July 28, 1970 W. M. WESTBERG ET AL 3,521,630

RESPIRATOR FACE MASK WITH REPLACEABLE FILTER

Filed April 7, 1967

FIG. 1

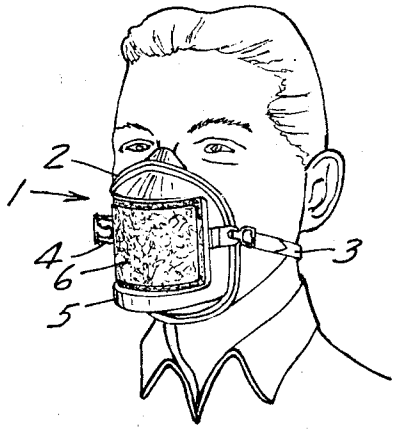


FIG. 2

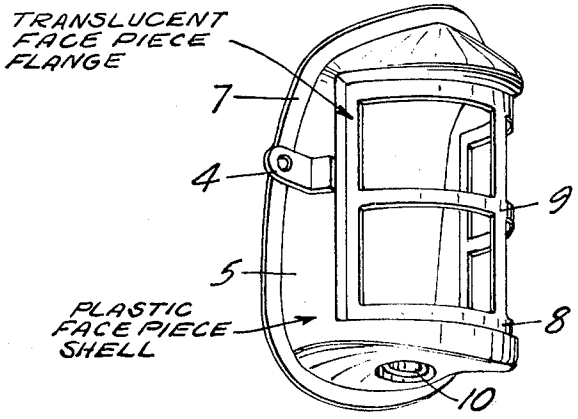


FIG. 3

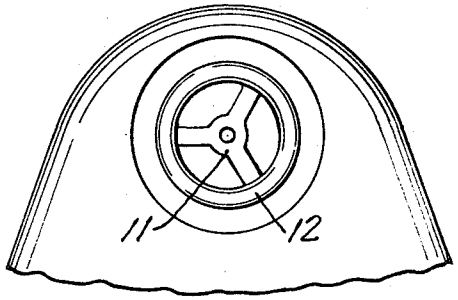


FIG. 4

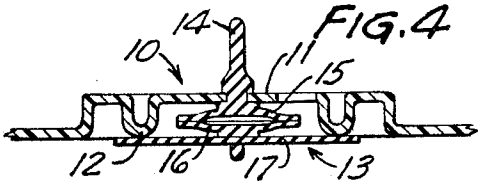


FIG. 5

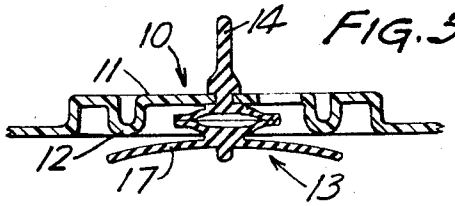


FIG. 6

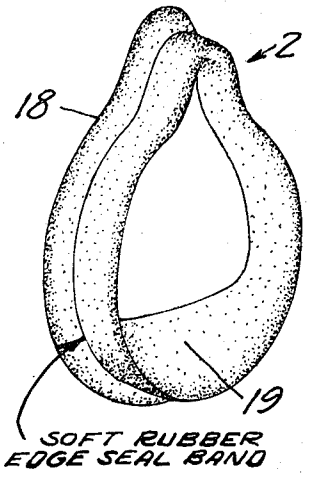
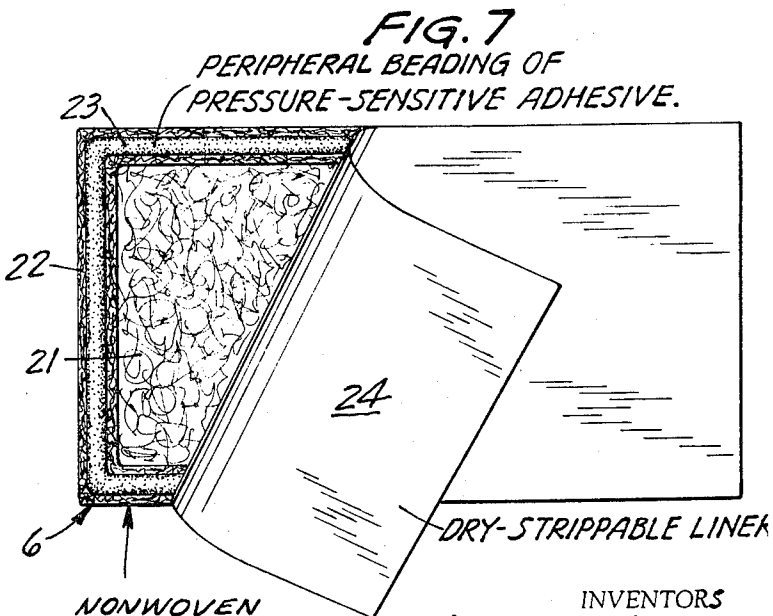


FIG. 7



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RESPIRATOR FACE MASK WITH REPLACEABLE FILTER

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U.S. Cl. 128—146.6 1 Claim

ABSTRACT OF THE DISCLOSURE

A lightweight filter-type respirator face mask for toxic dusts and mists, having a replaceable adhesively-held filter pad through which the wearer can readily speak. The nonwoven fibrous filter pad is bordered by a tacky pressure-sensitive adhesive beading which tightly but removably adheres the pad to the apertured front of the plastic shell facepiece as the sole fastening means.

BACKGROUND OF THE INVENTION

This invention relates to respirator face masks for toxic dusts and mists which have a plastic shell facepiece and a replaceable inhalation filter pad.

Our novel mask is characterized by a unitary molded plastic facepiece shell with soft rubber edge seal band, which stands out from the wearer's nose and mouth and fits over the nose bridge and across the cheeks and under the chin. The facepiece shell is apertured and recessed so as to provide a filter-holding frame having a recessed peripheral support flange surrounding a large frontal inhalation area.

Our mask is further characterized by use of a non-woven fibrous filter pad having a unified margin carrying a continuous beading of highly tacky pressure-sensitive adhesive as the sole fastening means by which the pad is tightly held and sealed to said recessed support flange There are no mechanical fasteners or clamps, nor is any metal device carried by the facepiece. This self-fastening adhesively-held pad can be easily peeled off and replaced by a fresh pad.

This expedient provides greater assurance against leakage of toxic dust or mist around the edge of the filter pad. It permits a supervisor to easily see that a worker is wearing a filter pad in his mask and that it is undamaged, properly fastened, and not obviously clogged or overloaded with dust particles. This design permits of an unusually lightweight respirator that is more comfortable and more foolproof than prior respirators which were provided with fastening or holding devices as shown, for instance, by U.S. Pat. Nos. 2,964,038 (Dec. 13, 1960); 3,029,812 (Apr. 17, 1962); 3,137,296 (June 16, 1964); 3,154,073 (Oct. 27, 1964). Mechanical fasteners can permit leakage without the faulty condition being visible, especially if metal parts become dirty or corroded.

The complete mask exclusive of the replaceable filter pad and detachable head band consists of only three parts: unitary plastic shell, rubber edge seal band, and rubber flap valve. The entire mask as worn can weight under 60 grams.

A particularly noteworthy feature is the ease with which the wearer can speak through the filter pad so as to be clearly audible, even when talking on a telephone. Thus he is less likely to remove the mask when communicating. This virtue results in part from the large size and position of the filter pad and in part from the absence of metal devices or fasteners which would interfere with or muffle his speech.

The preferred mask has a shell which is translucent

(at least in the filter holding region) and utilizes a filter pad having a colored adhesive beading. This enables the worker to see, by looking into his mask before putting it on, whether the adhesive is in continuous sealing contact with the shell. The adhesive provides a telltale, since a continuous colored stripe, visible through the translucent shell, is indicative of continuous adhesive sealing contact around the periphery of the pad. (The best effect is obtained when the shell wall is translucent without being clear and transparent, the plastic having a cloudy light-diffusing translucency.) If the margin of the pad had not been properly pressed down in mounting a fresh pad, or if the adhesive beading is defective, or if adhesive contact is inhibited by dirt or moisture, a nonuniform or interrupted colored stripe will be seen when the mask is held up to the light and viewed from the back. At the same time it can be noted whether there is any hole or defect in the filtration area of the pad. Thus the worker can have confidence that he will not be endangered by a faulty filter pad replacement since he can personally check his mask as he puts it on, and such checking becomes automatic.

Notwithstanding its simplicity and novelty, this respirator can be manufactured in compliance with the Schedule 21B requirements of the U.S. Bureau of Mines for permissible filter-type respirators for dusts and mists having a threshold limit value (TLV) not less than 0.1 milligram per cubic meter or 2.4 million particles per cubic foot (85 million particles per cubic meter). It embodies the Bureau's requirements as to exhalation valve, facial seal and attachment strap. In addition, the body of our mask has no metal parts to corrode or impair functional efficiency. All parts that contact the wearer's skin are of non-irritating inert plastic or rubber material. All components (except the filter pad) can stand repeated cleaning and disinfection by methods common to the industry.

SUMMARY OF THE INVENTION

The facepiece of the respirator mask is a flexible one-piece molded plastic shell (preferably cloudy translucent) which is adapted to cylindrically stand out away from the tip of the nose and the mouth. An inexpensive polyethylene or polypropylene shell is suitable. A peripheral cushion seal for the face is provided by a flexible soft rubber edge band with inward face-sealing flap, which is shaped to make a snap-on stretch fit over the outwardly flanged edge of the plastic shell. The mask is designed to make a snug but light-pressured, yieldable fit over the bridge of the nose, down the cheeks, and under the chin, with sufficient resilience of the flap to conform to any normal face and not leak during inhalation. It is held in place by an adjustable lightweight stretchy head band. Jaw motion is permitted by the under-the-chin construction without breaking the facial seal.

An elastic rubber flap disk valve is fitted into a recessed aperture in the bottom portion of the shell to provide a simple but effective exhalation valve, which permits the wearer of the mask to exhale more easily than would be true if exhaled air could escape only through the filter pad. This valve is automatically closed except during exhalation to prevent ingress of the environmental atmosphere. There is no inhalation valve.

The vertical cylindrical front of the shell, located in front of the nose and mouth, is provided with large apertures and narrow interveninng ribs shaped so as to support and be covered by a single rectangular filter pad. This apertured area of the shell is recessed to form a filter-holding frame in the facepiece, and includes a recessed peripheral flange against which the tacky adhesive border of the filter pad can be pressed to result in a continuous tight edge seal. This recessed frame facilitates

quick and accurate positioning of the pad. Location of the filter pad below the surface of the surrounding shell also provides protection against accidental dislodgement and loosening of the adhesive seal. A telltale colored adhesive on the pad and a translucent plastic flange are preferably utilized so as to provide the previously mentioned telltale indication of proper sealing contact.

The nonwoven fibrous filter pad can be a fluffy batt made of any suitable interlaced fiber mixture, adapted to adequately filter out toxic or noxious dust or mist from the environmental atmosphere while permitting comfortable inhalation by the wearer. Passage of dust or mist particles is primarily restrained by impingement against fibers as the inspired air tortuously moves through the interfilar passages of the fibrous structure. The choice of material will depend upon the field of use for which the respirator is intended. A medicament, adsorbent, catalyst or other functional material may be incorporated. The margin of the pad is compacted to form a dense border strip adapted to be coated with the peripheral adhesive beading composition. Preferably, thermoplastic binder fibers are included in the fiber mixture and the margin of the filter pad is heat-pressed to compact and unify the fibers, forming a translucent border. Face mask and filter combinations can be provided which meet U.S. Bureau of Mines requirements for toxic dusts and mists, Schedule 21B, as previously noted.

Suitable nonwoven fibrous filter sheeting from which the present pads can be manufactured has been commercially available and is not per se novel with us. However, to the best of our knowledge and belief, the above-described combination of pressure-sensitive adhesive filter pad and facepiece adapted for use therewith, does provide a novel respirator which had not previously been suggested, and one which incorporates new features important to safety and comfort. In our combination, the adhesive arrangement is not a mere substitute for a mechanical fastening or clamping means

DESCRIPTION OF THE DRAWING

In the accompanying drawing which illustrates the preferred embodiment of the invention hereafter described in detail:

FIG. 1 shows a complete respirator mask as worn upon a face, held in position by a stretchable head strap.

FIG. 2 shows in perspective the apertured molded plastic facepiece shell.

FIG. 3 is a bottom view of the shell showing the molded opening and seat of the exhalation valve.

FIGS. 4 and 5 show in enlarged cross-section the exhalation flap valve (in closed and open positions) which is seated in the facepiece shell.

FIG. 6 shows in perspective the flexible soft rubber edge seal band before mounting on the faceshield, viewed from the back.

FIG. 7 shows a filter pad being readied for mounting on the facepiece shell, the dry-strippable liner or cover sheet being peeled away to uncover the back side of the pad with its peripheral beading of tacky pressure-sensitive adhesive.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

In FIG. 1, the presently preferred embodiment of our complete face mask **1** is shown in position upon a man's face as normally worn during use as a respirator to filter inspired air to remove toxic dust or mist present in the environmental atmosphere.

The soft rubber edge seal band **2** makes airtight contact with the face by extending over the nose bridge, down the cheeks and under the chin. It is kept resiliently pulled against the face (so as to maintain the sealed relation), but with comfortable light pressure, by the adjustable elastic head strap **3** having clips for hooking into the holes

of the headband studs **4** located at each side of the facepiece shell **5** of the mask. The headband in normal use extends straight back across the checks and around the upper neck.

This shell is a lightweight translucent molded plastic which is cupped so as to stand out from the face and provide an enclosed air space in front of the nose and mouth. The convex vertical body portion has a cylindrical contour. The shell wall is flexible but rigid (inextensible) and tough, to prevent breaking, cracking or collapse, and to facilitate facial mounting. A preferred plastic is polyethylene, which is thermoplastic and can be injection molded or otherwise formed into the desired unitary thin-walled cloudy-translucent shell structure. The shell can be formed by combining two or more individually formed parts which are united by heat sealing. An exhalation flap valve (not shown here but see FIGS. 3, 4 and 5) is incorporated in the bottom of the shell so as to be in front of and below the chin.

Inhalation apertures (not shown) are located in the cylindrical front wall of the shell, which is recessed to provide a frame for the filter pad. The pad **6** fits into this curved recessed apertured area of the shell, completely covering the apertures, and is adhesively held along its entire periphery. It can be easily peeled off and replaced by a fresh pad.

It will be noted that the filter pad is located away from and in front of the wearer's mouth and is fully exposed to view. The pad is held in edge-sealed adhesive contact with the facepiece shell without the use of any other fastening or sealing means.

FIG. 2 shows the aforesaid unitary facepiece shell **5** without filter and face seal attachments. This shell has an outwardly extending rim **7** for holding the edge seal band. The frontal cylindrical portion is provided with a rectangular recessed filter-pad support frame comprised of the recessed peripheral flange **8** and the cross ribs **9** which embrace the four large inhalation apertures. Each aperture has a size of approximately 1 x 1¾ in. (2.5 x 4.5 cm.), so that the total open inhalation area is about 7 square inches (45 sq. cm.). The narrow filter-supporting ribs have a width of about 3/16 in. (0.5 cm.) and do not materially interfere with breathing or speaking. The exhalation valve **10** (details not shown) is located in the bottom portion of the shell.

The exhalation valve structure is shown in detail in FIGS. 3, 4 and 5. The bottom wall of the shell is molded to provide a valve body opening formed by the apertures in body portion **11** which has a small central hole. This valve opening has an internal diameter of about ¾ in. (2 cm.). A raised rib or rim **12** provides the valve seat. The rubber flap valve **13** is constructed of elastic rubber elements. It has a knob-carrying elastic stem portion **14** which can be manually pulled either way through said central hole. The compressible knob, when pulled through the hole to the inside of the valve body (as shown in FIGS. 4 and 5) retains the flap valve in place until it is manually pulled out. This stem is united to the inner of two elastic rubber strips **15** and **16** which are joined together at their ends and function as leaf springs, located just outside the valve body. The elastic valve disk **17** is united at its center to the center of the outer spring strip. During exhalation, the air pressure forces the spring-loaded disk away from the valve rim of the shell, this being easily permitted by separation of the leaf springs, so that air can escape, as indicated in FIG. 5. At all other times the elastic spring structure holds the valve closed, as indicated in FIG. 4. This valve is designed so that there will be a very low leakage through the valve when the pressure drop is in the range of about 0.0" to 0.5" water (0.0 to 1.3 cm. water), and so that an exhalation flow rate of 85 liters per minute results in a pressure drop of not over about 0.7" water (1.8 cm. water), such pressure drops

being measured by an inclined-tube water manometer.

FIG. 6 shows in detail the soft rubber edge seal band **2** which is molded with a folded over edge **18** adapted to be stretched over the aforesaid rim **7** of the facepiece shell **5** to make a snug airtight fit (as indicated in FIG. 1). The soft marginal flap **19** extends inwardly and is shaped so as to resiliently contact the face to provide an airtight seal which extends over the nose bridge, across the cheeks and under the chin.

The following test procedure is employed to make sure that the seal is operational: The wearer spreads one hand over the filter pad area, or holds an unused liner-protected filter pad over this area to cover it, and with a finger of his other hand he holds shut the exhalation flap valve; and he then exhales with a gentle puff. If the mask fits properly, this will develop a back pressure, and any leakage will be readily apparent. The seal can be easily tested whenever desired by following the same procedure, so that the wearer can assure himself that his mask is still working properly.

FIG. 7 shows a complete filter pad article as taken from a supply package for mounting in a mask, viewed from the adhesive side during peeling off of the liner.

The rectangular filter pad **6**, has a size adapted to fit over the ribs **9** and within the aforesaid recessed frame of the facepiece shell **5** (a suitable size being about 2⅝ by 4⅝ inches or approximately 7 by 11 cm.). It is cut from a nonwoven fibrous batt. It has a central low-density porous filter area **21** about ⅛ in. (5 mm.) thick, surrounded by a narrow compacted unified border **22**. This border carries a continuous peripheral beading **23** of colored highly-tacky pressure-sensitive adhesive adapted to make firm adhesive contact with translucent shell flange **8**. The rounded projecting adhesive strip or bead is approximately ⅛ in. (3 mm.) wide and 1/32 in. (1 mm.) thick. It is to be distinguished from the thin coatings of pressure-sensitive adhesive on conventional adhesive tapes; such thin coatings not being suitable for present use involving sealing as well as adhering. This adhesive beading is soft and thick enough to permit good continuous sealing contact to the mask shell flange (even if not clean) when the pad is pressed or rubbed with finger pressure along its edge. The fibrous border is sufficiently dense and unified, and the adhesive is sufficiently cohesive and rubbery, to permit the pad to be subsequently peeled away without splitting or leaving a residue. Any adhesive residue can be easily rubbed or peeled off with the finger.

The dry-strippable liner **24**, having the same rectangular size as the pad, removably covers the adhesive side of the pad and provides protection for the tacky adhesive beading to which it adheres. This enables filter pads to be stacked in a supply package without sticking together. The liner sheet can be a siliconed release paper (or equivalent treated paper or film to which the pressure-sensitive adhesive has a low degree of adherency), and is easily stripped off when the filter pad is to be used. (Such liners, which are well-known, are termed "dry-strippable" because they do not require moistening.)

A specific example of a presently preferred filter pad sheeting is comprised of a mixture of a major proportion of staple thermoplastic polyvinyl chloride fibers, a minor proportion of staple rayon (regenerated cellulose) fibers, and a small proportion of finely divided asbestos fibers. Illustrative proportions are 76% vinyl fibers, 17% rayon fibers and 7% asbestos fibers, by weight. A preferred type of polyvinyl chloride fiber is a copolymer of 85% by weight vinyl chloride and 15% vinyl acetate (such as the "Vinyon" PVC fibers employed as heat-activatable adhesive binder fibers in nonwoven tea bag fabrics). The asbestos fibers are much finer in diameter than the other fibers and improve filtration of fine particles. The fiber mixture can be sheeted out by carding or on a "Rando-Webber" machine (sold by Curlator Corp., Rochester, N.Y.) to form a continuous fluffy batt. This can then be passed over heated cylinders to shrink and interbond the thermoadhesive polyvinyl chloride fibers, to which the rayon and asbestos fibers adhere, and thereby unify the entire porous web structure.

The web has a ream weight of approximately 140 lbs. (weight of 320 square yards), corresponding to 540 grams per square meter. The caliper thickness is 0.200 in. (5.08 mm.) as measured with light pressure that barely compresses. The air porosity is such that 85 liters per minute will flow through a 5.4 sq. in. (35 sq. cm.) test area when the pressure drop as measured by a water gauge manometer is 0.7" water (18 mm. water).

A commercially available filter pad sheeting of this type is "Hovolite 313" sold by the Hollingsworth & Voss Company of West Groton, Mass.

The pressure-sensitive adhesive is preferably a polyacrylate of a type which is inherently a highly tacky viscoelastic material, and is pigmented (as with a blue pigment) to provide a colored opaque beading. It is applied to the compacted unified border of the rectangular adhesive pad as a high-solids solution which is extruded and dried to form the previously described peripheral adhesive beading. Polyacrylate pressure-sensitivve adhesives are described in the Ulrich patent Re. 24,906 (reissue of Pat. No. 2,884,126 issued Apr. 28, 1959).

This mask provides an effective respirator for toxic dusts and mists having a threshold limit value (TLV) not less than 0.1 milligram or 85 million particles per cubic meter; such as silica dust, lead dust, chromic acid mist, silica mist, etc.

We claim:

1. A respirator face mask for toxic dusts and mists having a replaceable filter pad; characterized by a unitary molded plastic facepiece shell with soft rubber edge seal band, which stands out from the wearer's nose and mouth and fits over the nose bridge and across the cheeks and under the chin; the facepiece shell being apertured and recessed so as to provide a filter-holding frame having a recessed peripheral support flange surrounding a large frontal inhalation area; in combination with a nonwoven fibrous filter pad having a unified margin carrying a continuous peripheral beading of highly tacky pressure-sensitive adhesive that makes continuous adherent sealing contact with said flange of the facepiece shell as the sole fastening means; said peripheral support flange being translucent, and said filter pad adhesive beading being differently colored, such that the presence or absence of proper continuous adherent sealing contact therebetween can be visually determined upon looking into the mask from the back; the filter pad being fully exposed to view and the arrangement permitting the wearer to readily speak through it.

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128—142.6