at least partially coated with silicone along the inner surface of the face mask body.

[0008] The present invention also relates to a face mask that includes an air permeable body having an inner surface, wherein the body is sized to cover the nose and mouth of a subject when worn by the subject, an inner seal connected to the inner surface of the body, wherein the inner seal is sized to form a perimeter around a wearer's nostrils and mouth, at least one strap connected to the body for securing the face mask to the subject's face, and an air impermeable layer formed along the top portion of the inner surface of the body, wherein the air impermeable layer redirects at least a portion of the exhaled air down into the lower regions of the air-permeable body. In one embodiment, the inner seal is configured to form a seal around the subject's nose and mouth when worn by the subject. In another embodiment, the inner seal comprises at least one leaflet for conforming a portion of the inner seal to the subject's nose. In another embodiment, the inner seal comprises silicone. In another embodiment, the at least one strap is connected to two or more extensions protruding from the side of the face mask. In another embodiment, the body is slightly rigid.

[0009] The present invention also relates to a face mask that includes an air-permeable body having an inner surface, wherein the body is sized to cover the nose and mouth of a subject when worn by the subject, an inner seal connected to the inner surface of the body, wherein the inner seal is sized to conform to the sides of the wearer's nose and cheek regions under the wearer's eyes, at least one strap connected to the body for securing the face mask to the subject's face, and a deflector layer connected to the inner surface of the body, wherein the deflector redirects at least a portion of the exhaled air down into the lower regions of the air-permeable body. In

one embodiment, the inner seal comprises at least one leaflet for conforming a portion of the inner seal to the subject's nose. In one embodiment, the inner seal comprises silicone. In one embodiment, the deflector layer is an air-impermeable layer. In one embodiment, the deflector layer comprises a silicone coating.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The following detailed description of preferred embodiments of the invention will be better understood when read in conjunction with the appended drawings. For the purpose of illustrating the invention, there are shown in the drawings embodiments which are presently preferred. It should be understood, however, that the invention is not limited to the precise arrangements and instrumentalities of the embodiments shown in the drawings.

[0011] FIG. **1** is an illustration showing the outside of a facial mask, according to one embodiment of the present invention.

[0012] FIG. **2** is an illustration showing a perspective view of the inside of a facial mask, according to one embodiment of the present invention.

[0013] FIG. **3** is an illustration showing the inside of a facial mask, according to one embodiment of the present invention.

[0014] FIG. **4** is an illustration showing the inside of a facial mask, according to one embodiment of the present invention.

[0015] FIG. **5** is an illustration showing the outside of a facial mask, according to one embodiment of the present invention.

[0016] FIG. **6** is an illustration showing a perspective view of the outside of a facial mask, according to one embodiment of the present invention.

[0017] FIG. **7** is an illustration showing a perspective view of the inside of a facial mask, according to one embodiment of the present invention.

[0018] FIG. **8** is an illustration showing a perspective view of the inside of a facial mask, according to one embodiment of the present invention.

[0019] FIG. **9** is a set of illustrations showing the inner seal of a facial mask, according to one embodiment of the present invention, wherein the inner seal is positioned on a user's face.

[0020] FIG. **10** is an illustration showing a perspective view of the inside of a facial mask, according to one embodiment of the present invention.

[0021] FIG. **11** is a set of illustrations showing the inside of various embodiments of the facial mask of the present invention.

[0022] FIG. **12** is a set of illustrations of facial masks. FIG. **12**A shows an inside view and side view of a facial mask, according to one embodiment of the present invention. FIG. **12**B shows an inside view and side view of a common facial mask, i.e., a mask currently available in the art.

[0023] FIG. **13** is an illustration showing a perspective view of the inside of a facial mask, according to one embodiment of the present invention.

[0024] FIG. **14** is an illustration showing a perspective view of the outside of a facial mask, according to one embodiment of the present invention.

[0025] FIG. **15** is a set of views of an exemplary mask having a deflector therein. FIG. **15**A is a perspective view of the inner surface of the exemplary mask,

[0026] FIG. **15**B is a side view of the exemplary mask, and **15**C is a perspective view of the outer surface of the exemplary mask.

[0027] FIG. **16** is a set of views of an exemplary mask having an air-impermeable layer therein. FIG. **16**A is a perspective view of the inner surface of the exemplary mask, and **16**B is a perspective view of the outer surface of the exemplary mask.

[0028] FIG. **17** is a set of perspective views (**17**A and **17**B) of an exemplary mask having a partial inner seal, a deflector and an air-impermeable layer therein.

DETAILED DESCRIPTION

[0029] It is to be understood that the figures and descriptions of the present invention have been simplified to illustrate elements that are relevant for a clear understanding of the present invention, while eliminating, for the purpose of clarity, many other elements found in medical face masks. Those of ordinary skill in the art may recognize that other elements and/or steps are desirable and/or required in implementing the present invention. However, because such elements and steps are well known in the art, and because they do not facilitate a better understanding of the present invention, a discussion of such elements and steps is not provided herein. The disclosure herein is directed to all such variations and modifications to such elements and methods known to those skilled in the art.

[0030] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. Although any methods, materials and components similar or equivalent to those described herein can be used in the practice or testing of the present invention, the preferred methods and materials are described.

[0031] As used herein, each of the following terms has the meaning associated with it in this section.

[0032] The articles "a" and "an" are used herein to refer to one or to more than one (i.e., to at least one) of the grammatical object of the article. By way of example, "an element" means one element or more than one element.

[0033] "About" as used herein when referring to a measurable value such as an amount, a temporal duration, and the like, is meant to encompass variations of ±20%, ±10%, ±5%, ±1%, or ±0.1% from the specified value, as such variations are appropriate.

[0034] The terms "contaminant," "particle," and the like may be used interchangeably herein, and refer to a constituent or impurity in the air or environment surrounding the user of the mask of the present invention that can adversely affect the user if inhaled.

[0035] Throughout this disclosure, various aspects of the invention can be presented in a range format. It should be understood that the description in range format is merely for convenience and brevity and should not be construed as an inflexible limitation on the scope of the invention. Accordingly, the description of a range should be considered to have specifically disclosed all the possible subranges as well as individual numerical values within that range. For example, description of a range such as from 1 to 6 should be considered to have specifically disclosed subranges such as from 1 to 3, from 1 to 4, from 1 to 5, from 2 to 4, from 2 to 6, from 3 to 6 etc., as well as individual numbers within that range, for

example, 1, 2, 2.7, 3, 4, 5, 5.3, 6 and any whole and partial increments therebetween. This applies regardless of the breadth of the range.

[0036] The present invention relates to a face mask that filters contaminants from air during inhalation and exhalation. The face mask of the present invention provides a more complete seal than face masks in the prior art, thereby decreasing the risk of contaminants bypassing the face mask's filter during inhalation or exhalation. In one embodiment, the face mask comprises a seal within the mask that fits around the nose and mouth of the user, i.e., an inner seal. In another embodiment, the face mask comprises two seals for sealing the mask to the user's face: an inner seal and also a seal around the edge of the mask, i.e., an outer seal. The mask also comprises an air-permeable body that serves to filter contaminants from air and a mechanism for securing the mask to the user's face, for example a strap that connects to the mask and can be positioned around the user's head.

[0037] Referring now to the drawings, FIG. **1** is an illustration of one embodiment of a face mask **10** of the present invention. FIG. **1** shows the outside of face mask **10**, comprising an air-permeable body **12** and straps **14**. Straps **14** may be used to secure face mask **10** to the user's face by placing straps **14** around the user's ears. Air-permeable body **12** of face mask **10** comprises a number of pleats **13** that allow for air-permeable body **12** to be stretched and configured without damaging or compromising the structural integrity of air-permeable body **12**.

[0038] In one embodiment of the face mask of the present invention, the air-permeable body **12** comprises a non-woven material or fabric. Non-woven materials are materials comprising fibers or filaments that are bound together mechanically, thermally, or chemically. The fibers or filaments are typically composed of synthetic polymers, but can be composed of any material suitable for both filtering particulates and contacting human skin, as would be understood by a person with ordinary skill in the art.

[0039] In one embodiment, straps **14** are configured to be placed around the ears of the user. In another embodiment, the straps are configured to be placed around the head or neck of the user. In one embodiment, the straps comprise an elastomeric material suitable for securing the mask to the user's face. In another embodiment, the straps further comprise a clasping mechanism for securing the straps around the user's head or neck.

[0040] Referring to FIG. **2**, an illustration of a perspective view of the inside of face mask **10** is shown, i.e., the side of face mask **10** that is in contact with the user's face when face mask **10** is worn. Face mask **10** comprises air-permeable body **12**, an inner seal **16** and an outer seal **18**.

[0041] In one embodiment of the present invention, the inner seal **16** of the face mask of the present invention comprises a relatively soft material that forms a substantially circular or elliptical shape around the user's nose and mouth when the mask is worn. Referring to FIG. **9**, a series of illustrations shows inner seal **16** conforming to a user's face. In one embodiment, inner seal **16** further comprises wider or thicker regions, also referred to herein as leaflets **20**, that conform to the shape of the user's face on either side of the user's nose to improve the sealing characteristics of inner seal **16**. In one embodiment, inner seal **16** comprises a region **22** between leaflets **20** that forms a seal with the bridge of the user's nose. In various embodiments, the length of region **22** may be sized appropriately so that leaflets **20** form a seal with the sides of the user's nose, i.e., so an optimal seal is formed in the area of the user's face where there are creases between the user's nose and cheeks. Further, in one embodiment, inner seal **16** comprises a side loop **23** that fits around the side of user's cheek in order to provide an optimal seal with the user's face. In one embodiment, the inner seal is made of silicone. In another embodiment, the inner seal may comprise any elastomeric material such as a thermoplastic elastomer (TPE), or a combination of materials such as TPE with ethylene-vinyl acetate (EVA) and/or polyurethane (PU), suitable for forming an air-tight seal around the user's nose and mouth.

[0042] In one embodiment, the outer seal **18** of the present invention comprises a relatively soft material that can conform to the contours of the user's face in order to form an air-tight seal between the air-permeable body of the present invention and the user's face. In one embodiment, the outer seal comprises foam made from a TPE/EVA blended resin. In another embodiment, the foam of the outer seal comprises polyurethane. In another embodiment, the outer seal may comprise any material, or combination of materials, suitable for forming an air-tight seal between the mask and the user's face. In yet another embodiment, the face mask of the present invention may comprise only one seal, wherein the single seal is an outer seal instead of an inner seal.

[0043] In one embodiment, a mild adhesive may be used in conjunction with the inner seal, outer seal, or both, in order to further improve the quality of the seal between the mask and the user's face. In another embodiment, the inner seal, outer seal, or both, may comprise an elastomeric material that is formulated to produce a sticky or tacky effect, in order to further improve the quality of the seal between the mask and the user's face

[0044] Referring to FIG. **3**, an illustration of the inside of face mask **10** is shown. Face mask **10** comprises straps **14**, inner seal **16**, and outer seal **18** Inner seal **16** is attached to face mask **10** at two points via connector strips **15**. The dimensions of various parts of an exemplary embodiment of face mask **10** are also shown in FIG. **3**, in millimeters (mm). FIG. **3** shows one possible configuration of face mask **10**, in which air-permeable body **12** and inner seal **16** are not stretched vertically, i.e., the inner seal is in a relaxed state. Specifically, the height of air-permeable body **12** is about 60 mm at all points, while the width of inner seal **16** is about 150 mm. The overall width of air-permeable body **12** is about 230 mm.

[0045] In various embodiments, the face mask of the present invention can be configured or adjusted to fit the contours of the user's face. In one embodiment, pleats **13** in the air-permeable body **12** allow for the body to be stretched to match the dimensions of the user's face. In one embodiment, outer seal **18** is suitably flexible to stretch or adjust in conjunction with air-permeable body **12** without separating or detaching from air-permeable body **12**.

[0046] In one embodiment, inner seal **16** is attached to air-permeable body **12** via at least one connector strip **15**. In a preferred embodiment, inner seal **16** is attached to air-permeable body **12** via two connector strips, such that the inner seal **16** can maintain sufficient flexibility to change shape when air-permeable body **12** is adjusted vertically, while remaining connected to air-permeable body **12**. In one embodiment, each connector strip **15** serves to fasten inner seal **16** to air-permeable body **12** in a single location, thereby leaving the remaining portion of inner seal **16** unconnected to air-permeable body **12**. In such an embodiment, most of inner

seal **16** is free-floating, i.e., unconnected to air-permeable body **12** or any other part of face mask **10**, in order to allow inner seal **16** to adjust and conform to the user's face when worn by the user. In one embodiment, inner seal **16** is forced against air-permeable body **12** when worn by the user, thereby forming a seal between inner seal **16** and air-permeable body **12**, in addition to the seal formed between inner seal **16** and the user's face. In such an embodiment, the seal formed between inner seal **16** and air-permeable body **12** is a mechanical seal resulting from the pressure of inner seal **16** against air-permeable body **12** caused by the force of the user's face pushing against inner seal **16**.

[0047] Referring to FIG. **4**, an illustration of the inside of face mask **10** is shown, in which a portion of face mask **10** has been stretched to match the dimensions of a user's face, i.e., to cover the user's nose and mouth. Specifically, the height of air-permeable body **12** is about 130 mm at its fully expanded point, while the width of inner seal **16** is about 100 mm (compared to 150 mm in FIG. **3**). Notably, the overall width of air-permeable body **12** is about 230 mm, i.e., the same as in FIG. **3**. Therefore, as depicted in FIG. **4**, inner seal **16** and a portion of air-permeable body **12** have been stretched vertically without substantially changing the overall width of air-permeable body **12**. Further, the shape of outer seal **18** has been adjusted accordingly with air-permeable body **12**.

[0048] Referring to FIG. **5**, an illustration of the outside of face mask **10** is shown, in which air-permeable body **12** has been configured to cover the user's nose and mouth. As described herein, air-permeable body **12** comprises pleats **13** that enable air-permeable body **12** to be stretched without reducing or compromising the structural integrity of air-permeable body **12**.

[0049] Referring to FIG. **6**, an illustration of a perspective view of the outside of face mask **10** is shown. Connector strips **15** are used to attach the inner seal **16** (not shown) to air-permeable body **12** of face mask **10**. In this view, face mask **10** is configured to the approximate shape of face mask **10** when it is secured to a user's face. In this embodiment, straps **14** may be secured around the user's ears to secure face mask **10** to the user's face, while air-permeable body **12** is configured to cover the user's nose and mouth.

[0050] Referring to FIG. **7**, an illustration of a perspective view of the inside of face mask **10** is shown. In this embodiment, air-permeable body **12** and inner seal **16** are configured to cover the user's nose and mouth, similarly to FIG. **6**. Outer seal **18** maintains the shape of the perimeter of air-permeable body **12**. Connector strips **15** connect inner seal **16** to air-permeable body **12**. Further, inner seal **16** comprises leaflets **20**, i.e., a wider region of the inner seal, that provide an optimal fit of inner seal **16** to the bridge of the user's nose. As contemplated herein, inner seal may include additional leaflet regions to provide additional depth and/or thickness to better conform to the user's facial contours, such as around the cheeks, mouth and portion of the chin.

[0051] Referring to FIG. **8**, an illustration of a perspective view of face mask **10**, comprising inner seal **16** is shown.

[0052] Referring to FIG. **10**, an illustration of the inside of another embodiment of the face mask of the present invention is shown. Face mask **30** comprises an air-permeable body **12**, straps **14**, and an inner seal **16** Inner seal **16** is connected to air-permeable body **12** via connector tabs **26**. Inner seal **16** comprises a bottom region **24** that is wider than other areas of inner seal **16**, much like leaflets **20**. Bottom region **24** may be suitable for forming a seal with an area on user's chin. Air-permeable body **12** of face mask **30** comprises angled regions **32**, wherein the height of air-permeable body **12** reduces from its widest point to its narrowest point near the part of face mask **30** where straps **14** are connected. In one embodiment, angled region **32** is created by manufacturing air-permeable body **12** in a shape that is generally rectangular, but with a sloping angle near the ends of the rectangle, i.e., a reduced width at each of the four corners of the rectangle as compared to the width at the center of the rectangle.

[0053] In another embodiment, angled regions **32** are created by manufacturing air-permeable body **12** in the shape of a rectangle, then folding each of the four corners of the rectangle toward the inside surface of air-permeable body **12**. An example of such an embodiment is shown in FIG. **11**. In FIG. **11**, four embodiments of face mask **30** are shown, wherein each embodiment comprises the same shape and features, but with different dimensions, as indicated. Angled regions **32** are shown on air-permeable body **12**, wherein a portion of air-permeable body **12** has been folded to create flaps **34** at each corner of air-permeable body **12**. Accordingly, a region near each of the four corners of air-permeable body **12** has two layers of material where flaps **34** have been folded. Flaps **34** may improve the seal between the user's face and air-permeable body **12** by increasing the stiffness of at least a portion of air-permeable body **12**, which may prevent undesired folding of face mask **30** when worn by the user. Further, flaps **34** may be used to secure, or aid in securing, straps **14** to air-permeable body **12**. In one embodiment, flaps **34** may be secured to the inner surface of air-permeable body by any means that would be understood by a person of ordinary skill, for example, but not limited to, an adhesive or a clamp.

[0054] In addition, the width of the region of air-permeable body **12** that has been folded to form flaps **34** is less than other regions of air-permeable body **12**. In one embodiment, this reduced width at the ends of air-permeable **12** may improve the seal of the face mask of the present invention to the user's face by providing a narrower region where straps **14** can connect to face mask **30**. Such a narrow region may reduce the possibility of folds or gaps being created when the straps are attached to the user, for example when straps **14** are placed around the user's ears.

[0055] As shown in FIG. **11**, in various embodiments, face mask **30** may comprise different lengths, for example 160 mm, 180 mm, 220 mm, or 230 mm. Further, face mask **30** may comprise different widths at its widest point, for example 65 mm, 70 mm, 75 mm, or 85 mm. Further still, inner seal **16** may comprise different widths, for example 101 mm, 111 mm, or 134.36 mm. However, as would be understood by a person with ordinary skill in the art, the present invention is not limited to the dimensions described herein.

[0056] In one embodiment, face mask **30** differs from face mask **10** by eliminating the outer seal of face mask **10**. Accordingly, flaps **34** may create an air-tight seal between the user's face and face mask **30** without the need for an outer seal. However, in another embodiment, at least a portion of the perimeter of air-permeable body **12** of face mask **30** comprises an outer seal.

[0057] Referring to FIG. **12**, a comparison between an embodiment of the face mask of the present invention and an embodiment of a face mask currently available is shown, including some relevant dimensions of both face masks. The diagram at the left of FIG. **12**A shows the inside of face mask **30** of the present invention, wherein the diagram at the right

shows the profile of face mask **30**. The image at the left of FIG. **12** B shows the inside of a face mask of a type currently available wherein the image at the right shows the profile of the face mask currently available. As can been seen in FIG. **12**, this embodiment of face mask **30** differs from the currently available face mask in a number of respects such as, but not limited to: face mask **30** is substantially longer than the face mask in FIG. **12**B (220 mm vs, 175 mm, excluding the size of the ear straps); face mask **30** comprises an inner seal **16**, whereas the mask in FIG. **12**B does not; and ear straps **14** of face mask **30** are connected to the mask to allow for flaps **34** to be folded, while the mask in FIG. **12**B does not have such flaps, and could not have such flaps, because the ear straps of the mask in FIG. **12**B are connected close to the edge of the corners of the rectangle.

[0058] Accordingly, these differences between face mask **30** and the face mask in FIG. **12**B, at least, result in improved sealing of face mask **30** to the user's face when compared to the mask in FIG. **12**B. For example, the longer size of face mask **30**, along with flaps **34**, optimizes the seal of the mask at the sides of the user's face, i.e., the area of the user's face closest to the user's ears. In addition, the inner seal of face mask **30** creates an air-tight seal around the user's nose and mouth. Conversely, the face mask in FIG. **12**B allows for gaps between the mask and the user's face when worn by the user, created, for example, by the body of the mask folding or bunching, or by the lack of a mechanism properly adhere the mask to the different contours of the user's face. Accordingly, the mask in FIG. **12**B cannot provide an optimal, air-tight seal to all portions of the user's face.

[0059] Referring to FIG. **13**, an illustration of one embodiment of the inside of face mask **30** is shown, comprising angled regions **32**. In this embodiment, an embodiment of inner seal **16** is shown, wherein inner seal **16** comprises a region **22** between leaflets **20** that is wide enough to form an optimal seal with the bridge of the user's nose.

[0060] Referring to FIG. **14**, an illustration of a perspective view of the outside of face mask **30** is shown.

[0061] In another embodiment of the present invention, the mask is uniquely structured to prevent or significantly reduce exhaled breath from escaping out the top region of the mask toward the wearer's eyes. It is well recognized that one of the biggest problems for wearers of surgical masks is the unwanted flow of moist, exhaled breath up the inner surface of the face of the mask, exiting towards their eyes. This exhaled breath can irritate the wearer's eyes, and if the wearer is also wearing glasses, significant fogging can occur. While anti-fogging strips are available for placement onto typical surgical masks, they unfortunately reduce the surface area for air to exit the mask, driving even more exhaled air out towards the eyes.

[0062] Air flow within a surgical mask is determined by several factors. For example, air flow is affected by how well the mask seals at all contact points along its edge. Further, air flow is effected by the resistance of the filter material, which itself is determined by both how tight the filter material is (meaning the size of the openings in the material) and the surface area across which the air flow is dispersed. For a surgical mask to be effective in preventing bacteria, viruses or other particulates from passing through the mask material in both directions, the openings in the material need to be very small. As a consequence of this, the smaller sized openings that filter out the unwanted particulates inevitably increase resistance to exhaled breath passing through and exiting the face of the mask. This results in a temporary increase in air pressure between the wearer's face and the mask, and directs the air flow to any path of lesser resistance. For existing masks, the path of least resistance is at the top portion of the mask around the wearer's eyes and bridge of the nose.

[0063] Accordingly, the mask of the present invention prevents or reduces air flow toward the eyes of the wearer by creating a superior seal around the bridge of the nose and upper cheeks under the eyes. Further, exhaled breath is redirected away from the upper portion of the mask, thereby allowing air to flow back toward the face of the mask and exit the mask preferably through the filter material.

[0064] For example, as shown in FIGS. **15**A and **15**B, mask **40** may include an inner seal **16**, shaped and constructed in a similar manner as described and shown in the embodiments of FIGS. **9** and **10** herein. Face mask **40** similarly comprises an air-permeable body **12**, straps **14**, along with inner seal **16**, which forms a superior seal around all contact points of inner seal **16** to the wearer's face Inner seal **16** of mask **40** is constructed from a relatively soft material that forms a substantially circular or elliptical shape around the user's nose and mouth when the mask is worn, such that it sufficiently conforms to the contours of all contact points to the wearer's face. To enhance the strength of the seal and to promote additional comfort, inner seal **16** comprises leaflets **20**, which are wider and/or thicker regions that better conform to the shape of the wearer's face on either side of the wearer's nose Inner seal **16** also comprises bridge region **22** between leaflets **20** that may vary in length to account to the particular structure and size of the wearer's nose. Further, inner seal **16** comprises side loop **23** that fits around the side of the wearer's cheek in order to provide an optimal seal with the wearer's face.

[0065] Air-permeable body **12** may be foldable, as shown in other various embodiments described herein, or it may be moderately rigid, such that body **12** may substantially hold its generally cupped shape when little or no force is put against it. To provide a moderate amount of rigidity, the outside surface of body **12** may include a ridge **39** formed from the mating of two portions of body **12** in construction of mask **40** or from the pinching and fixing of a ridge-like line vertically and centrally along the outer surface of body **12**, such that body **12** can substantially hold its generally cupped shape, as shown in FIG. **15**C. Likewise, body **12** may flex slightly when worn by a user, such that a superior seal is formed against the wearer's face, yet body **12** still maintains its generally cupped shape to provide a distance between the mouth and nostrils of the wearer's face and allow air to flow between the wearer's face and the inner surface of body **12**. To improve a smooth and flush contact of inner seal **16** against the wearer's face, the sides of mask **40** may include extensions **36** to which strap **14** is affixed. Extensions **36** prevent or reduce any bunching of material of mask **40** when worn, such that inner seal **16** is not offset at an undesirable starting angle when contacting the wearer's face.

[0066] Mask **40** may further include a deflector sheet **38**, positioned along the top portion of the inner surface of body **12** and optionally in contact with the bottom portion **25** of leaflets **20** and bridge region **22** of inner seal **16**. In one embodiment, deflector sheet **38** contacts enough of bottom surface **25** of leaflets **20** and bridge region **22** to create a ridge or a small pocket that effectively blocks air flow from pushing out the top of inner seal **16** toward the eyes, and instead re-directs the air flow back down into the open space near the

face of the mask, where the air can exit through the material of body **12**. Alternatively, deflector sheet **38** may include a folded region, such that the line of the fold is at the top of mask **40**, and leaflets **20** and bridge **22** of inner seal **16** are attached to the flap created beyond the fold line. Thus, the flap and fold region may create a pocket that deflects air traveling up the inner surface of body **12** back down into the open space near the face of the mask, where the air can suitably exit the mask through the material of body **12**.

[0067] Accordingly, deflector sheet **38** is attached near the top edge of mask **40** so that when the wearer exhales against the resistance caused by the material of body **12**, the air flow is pushed up along the front surface of body **12** towards the eyes. As it passes between the material of body **12** and deflector sheet **38** and reaches the top edge, the air cannot escape in that direction and is therefore directed back down towards the front of the nose and mouth. This brief period is sufficient time for the pressure inside mask **40** between the mask and the wearer's face to drop as the other exhaled breath passes through and exits the material of body **12** without causing the moist air to fog the glasses or irritate the eyes of the wearer. Deflector **38** may extend downward along the inner surface of body **12**, such that the deflector covers about the top 1-50 mm of the inner surface of body **12**. In other embodiments, the deflector covers about the top 1-40 mm, the top 1-30 mm, the top 1-20 mm, the top 1-15 mm, the top 1-10 mm, or the top 1-5 mm.

[0068] In another embodiment, deflector **38** may be coated with an air-impermeable material, such as silicon. Accordingly, as shown in FIG. **16**A, an impermeable layer **39** is formed by the silicon coating, such that no air can pass through either impermeable layer **39** or through nose bridge **22** and leaflets **20** of inner seal **16**. This results in the exhaled air being forced back down to escape either through the lower portions of the mask filter material **12** or alternatively through the sides or bottom of the mask. In some embodiments, impermeable layer **39** only covers a portion of deflector **38**. In other embodiments, impermeable layer **39** covers substantially all of deflector **38**. In still other embodiments, impermeable layer **39** covers all of deflector **38** as well as at least a portion of body **12** going down towards the middle region of mask **40**. In yet another embodiment, impermeable layer **39** may be on the outside surface of mask **40**, as shown in FIG. **16**B. In other embodiments, impermeable layer **39** is on both the inner surface and outer surface of mask **40**. In some embodiments the impermeable layer may be formed as part of the inner seal, and may be molded at the same time as the inner seal is molded and positioned onto the mask body.

[0069] It should also be appreciated that impermeable layer **39** may be applied to mask **40** without an additional deflector **38** component. For example, a silicon layer may be applied to the top portion of the mask, such that it extends downward below nose bridge region **22** and leaflets **20** of inner seal **16**. Because exhaled air cannot escape through either impermeable layer **39** or through nose bridge region **22** and leaflets **20** of inner seal **16**, the exhaled air is forced back down into the lower region of the mask, where it can escape through the filter material body **12** without causing the wearer's glasses to fog or to irritate the wearer's eyes. Air impermeable layer **39** may extend downward along the inner surface of body **12**, such that the impermeable layer covers about the top 1-50 mm of the inner surface of body **12**. In other embodiments, the impermeable layer covers about the top 1-40 mm, the top 1-30 mm, the top 1-20 mm, the top 1-15 mm, the top 1-10 mm, or the top 1-5 mm.

[0070] In another embodiment, as shown in FIGS. **17**A and **17**B, mask **50** may include a partial inner seal **16** that includes nose bridge region **22** and leaflets **20**. Accordingly, because the sides and bottom portion of inner seal **16** are absent, exhaled air can escape from the sides and bottom of the mask. Mask **50** may optionally include deflector **38** and/or impermeable layer **39**, which functions in the same fashion as described for mask **40** herein. Thus, as the wearer exhales breath, any portion of the exhaled breath that travels up the inner surface toward the eyes is blocked by one or more of bridge region **22** and leaflets **20** of partial inner seal **16**, deflector **38** and/or impermeable layer **39**. When the exhaled air is force back down, it can escape mask **50** from either or both of the sides or bottom of mask **50**

[0071] The disclosures of each and every patent, patent application, and publication cited herein are hereby incorporated herein by reference in their entirety.

[0072] While this invention has been disclosed with reference to specific embodiments, it is apparent that other embodiments and variations of this invention may be devised by others skilled in the art without departing from the true spirit and scope of the invention. The appended claims are intended to be construed to include all such embodiments and equivalent variations.

1. A face mask for filtering contaminants from air, comprising:

an air-permeable body having an inner surface, wherein said body is sized to cover the nose and mouth of a subject when worn by said subject;

an inner seal connected to said inner surface of said body, wherein said inner seal is sized to form a perimeter around a wearer's nostrils and mouth;

at least one strap connected to said body for securing said face mask to said subject's face; and

a deflector layer connected to the inner surface of said body, wherein the deflector redirects at least a portion of the exhaled air down into the lower regions of the air-permeable body.

2. The face mask of claim **1**, wherein said inner seal is configured to form a seal around said subject's nose and mouth when worn by said subject.

3. The face mask of claim **1**, wherein said inner seal comprises at least one leaflet for conforming a portion of said inner seal to said subject's nose.

4. The face mask of claim **1**, wherein said inner seal comprises silicone.

5. The face mask of claim **1**, wherein the at least one strap is connected to two or more extensions protruding from the side of the face mask.

6. The face mask of claim **1**, wherein the air-permeable body is slightly rigid.

7. The face mask of claim **6**, wherein an exterior surface of the air-permeable body includes at least one ridge to provide the slight rigidity.

8. The face mask of claim **1**, wherein the deflector layer is air-impermeable.

9. The face mask of claim **8**, wherein the deflector is at least partially coated with silicone along the inner surface of the face mask body.

10. A face mask for filtering contaminants from air, comprising:

an air permeable body having an inner surface, wherein said body is sized to cover the nose and mouth of a subject when worn by said subject;

an inner seal connected to said inner surface of said body, wherein said inner seal is sized to form a perimeter around a wearer's nostrils and mouth;

at least one strap connected to said body for securing said face mask to said subject's face; and

an air impermeable layer formed along the top portion of the inner surface of said body, wherein the air impermeable layer redirects at least a portion of the exhaled air down into the lower regions of the air-permeable body.

11. The face mask of claim **10**, wherein said inner seal is configured to form a seal around said subject's nose and mouth when worn by said subject.

12. The face mask of claim **10**, wherein said inner seal comprises at least one leaflet for conforming a portion of said inner seal to said subject's nose.

13. The face mask of claim **10**, wherein said inner seal comprises silicone.

14. The face mask of claim **10**, wherein the at least one strap is connected to two or more extensions protruding from the side of the face mask.

15. The face mask of claim **10**, wherein the body is slightly rigid.

16. A face mask for filtering contaminants from air, comprising:

an air-permeable body having an inner surface, wherein said body is sized to cover the nose and mouth of a subject when worn by said subject;

an inner seal connected to said inner surface of said body, wherein said inner seal is sized to conform to the sides of the wearer's nose and cheek regions under the wearer's eyes;

at least one strap connected to said body for securing said face mask to said subject's face; and

a deflector layer connected to the inner surface of said body, wherein the deflector redirects at least a portion of the exhaled air down into the lower regions of the air-permeable body.

17. The face mask of claim **16**, wherein said inner seal comprises at least one leaflet for conforming a portion of said inner seal to said subject's nose.

18. The face mask of claim **16**, wherein said inner seal comprises silicone.

19. The face mask of claim **16**, wherein the deflector layer is an air-impermeable layer.

20. The face mask of claim **19**, wherein the deflector layer comprises a silicone coating.

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