MUSTARD GAS PROOF APPAREL

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Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

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MUSTARD GASPROOF APPAREL
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5 Claims. (Cl. 117—76)

This invention is a continuation in part of my parent patent application Ser. No. 423,268 filed Dec. 17, 1941. It relates to mustard-gas-proof apparels and particularly mustard-gas-proof garments.

Since the summer of the year 1917, when mustard gas was first used as an instrument of war, there has been a continuous effort to ameliorate or eliminate the terrible effect of this gas on living tissues and its destructive effect on instrumentalities intended to afford protection thereagainst. To this end protective clothing has been proposed. Usually, such protective instrumentalities have utilized rubber and rubber-like materials to withstand the action of the mustard gas. However, all materials which have heretofore been proposed to protect against the effect of mustard gas, do not neutralize the gas and, in time, have been penetrated by the gas. Additional chemicals, such as lime, have been relied upon to neutralize the gas as it comes in contact with protective devices and to overcome all deleterious effects thereon and therefrom to the person. Where chemicals, such as lime, are used to neutralize the effect of mustard gas, these are generally impractical for troops in the field because of the quantity required and the difficulty of transportation in even reasonably sufficient quantities by individual soldiers; their application by the individual to areas on the person or his clothing attacked by the gas, or to that of his affected companions, is difficult and interrupts and diverts attention from the pressing tactical problem. Similar difficulties present themselves where a civilian population is exposed to attack by mustard gas, but naturally not to the same extent because counteracting facilities can be more readily provided.

Moreover, where rubber or rubber-like materials have been relied upon to resist the effects of the gas for a sufficient length of time to be at all practical as a protection, such material has had to be utilized in relatively thick layers or in such a plurality of layers as to increase the weight of the protective garment and render it cumbersome.

The substances which are used in the manufacture of mustard-gas-proof garments may be rightfully listed in two groups:

1. The first group includes those substances which when incorporated into the garment create resistance to the passage of the mustard gas, or in other words make the garment mustard-gas-impervious.

2. The substances of the second group destroy the mustard gas by chemical reaction which results in the formation of non-poisonous compounds, but they do not produce imperviousness.

The great drawback of the substances of the first group such as glue consists therein that the garments to which they are applied do not retain their pliability; they also become pervious to the passage of mustard gas after a short time and, therefore, ineffective. Furthermore, if these substances are not very carefully applied to the garment, a penetration by mustard gas after a surprisingly short time is unavoidable.

The disadvantages of the substances of the second group consist therein that as soon as the quantity which is applied to the garment is consumed by the chemical reaction, every protection ceases; due to the increase of weight and volume only a limited quantity of these substances can be incorporated in the garments.

My invention avoids the disadvantages of the substances of both groups and it creates advantages not obtainable by either of them.

It is based on the important discovery that polyamides are much more resistant to mustard gas than any substance hitherto used for this purpose.

1. Polyamides react with mustard gas and
2. They form compounds which produce mustard gas imperviousness for an indefinite period of time.

This surprising result is achieved by the application of the polyamides to a garment material having a possibly large number of very small air cavities evenly distributed throughout its body.

Suitable materials are, for instance, textiles and fabrics. The mustard gas proofing compounds are created by the reaction of the mustard gas with the polyamides are firmly anchored in these minute air cavities by chemical deposition and form a uniform water- and mustard-gas-proof body in the garments without impairing the pliability of the same.

The inert compound of which this body is composed is believed to have the formula

\[ \text{CH}_2-\text{CH}_2\text{Cl} \quad \text{N} = \text{R} \]  
\[ \text{CH}_2-\text{CH}_2\text{Cl} \]

where N stands for the polyamides, such as nylon.

The capability of substances to be in the first place resistant to mustard gas under certain conditions, in the second place to react with the mustard gas and in the third place to form substances by the reaction which are indefinitely
impervious to the poison and contribute this property to textiles has not been known heretofore.

It is fully admitted that polyamides such as nylon have been used for the manufacture and the impregnation of garments; it was, however, not to be foreseen that they are much more resistant to mustard gas than other substances and that by the reaction with mustard gas bodies which are indefinitely impervious to this poison and waterproof could be deposited in textiles and fabrics forming an exceedingly large number of minute air cavities without impairing the pilability of the same.

Therefore, it is an object of the invention to manufacture a mustard-gas-proof apparel and particularly mustard-gas-impervious garments from textiles and similar materials having a large number of minute air cavities distributed throughout its body.

It is a further object of the invention to create the mustard-gas-proof body within those materials by chemical reaction with the object of the invention to evenly distribute the mustard-gas-proof body in textiles and fabrics and firmly anchor it therein.

It is also an object of the invention to produce a mustard-gas-proof garment from textiles and fabrics which is pliable and elastic.

These and other objects of the invention and the means for their attainment will be more apparent from the following detailed description taken in connection with the accompanying drawings illustrating various embodiments by which the invention may be realized and in which:

Figure 1 is a view showing a coat treated with the resistant material of this invention.

Figures 2, 3, 4, 5 are fragmentary views showing fabrics from which mustard gasproof garments may be made and to which the mustard gas-resistant and neutralizing materials of my invention are applied.

The protective effect of nylon reacted with mustard gas may be readily demonstrated in a test developed by me as the result of studies which I have carried on. A glass bowl of one inch diameter and one-half inch high, is about three quarters filled with distilled water, for example, 51,000 ohms resistance. Platinum wires enter diametrically through the sides of the glass bowl about one-eighth inch above the bottom of the bowl and terminate at the center of the bowl in small plates at their ends, out of contact with one another. These wires are included in a circuit with a Wheatstone bridge. A sheet of protective material, either a test sheet of the polyamides alone or a test piece of textile, such as fabric, or other material impregnated with, coated with, or laminated with the polyamides, as the case may be, is placed over the bowl. If, then a 0.1 cubic centimeter (three drops) say, of mustard gas of 99.9% concentration is placed on the protective material and the material hermetically enclosed by a bell jar fitted tightly over the material on the glass bowl and registering therewith, it is found, even after a period of, say, three hours, that the conductivity of the water has remained at approximately 51,000 ohms resistance. Had the mustard gas penetrated the layer or sheet or impregnation of polyamides, the gas absorbed in the water would have increased the acidity of the water and increased its conductivity and the resistance as shown by the Wheatstone bridge would have decreased. After treating the test piece with a solution containing active chlorine to neutralize any mustard gas remaining thereon, the test piece can be washed to demonstrate that while the spots where mustard gas has come in contact now present a milky appearance showing that a reaction has taken place, the remainder of the material is as glass clear as it was originally. The milky appearance increases as the quantity of mustard in contact with a particular part of the material increases. The reaction of the polyamide and the mustard gas is believed to form an additive compound containing a tetravalent sulphur atom.

The reaction product is a bright white spot which is easily recognized and is gas-proof, but, if desired, can be readily covered by a nylon foil or solution thus rendering the garment in a condition which is similar to its original state.

Furthermore, I have found that polyvinyl alcohol may be advantageously used in cooperation with polyamides because polyvinyl alcohol itself is mustard-gas-proof and water soluble, whereas the solubility of the polyamides in solvents is greatly restricted. Polyvinyl alcohol may be used according to this invention in such a manner that the textiles are impregnated with an aqueous solution of the same.

Aqueous solutions containing about 3 to 12% in weight of polyvinyl alcohol are recommended. The volume of the water is in proportion to the percentage of alcohol in the solution. Glycerin or acetyl ethylamine may be employed as plasticizers. The polyamides may be applied to the textiles either in the form of a solution or as a film.

One may also proceed in such a manner as to use a solution of polyamides and polyvinyl alcohol, for example in ethylene chlorhydrin.

The mustard-gas-proof garments may also be manufactured from textiles which are coated with polyvinyl alcohol and polyamide films by gluing or hot pressing.

The polyvinyl alcohol may be rendered water impervious by treating the same with chromium salts.

In Figure 1 there is illustrated a coat which may be considered illustrative of any garment comprising the protective material. The sheets 1 of the protective material, say, 0.008 of an inch thick are cut according to the pattern of the garment and sewed together, as at 8, or otherwise adhered together as by an adhesive or a heat sealing substance. Where sewed, the seams may be coated as with a rubber compound or other polymer and permitted to dry. A hermetic seal 13 is formed. Since the material is relatively thin, it is preferable that the edges of the material be hemmed, as at 11, to prevent tearing.

As an alternative, fabric 12 may be covered with sheets 7 of the polyamides and adhered to the textile in any convenient manner, as by an adhesive 13.

In the alternative, Fig. 2, fabric 12, shown as a woven fabric in the form of a coat, for instance, may be impregnated with the polyamides 17 as by being sprayed thereon and a protective coating is formed thereon. Such impregnation may be performed before or after the garment is made. If before, the seams must be treated as previously, as before. In Fig. 3 a textile is shown which is woven of threads 18 impregnated with a non-water soluble solid synthetic linear polyamide and of threads 19 of a suitable plastic material.

Fig. 4 shows a portion of a fabric 22 for the manufacture of a mustard gasproof apparel to which an outer stratum 29 of a non-water soluble
The material for the manufacture of a mustard-gas-proof apparel, as shown in Fig. 5, is composed of a fabric 23 and of a film 24, both consisting of a nonwater soluble solid linear synthetic polyamide.

A garment which permits a suitable degree of ventilation for perspiration of the wearer may be made by impregnating wool threads, for instance, with nylon and weaving the fabric consisting of, for example, seventy-five percent of such impregnated threads with twenty-five percent of a plastic thread such as nylon, cellulose acetate or the like. Obviously, such garment being somewhat porous would not afford complete protection against concentrations of mustard gas. However, in those situations where mustard gas is sprayed from airplanes or by gas shells, the mustard gas is diluted by the atmosphere and in this situation such a garment affords adequate protection.

Nylon stockings may be treated with an aqueous nylon dispersion and dried. One-third of a pound of twenty-five percent aqueous nylon dispersion is usually required to cover one square foot of nylon fabric. Such stockings may be worn directly over the skin or as a protective cover for the trousers and are protective against mustard gas. A nylon film, say, 0.0005 of an inch thick may be laminated with nylon fabrics, as by cement, to produce gas-proof underwear and other protective garments. The nylon fabric may be covered on both sides with nylon film or the nylon film may be sandwiched between layers of nylon fabrics. Viscous fabric or foil may be treated with an aqueous dispersion of nylon in the proportion of about three pounds of nylon to every square yard of the fabric or foil. Such treated fabric or foil may be manufactured into any protective covers or garments. Similarly, cellulose fabric or foil may be treated by applying a nylon film, say, 0.003 of an inch thick either by cement and an adhesive or by softening and rendering adhesive the nylon foil with a solvent. Laminations of cellulose fabric or foil and nylon foil are pliable and very suitable for the manufacture of mustard-gas-proof protective garments and other covers. Duck may be rendered moisture-proof by laminating with nylon film of about 0.002 of an inch thick.

It will thus be seen that protective apparel such as garments and other covers may be readily rendered proof against mustard gas to a greater degree than that heretofore realized by mass production and without the use of special facilities or skilled labor and from relatively cheap material which is readily available in unlimited quantities and an effective protection against mustard gas and other chemicals and caustics and irritants may be provided.

Various modifications may be made in the selection of the particular polymers, their dispersion and the application thereof, and no limitation is intended by the phraseology of the foregoing description or illustration in the accompanying drawings except as indicated in the appended claims.

I claim:

1. A mustard-gas-proof apparel comprising a textile material containing incorporated therein reaction products of mustard gas and of a nonwater-soluble solid synthetic linear polyamide.

2. A mustard-gas-proof apparel comprising a textile woven of a major proportion of fibrous threads impregnated with a non-water-soluble solid synthetic linear polyamide and a minor proportion of plastic threads.

3. A mustard-gas-proof apparel comprising a textile material to which a non-water-soluble solid synthetic linear polyamide and polvinyl alcohol are applied the polyamide being located on the exposed exterior surface.

4. A mustard-gas-proof apparel which is coated with non-water-soluble solid synthetic linear polyamide and polvinyl alcohol films the polyamide film being located on the exposed exterior surface.

5. A mustard-gas-proof apparel which is coated with stratified non-water-soluble solid synthetic linear polyamide and polyvinyl alcohol films the polyamide film being located on the exposed exterior surface.

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