

Jan. 20, 1970

R. R. JACKSON

3,490,447

SURGICAL MASK

Filed Jan. 3, 1967

2 Sheets-Sheet I

Fig. 1

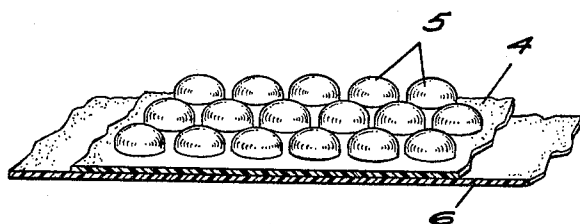
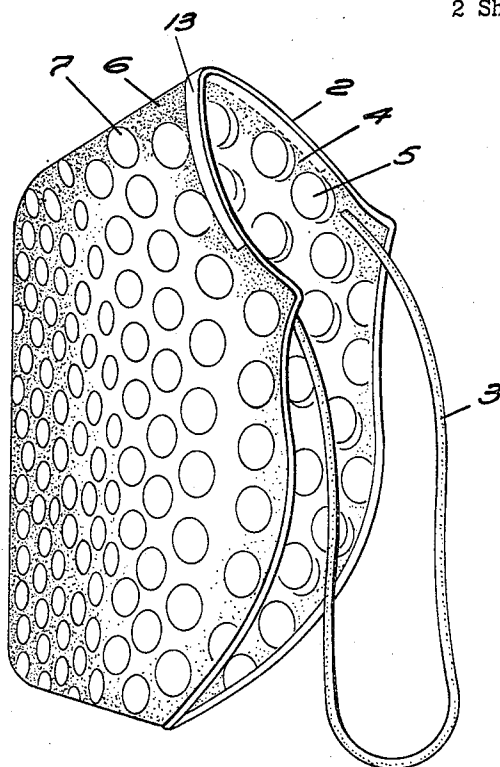


Fig. 2

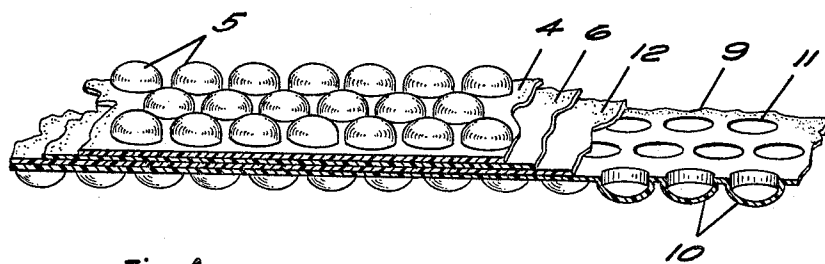


Fig. 4

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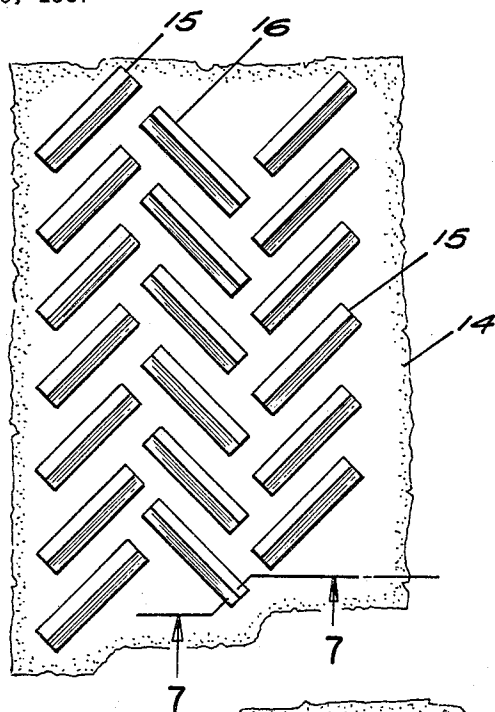


Fig. 6

Fig. 7

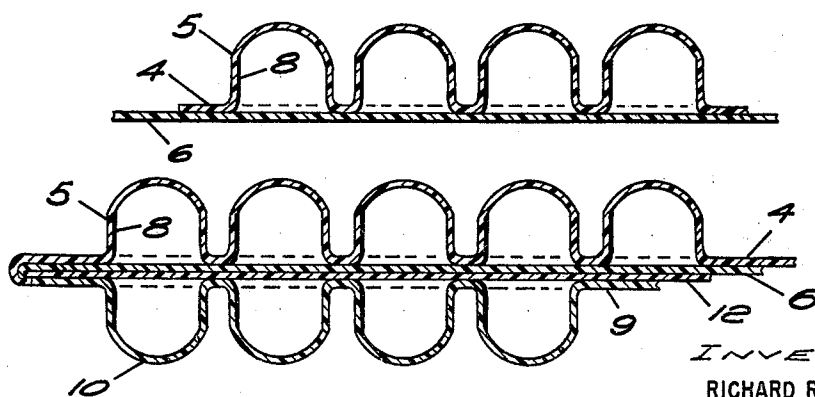
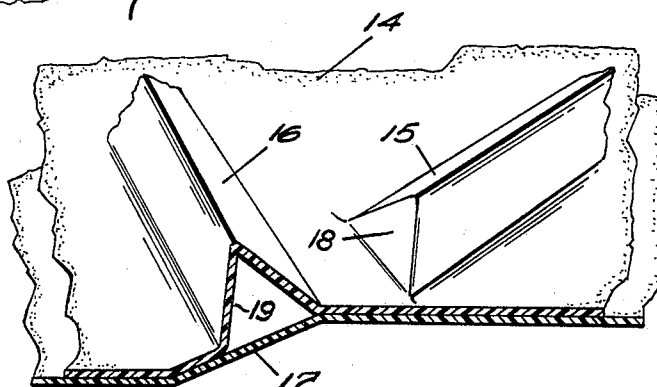


Fig. 5

Fig. 3

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1

3,490,447

SURGICAL MASK

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10 Claims

ABSTRACT OF THE DISCLOSURE

A face mask for use by medical personnel to reduce the distribution of bacteria and other contaminants carried by exhalations of moisture droplets or vapors into aseptic environments such as operating rooms. The improved mask is fluid-impervious, and has a series of inward protrusions which rest against the face to form tortuous breathing passages extending to the edge of the mask. Bacteria are trapped with moisture condensing or impinging on the inner surface. The mask is cooled when relatively dry air is inhaled and causes evaporation of the moisture.

BACKGROUND OF THE INVENTION

Conventional surgical masks use a filtration principle; they are made of a permeable filtering material such as cloth, fiberglass impregnated with charcoal, or perforated paper. Such masks are of somewhat limited effectiveness in entrapping contaminants, which are carried in fine droplets of moisture projected from the mouth and nose by exhalation. Some portion of the exhaled droplets and vapor passes directly through the permeable filtering material. Masks of this kind also tend to be uncomfortably hot, as the materials used are thermal insulators. To be effective, the mask must be closely fitted to the face, but the discomfort of its warmth often interferes with the user's concentration to such an extent that he may wear it very loosely over the cheeks for relief. This interferes greatly with the effectiveness of the mask, as the exhalations pass almost directly into the atmosphere.

It is the primary object of my invention to provide an improved mask which is more effective in trapping contaminants, and is at the same time substantially cooler and more comfortable to wear in a correct manner. Further objects and advantages of my invention will appear as the following description proceeds.

SUMMARY OF THE INVENTION

My improved surgical mask entraps moisture droplets and vapor with included contaminants, by principles of condensation and impingement, rather than filtration. The mask is substantially impervious to fluids, and its inner surface is formed with a series of spaced nodular protrusions of substantially uniform height, the ends of which rest against the wearer's skin. These protrusions support the balance of the inner surface area of the mask out of contact with the wearer's face and form irregular but continuous passageways which extend between the mouth and nose and the atmosphere about the edge of the mask.

Exhalation of warm, moist air by the wearer results in condensation of vapor, and collection of droplets by direct impingement, upon the inner surface of the mask. Since the bacteria discharged from the respiratory tract are entrapped in this moisture, the exhaled air is substantially purified. The mask is preferably made of a material having good thermal conductivity, such as metal foil or plastic sheet, to carry the heat of the face and breath away rapidly, and thus promote condensation as well as cooling. The protuberances provide an increased interior surface area for promoting condensation. They

2

are arranged to define a random or irregular, elongated breathing passageways, both to improve the probability of impingement and capture of air-borne droplets, and to increase the degree of condensation.

5 Cooler and drier air, drawn through the passageways on inhaling, evaporates condensed moisture from the inner surface of the mask and returns it to the wearer's respiratory tract. The evaporation cools the air flowing in, and this aids materially in preventing the mask from becoming warm and uncomfortable. Thus the cyclical process of condensation and evaporation serves both to retain contaminated moisture within the mask, and to cool the mask and render it comfortable enough to be worn properly without distracting the user.

15 In one construction, the mask is made up of two laminated sheets of plastic. One layer, called the "outer" layer, is flat. The inner layer has staggered rows of bubbles, partially spherical in form. The layers are heat-sealed or cemented in the areas between the bubbles. Laminated material of this kind is commercially sold for use as a cushioning layer in packaging, to be used as a substitute for corrugated linerboard or excelsior. Two sheets of metal foil, such as aluminum foil, may be laminated to form a similar structure.

25 In a modified construction, the laminated sheet is doubled with the flat layers in mutual contact and the bubble layers forming the inner and outer layers of the mask. This has the advantage of insuring the structural integrity of protuberances or bubbles located in overlapping relation to the edges of the mask. The collapse of protuberances near the edges would reduce the effective area of the breathing passageways. Of course the protuberances can be located away from the edges if the material is to be specially prepared, but this will be difficult to achieve if the less expensive commercially-available packaging laminate is used.

30 In a further construction, elongated pyramidal protuberances are arranged in rows, with their longer dimensions parallel within each row, but extending at different angles in adjacent rows. The effective length and irregularity of the passageways may both be increased by this expedient.

40 While the specification concludes with claims particularly pointing out the subject matter which I regard as my invention, it is believed that a clearer understanding may be gained from the following detailed description of preferred embodiments thereof, with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a pictorial view of one embodiment of the improved mask;

FIGURE 2 is a fragmentary view showing details of the construction of FIGURE 1;

55 FIGURE 3 is a sectional view in elevation of the material of FIGURES 1 and 2;

FIGURE 4 is a fragmentary view showing a modified construction;

60 FIGURE 5 is a sectional view in elevation of the material of FIGURE 4;

FIGURE 6 is a fragmentary plan view of another construction; and

65 FIGURE 7 is a fragmentary sectional view in perspective, being taken along line 7—7 in FIGURE 6, looking in the direction of the arrows.

DESCRIPTION OF THE INVENTION

70 A first form of the improved mask, shown in FIGURES 1—3, is made of a laminated material comprising an internal layer 4 formed with a series of rows of inwardly-extending bubbles or protuberances 5, and a flat outer layer 6. The protuberances 5 preferably are of

3

substantially uniform height so that their ends will rest against the wearer's skin and thus define the tortuous passages. The layers may be made of aluminum foil, plastic, or other flexible material, at least one of the layers being substantially impervious to fluids. The material should preferably have a substantial thermal conductivity. The flat areas of the layer 4, intervening between the bubbles 5, are heat-sealed, cemented, or otherwise secured in a manner suitable to the material employed, to the outer layer 6, thus hermetically sealing the bubbles. The air-filled chambers 8 (FIGURE 3) serve to support the bubbles against collapse when pressed against the face. The construction shown is made of transparent plastic layers, and the undersurfaces of the bubbles are externally visible as shown at 7 in FIGURE 1. The mask may be molded to shape as shown in FIGURE 1, although it may be more economical to form it from a flat sheet of the laminate, which is commercially available for use as a cushioning material in packaging. A flat sheet can be folded to shape and the edges secured and sealed by cementing, heat-sealing, stapling, or a combination of these means which will provide adequate mechanical strength as well as fluid sealing. The mask terminates at an edge 2 shaped to fit over the nose, mouth, and chin of the wearer to form a snug fit with the face. An elastic band 3 is attached to hold the mask in place. A thin strip 13 of metal, which the wearer can bend to conform to the contours of the nose, is shown cemented along the upper edge of the mask.

The nodular bubbles 5 are arranged in irregularly aligned rows to form tortuous but continuous passageways from the wearer's nose and mouth over the inner surfaces of the mask so that the air stream will flow along a random path, and into communication with the atmosphere about the edge 2. The substantially uniform height of the bubbles 5 insures that the ends of the bubbles will contact the wearer's skin so that the air stream will flow around the bubbles and along the desired, random path.

As the user of the mask exhales, the warm moist air from his nose and mouth passes over the cool interior surface of the mask, and condensation removes a substantial part of the water vapor. Furthermore, moisture droplets projected in the air stream from the nose or mouth have a high degree of probability of impinging on the bubbles 5 and being captured. Thus a substantial portion of the moisture is removed from the exhaled air, along with bacteria entrapped in this moisture. Inhalation of drier air from the atmosphere tends to reverse the moisture-collecting process, and the collected moisture evaporates and returns to the respiratory system. The evaporation process has the advantage of cooling the mask and rendering it far more comfortable than the filtration masks now in common use. The cyclical condensation and evaporation effect can be observed clearly in a transparent plastic mask.

Use of a material having good thermal conductivity, such as plastic sheet or aluminum foil, is desirable to promote the condensation effect. The protuberances 5 should be formed to provide a maximum surface area as a further aid in promoting condensation, but must be spaced apart far enough to give ample cross-sectional area for breathing through the passageways between them. The heightwise dimensions of the protuberances 5 preferably are substantially uniform and are sufficient to provide the desired cross-sectional flow area between the inner surface of the mask and the wearer's skin. The commercially-available plastic packaging material which is illustrated has bubbles with partially-spherical surfaces, and gives a very substantial surface area; the bubbles are also arranged in irregularly-spaced rows, forming tortuous breathing passages.

In a modified construction shown in FIGURES 4 and 5, a plastic laminate sheet like that of FIGURE 2 is

4

doubled, so that two flat layers 6 and 12 are in surface engagement, while the inner layer 4 and outer layer 9 bear protrusions 5 and 10, respectively. The bases of the protrusions 10 are visible at 11 in FIGURE 4. This construction is particularly advantageous when the mask is formed by the folding of a flat sheet of material, since it insures that those bubbles or projections which overlap the edge of the mask will be complete and fully enclosed to maintain their structural integrity. It will be apparent that any collapsing of protuberances at the edge would reduce the total cross-sectional area of the passageways available for breathing.

In another embodiment shown in FIGURES 6 and 7, each of the protuberances 15 and 16 is in an elongated pyramidal form, with either end 18 being enclosed to seal an air chamber 19 between the inner layer 14 and the flat outer layer 17. In each of the vertical rows in FIGURE 6, the longer dimensions of the protuberances are parallel, but adjacent rows are oppositely aligned, preferably at right angles as shown. This arrangement provides irregular passageways of increased effective length, as compared with the masks of FIGURES 1 through 5. This promotes condensation, and also improves the probability of impingement of droplets against the surfaces of the protuberances because of the sharp changes in direction imposed on the air stream.

While I have illustrated and described preferred embodiments of my improved surgical mask by way of illustration, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the true spirit and scope of the invention. For example, the protuberances may assume a variety of forms, and can be arranged in many patterns to provide tortuous air passageways. The mask may be made of a single layer of material formed with protuberances; although this does not provide enclosed chambers which entrap air and therefore resist collapse, the form of the protuberances and the stiffness of the material may be such as to retain the full effective area of the breathing passages in normal use. I intend to define the invention in the appended claims without limitation to the details of the illustrated embodiments.

What I claim is:

1. A surgical mask for covering the nose and mouth to entrap moisture-borne contaminants from the exhalations of the wearer; said mask extending continuously within a peripheral edge, being substantially fluid-impervious, and having an interior surface formed with a plurality of spaced-apart inwardly-extending nodular protrusions of substantially uniform height to rest against the face of the wearer; said protrusions supporting areas of an interior surface of the mask intervening therebetween away from contact with the face of the wearer to form tortuous continuous passageways over said interior surface for communicating the wearer's exhalations, along a random, irregular path between said protrusions, with the exterior atmosphere about said peripheral edge of said mask.

2. A surgical mask as recited in claim 1, in which said mask is formed of a material having substantial thermal conductivity for distributing the wearer's facial heat and the heat of his exhalations, to cool the mask and promote condensation of liquids from the exhalations upon said interior surface.

3. A surgical mask as recited in claim 2, in which said mask is at least in substantial part formed of metallic foil.

4. A surgical mask as recited in claim 2, in which said mask is at least in substantial part formed of plastic sheet material.

5. A surgical mask as recited in claim 1, in which said mask includes a first sheet of material formed with said spaced-apart protrusions and comprising an interior surface layer, and a further sheet of material comprising an exterior layer.

6. A surgical mask as recited in claim 5, in which said further sheet is laminated with said first sheet in said in-

5

tervening areas to entrap air within said protrusions for preventing their collapse.

7. A surgical mask as recited in claim 1, in which said protrusions are formed in irregularly-aligned rows to provide said irregular continuous passageways.

8. A surgical mask as recited in claim 1, in which said protrusions are arranged in rows, and are of a pyrimidal form elongated in a direction parallel to said interior surface, the elongated dimensions of the protrusions within each of said rows extending in substantially parallel relation, and the elongated dimensions of the protrusions of adjacent rows extending at angles to one another.

9. A surgical mask as recited in claim 1, in which said protrusions have at least partially spherical surfaces to provide an enlarged interior surface area for promoting condensation and impingement of moisture thereon.

10. A surgical masks as recited in claim 1, in which said mask is formed of a sheet of laminated material having a first layer formed with protrusions and a second flat

6

layer, said sheet being double with said first layer exposed interiorly and exteriorly of the mask, whereby said first layer extends continuously from the interior to the exterior surface around the peripheral edge of the mask to aid in preserving the structural integrity of protrusions adjacent the peripheral edge and thereby resist collapse of the mask against the wearer's face in this region.

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