HIGH EFFICIENCY RESPIRATOR

TECHNICAL FIELD

The present invention relates to filtration face masks designed to cover the nose and mouth of a human wearer and particularly to masks having an expanded filtration surface area.

BACKGROUND

Filtration face masks (hereinafter masks) are used in a wide variety of applications when it is desired to protect a human's respiratory system from particles suspended in the air or from unpleasant or noxious gases.

Wearer comfort is paramount to overcome the frequently encountered resistance to use. In addition to the comfort derived from a proper fit to a human face, it is desirable that a mask require a minimum to effort to draw air in through the filter media. This is referred to as the pressure drop across a mask, or breathing resistance.

To reach higher levels of filter efficiency, more or thicker layers of filter material are typically used. If the filter area is held constant the addition of more layers of filter material raises the pressure drop across a mask. Provision of high efficiency face masks has been limited by the fact that the thicker filtration layers needed for such performance leave conventionally designated face masks with unacceptable pressure drops. Formation of face masks with a larger filter material surface area typically lowers the pressure drop, and masks having an increased filter surface area over that of a generally cup-like shaped mask are described in, for example, U.S. Pat. Nos. 4,248,220 and 4,417,575, and EPO application No. 149,590 A3. Masks disclosed in these references suffer from difficulties in manufacture and/or poor fit to the wearer's face. In addition, prior art attempts at increasing surface area have included the use of sharp pleats or folds in the filter material. While this is acceptable for thin, paper-like filter material it will not work when a thick filter material is used.

It is, therefore, highly desirable to provide a mask which has an increased filter media surface area over that of a cup-like shaped mask without the use of sharp pleats or folds, is exceptionally easy to manufacture, and is comfortable and firmly fitting on the face of a typical human wearer.

SUMMARY OF THE INVENTION

These and other advantages are provided by the expanded area filtration face mask of the invention which is adapted to cover the mouth and nose of a wearer of the mask and comprises a filter member having a shape retaining annular base disposed around the open edge of the mask and adapted to fit conformingly against the face of a wearer of the mask; at least two sidewall portions generally extending away from the face of the wearer and away from the annular base; a frontal portion bridging the sidewall portions; and at least two supporting arch structures disposed at the junction of the sidewall and frontal portions, and intersecting the annular base; the interior surface area of the filter member defined by the sidewall and frontal portions being greater than that of the segment of a sphere defined (i.e., separated from the rest of the sphere) by a plane having the same area as enclosed by the annular base and having a height equal to that of the inside of the mask, whereby the pressure drop through the filter member is

no more than about 40 mm H_2O at a flow rate of 85 liters/minute. This flow rate is within the range of the standard for accepted breathing resistance. Preferably, the mask is constituted such that upon removal of the annular base, the sidewall portions can be folded along the supporting arches in face-to-face contact with the frontal portion to form a flat structure having an at least partially curved perimeter.

An advantage of face masks as described is that they are adapted to provide high efficiency filtration. For example, face masks of the invention can have a thickness such that the mask allows no more than an approximately 3 percent penetration of 0.3 micrometer-diameter particles of dioctyl phthalate (DOP) at a flow rate of 85 liters/minute with a pressure drop of less than 40 mm H_2O, and preferably no more than an approximately 0.1% penetration.

The invention further contemplates a method for producing a mask blank comprising the steps of bonding filter sheets together along a pair of oppositely disposed arches, the filter sheets comprising at least one layer of filter material, removing the sheet lying outside of the arches to form a filter blank, and slitting one of the sheets between the arches. Slitting is obviated if a two piece sheet is used. The blank may then be opened along the slit so as to form a cup-like filter member having a pair of side wall portions formed from the slit sheet and a frontal portion formed from the un-slit sheet which bridges the side wall portions. A shape retaining annular base may be formed which is disposed around one edge of the mask and adapted to fit conformingly against the face of a wearer of the mask.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. **1** is a perspective view of a mask of the invention.

FIG. **2** is a cross-sectional view of another embodiment of this invention.

FIG. **3** is a front view of the mask shown in FIG. **2**.

FIG. **4** shows the outline of a mask blank of the present invention before it is cut from two sheets of filter material.

FIG. **5** is a cross sectional view along line **5—5** of FIG. **4** showing the two sheets of filter material.

FIG. **6** is an unassembled mask blank of the invention after bonding and cutting along the dotted lines shown in FIG. **4**.

FIG. **7** is a cross-sectional view along the line **7—7** of FIG. **6**.

DETAILED DESCRIPTION

Referring to FIG. **1** there is shown a mask **10** of the present invention. The details of the mask **10** can be seen by referring to FIGS. **1-3**. The mask **10** generally comprises a filter member **11**, and preferably, a cup-shaped inner support **20**.

The filter member **11** includes a first filter sheet **12**, and a second filter sheet **13** (see FIGS. **5** and **7**), organized in the mask form of FIGS. **1-3** as a frontal portion **14**, a pair of side walls **16**, and a pair of longitudinally disposed supporting arches **18**. The side walls **16** generally project from the face of the wearer. The frontal portion **14** bridges the side walls **16**. The side walls **16** and the frontal portion **14** are bonded along a pair of lines which define a pair of support arches **18**. The support arches **18** in the embodiment of FIGS. **1-3** have