Jan. 16, 1945. L. J. STROBINO 2,367,446

PROCESS FOR MAKING FLEXIBLE PROTECTIVE SHIELDS

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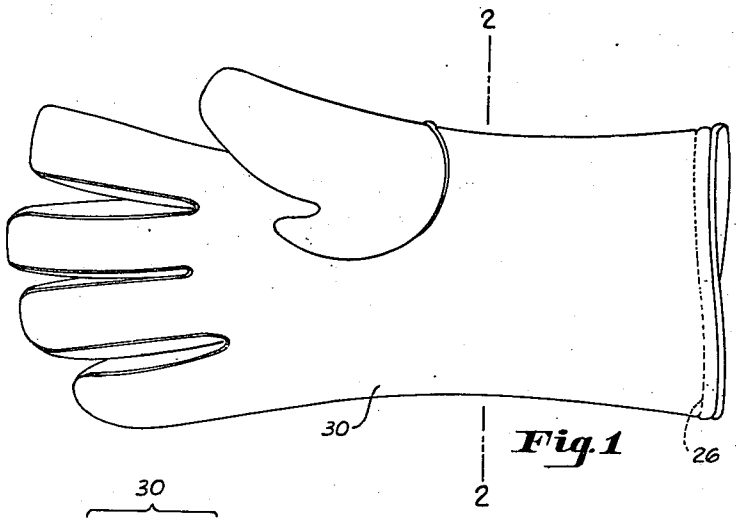


Fig. 1

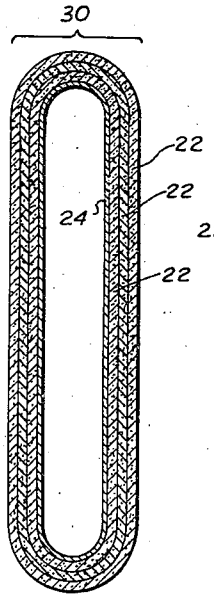


Fig. 2

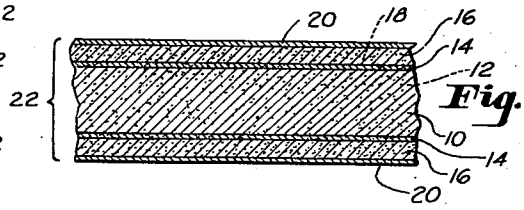


Fig. 3

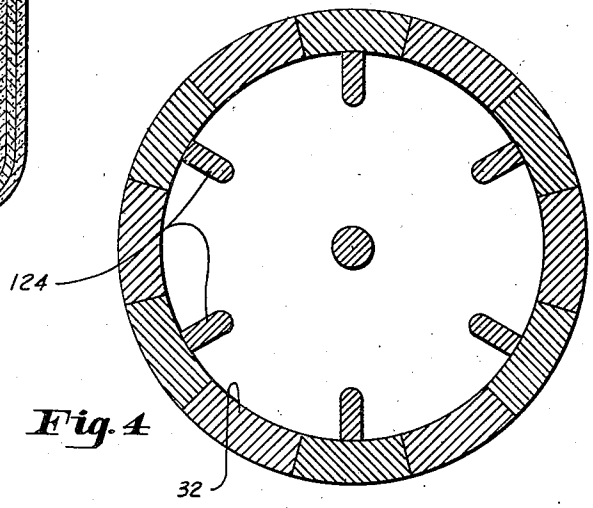


Fig. 4

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PROCESS FOR MAKING FLEXIBLE PROTECTIVE SHIELDS

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Application November 13, 1941, Serial No. 419,012

1 Claim. (Cl. 117—160)

This invention relates to improvements in process for making flexible protective shield.

More particularly it relates to the making material for flexible shields for protecting a human part, as a hand or body, for obstructing and thus retarding the onset of X-rays, or heat, or a chemical reagent, or some other particular energy whose reaching the shielded area may be undesirable.

The invention is herein illustratively described for gloves to shield X-ray operator's hands. In this as in other fields of chemical or physical energy, ordinary gloves are not sufficient to stop the particular inimical energy against which the invention is directed; and the adding of layers of obstructive material, as heretofore known, produces inflexibility that restricts the manipulative power of the wearer's hands, as by disabling the hand from writing, dulling its sensitivity to touch through the glove, diminishing its operative skill, and slowing the operator's action. Similar needs exist in other fields, as where the material being handled has a high temperature; or is productive of chemical reaction, as in the case of material handled by workers in electro-plating, etc. For X-ray shields it has been proposed to impregnate gloves with lead acetate, and to cover this with a layer of rubber to hold the acetate from escaping in moisture, but this makes the material stiff; and without the rubber the lead acetate is fugitive in moisture. The combining of satisfactory flexibility with satisfactory opaqueness to inimical energy has been many times attempted, but so far as I am aware has not hitherto been adequately solved.

The application for this patent is a continuation in part of my application, Serial 372,160, filed December 28, 1940.

The shield of the invention combines flexibility with resistance by concentrating insoluble resistant particles within a porous sheet material that is inherently flexible, as leather or cloth or felt, so that the inherently flexible sheet takes on also a character of being concentratedly obstructive to the passage of the particular energy or influence against which it is to be a shield. The treated material can also have superficial obstructive deposits, and films to confine the deposits; and can be made into other articles as well as gloves. The particles of obstructive substance with which the sheet material becomes pervaded are divided so extremely finely, and are so completely dispersed through the body of the sheet, that these particles do not detract too much from the flexibility of the sheet. They can be so much staggered, relative to each other, and be so deeply permeating the body of the sheet, that every space between adjacent particles is, at some depth or other, underlain or overlain by other particles, so that all rays that strike in encounter them as obstructions.

In the case of a shield against X-rays, the glove material, such as leather or textile fabric, becomes permeated with solid particles of lead, or an insoluble lead salt, or some other heavy metal or salt which is an obstacle to the X-rays. In the case of material for handling hot steel, or hot castings, the solid particles dispersed through the sheet body are of a substance selected as being a poor conductor of heat, as, for example, lamp black, or diatomaceous earth (diatomite), or any of numerous salts. In any case where the shielding may encounter water or perspiration when in use, the dispersed material may be one that is insoluble in water, as, a salt that has been precipitated in situ from aqueous solution within the leather or other flexible sheet. Also some liquids and semi-liquids may be used, especially insulating waxes, which become liquid at elevated temperatures.

For resisting chemicals, especially acids and bases, there may be impregnation of leather with amphoteric hydroxides, precipitated in situ. Among these are aluminum hydroxide, zinc hydroxide and chromium hydroxide.

The invention attains these results by starting with a duly flexible porous sheet, and filling that sheet with finely divided opaque material of the variety chosen. The word "opaque" as herein used refers only to opacity or obstructiveness to the particular influence which is to be stopped, as X-rays or temperature or a chemical reagent, and has no significance as to the transmission of light or vision.

The sheet material may be selected from among tissues of any suitable strong yet porous sort, examples being found in leather, and in woven and felted fabrics.

The opaque particles or the reagents which produce them are to be pounded into the sheet body in a fluid state of dispersion, being either minute solids dispersed in liquid or being fully liquid in solution. In the latter case there is production of solid particles by chemical reaction, of two solutions, with each other within the body of the sheet.

If introduced as solids, the extreme fineness of the solid particles, and the pounding that occurs as the sheets tumble in their penetrative fluid vehicle, gets them into the microscopic in-

terfibrous pores throughout the sheet of leather or of fabric, and the fibres of the sheet subsequently hold them entangled there.

Within the sheet, the close propinquity of the particles makes the sheet as a whole opaque to energy in forms which travel radiantly, such as X-rays or heat rays. For obstructing flow of heat, the discontinuity of heat capacities of the particles and of the fibres, and the spatial insulating of those particles from each other, constitute obstacles to conduction of heat. In the case of the amphoteric hydroxides, the bi-reactive character of the hydroxide particles retards onset of an acid or alkali in its progress toward the wearer's hand.

For obstructing X-rays, lead can be introduced by combined and simultaneous tumbling, flexing and beating. Any substance can be used, which is obstructive to the attack that is to be minimized, if capable of being introduced into the flexible tissue either in finely divided solid or colloidal form, or in solution to be therein thereafter precipitated by reaction.

Uses other than gloves, not needing so high a degree of flexibility are, for aprons, enwrapments or shields of any sort for protecting a person, animal or thing exposed during any of the many processes of hospital, laboratory and industry in which protection of the sort described may be desired.

For dispersing the opaque material within the sheet material, the porous tissue, as skins, fabrics or other sheets, is tumbled repeatedly into and out of the laden liquid vehicle. It is convenient to do this in a rotary drum or other container having internal pegs or ridges, this being partly filled with the liquid which carries, into the body of the tissue, the opaque material, either actually or potentially. In a process which I have found good, the material for opacity of X-ray is metallic lead, very finely divided and dispersed in water. When fine enough to go through a 300-mesh screen, and mixed with water, metallic lead goes into suspension in the water, and the tumbling of it in the water works it into the interior of a skin. A salt which can be introduced similarly is lead oxide, not quite so good. The tumbling involves a repeated lifting of the tissue from the liquid and dropping it back in, with concurrent flexing, and with impacts of tissue against liquid, and of wooden knobs or ridges against liquid and tissue.

This action is, in general, a beating together of the liquid and the tissue in a body of the liquid exceeding what the tissue can absorb. It can be executed with other apparatus, as by a reciprocating plunger working as a beater in a stationary container holding a suitable quantity of the fluid. Apparatus of a type already known for washing clothes can be used for this. Or it can be done by hand.

For the making of a sheet resistant material, suitable for gloves for steel workers, and for welders, etc., the impregnation can be similarly carried out. The solid opaque or insulating material, which for this use may be lamp black or pulverized diatomite, disperses in water in the tumbling drum in such fineness and so thoroughly that it goes into a state of suspension throughout the body of the water, and enters the tissue with the water.

However the internal depositing of a finely divided solid can be effected by impregnating the tissue successively with solutions which react together so as to precipitate the opaque substance. Illustratively, such two solutions may be lead acetate and sodium bromide, each solution being introduced separately by tumbling the tissue in it and then draining away its excess above what has been absorbed by the tissue. Either may be put in first, and after the other is put in the precipitation of lead bromide occurs in finely divided form. This process may be repeated several times, until the skin will not absorb and hold any more.

Either of these lead-impregnating methods may be used alone, or both may be used, cumulatively, the one being applied after the other, to add to the body of lead, lead salt or other obstructive substance which the leather or other tissue can thus be made to carry. Following this the impregnated sheet is to be dried, and the contained liquid evaporated out.

For opacity or insulation against heat, there are numerous salts that can be carried into the tissue by the method above described for lead. Similarly with an amphoteric hydroxide which will resist reactive penetration by acidic and basic chemicals. And this can be made by precipitation from reagents.

In all cases washing and drying may follow; and, in cases where the tissue is a skin, the fat liquoring and other usual steps may be taken in the manner of tanners, in any suitable way. After the leather is finished, surface coatings of the opaque matter may be added, and sealing films applied over them. The composite flexible opaque sheet material is then ready to be made into any suitable articles, as gloves, or to be used in simple sheet form.

The accompanying drawing represents apparatus that may be used in introducing, into a flexible porous sheet, the lead or other obstructing substances, or the reacting compounds from which the substance is precipitated; also a product of the invention, in sheet material; and an embodiment of that material in a glove; but it will be understood that the invention is not limited to the particular showing herein made for illustration of the principles involved.

It is intended that the patent shall cover, by suitable expression in the appended claim, whatever features of patentable novelty exist in the invention disclosed.

In the accompanying drawing:

Figure 1 is a view of the palm side of a glove made according to the process of the invention;

Figure 2 is a section on the line 2—2 of Figure 1, on a larger scale, diagrammatically showing structure of a composite glove which has three plies of opaque sheets;

Figure 3 is a fragment on a still larger scale showing diagrammatically the structure of one of the plies of Figure 2; and

Figure 4 is a vertical section through a drum suitable for working the process of the invention.

The drawing illustrates an application of the invention in the field of protection for an operator's hand from X-rays.

In Figure 3, the middle element 10 represents an animal skin, but it may be cotton or woolen fabric, or other flexible tissue sheet which is somewhat porous; and the small dots 12 distributed all through this element indicate the presence of small particles of lead or other substances which is opaque to X-rays, thickly dispersed throughout the whole of the element 10. Covering each face of the skin is a layer 14 of adhesive, which may be latex that has been

sprayed upon it. Outside of this, on each side, is a layer 16 representing a material such as is used for carrying pigment, throughout which are distributed small dots 18 representing X-ray opaque material in finely divided condition, which may be the same as or different from the kind of material represented by the dots 12. And outside of this is a layer 20 which represents a thin coating of lacquer or other flexible smooth finish applied by spraying or otherwise.

The element 10 is inherently flexible and may, for example, be sheepskin or split pigskin. The superficial film 14 should also be flexible. If a high degree of flexibility is desired the latex mentioned as possibly constituting this element may be found to introduce more stiffness than is wanted, when it is dry. In that case this element should be omitted, and the opaque material, which it would be carrying if present, can, if needed, be added by other means, to that carried within the body of the sheepskin. The element 16 is a film of drying oil or the like, made flexible by the inclusion of glycerine or the like and carrying the finely divided opaque material dispersed throughout its body. This holds itself naturally to the latex, or to the element 10 if the latex element 14 should be absent. The inherently flexible coating of lacquer 20, which adheres to its outer face, strengthens it against breakage by flexure.

In Figure 2, which shows a cross section through the wrist of a shielding glove 30, seen in Figure 1, the glove has a plurality of plies 22, each being such as the whole of the unit shown in Figure 3, containing a basal flexible sheet 10 with opaque substance 12 dispersed through that sheet by the process of tumbling hereinafter described with reference to Figure 4. Each of the represented three plies 22 is a complete glove. These are nested successively within each other, and another complete glove 24 inside of them all is made of some thin easy-slipping textile material such as rayon. These four plies are held all together by one or more lines of stitching 26 at the wrist-edge of the glove. The maker of the glove has considerable latitude in designing the details, contents and construction of each unit 22, as the tissue 10 of Figure 3 may be either skin or manufactured fabric, and the layers 16 are merely for holding additional thickness of the opaque dispersion, while the layer 20 is for physical retention and enclosure of the opaque material.

For easy flexibility the successive plies lie loosely over each other, so that each can slip somewhat relative to its neighbors, when fingers bend.

The impregnating step is best executed with penetrating fluids of low viscosity. Mixing water with the described very fine metallic lead helps carry the lead into the porous sheet, with entrance of water. If the lead is introduced in a form which is not actually metallic, as in lead acetate, that aqueous solution and the aqueous solution of the reagent which is to precipitate it, are to be used with a fluidity approximating the thinness of water, if optimum effect is desired. In either case the resulting insoluble powder of lead or other opaque substance is held entangled physically within the sheet of tissue, after the liquid has been evaporated; and its escape, when somewhat loosened by repeated flexure of the holding sheet, is prevented by the continuous superficial sheet of film and of close woven textile.

If the penetration is effected in a tannery, in drums such as are used there, the interior of the drum will have pegs several inches long distributed a foot or so apart; and skins of standard size will thus be carried up and dropped repeatedly, flexing the skin until the fluid and whatever is dispersed through it has fully penetrated, which may be in a half hour, or less. The pounding loosens the fibres in the skin, somewhat, and moves them about a little relative to each other, and thus makes spaces into which the solution goes more readily than if the leather were merely immersed.

In the diagram of drum 32 herein shown, the elements 124 may represent the pegs of the tanner's drum above mentioned, or, instead of pegs they may be considered to represent a series of ridges which extend interiorly from end to end of the drum, equi-spaced around its periphery. Such ridges may be planks set on edge, constituting large slats, to perform the same function as the pins, before mentioned, engaging and carrying the skins up, and then dropping them, with repeated flexing and pounding of the skins so that the solution goes readily into their pores.

For the impregnating, a strong or concentrated solution is advisable, one in the region of 50% saturation in water being useful at a temperature in the region of 120–125° F.

The precipitation occurs wherever the sodium bromide, or potassium iodide, if that be used, finds the acetate, within or on the surface of the skin. The body of liquid outside the skin facilitates the tumbling, and helps to avoid injury to the skin in the tumbling. The precipitated lead salt coats the leather fibres and is adsorbed thereon rather strongly.

In practicing the invention to make shields against ultra violet rays, which may be important in various industries, one example being in welding, metallic dusts, such as dusts of copper, aluminum or iron, have been found suitable. Any such dust may be incorporated in leather to block the passing of ultra violet rays.

Diatomic earth of fineness to pass through a screen of 600 mesh, more or less, has a higher insulating index than ordinary leather; and this, like the said metallic dusts, can be impregnated into leather, for example, or into other tissue, according to the method herein described for the impregnation of tissue with lead dust. Leather thus loaded with diatomic earth has been found to withstand 600 to 800° F. of dry heat for short intervals without impairment.

Flexible shields for protection against other inimical emanations can be made with use of suitable materials by the methods herein disclosed. For example large amounts of aluminum hydroxide can be made to enter leather, by procedure similar to that for impregnating leather with lead dust.

Easier penetration of the preferred kind of skin, as pigskin or sheepskin, is had by first degraining the skin, as by splitting, shaving, bucktailing, sueding or other method. The tannings may be by any method, but it is best if the method chosen is one which makes a soft spongy leather, preferably chrome tanning. The presence of the introduced solid material makes it advisable to use unusually large amounts of fat liquor to keep the leather soft, because of the tendency of finely divided powders to absorb oils and fat liquors. This augmentation of fat liquor operates toward increasing the strength of the product, counter-

acting weakness which the abnormal separating of the leather fibres by inert particles would otherwise introduce.

I claim as my invention:

A process for making a flexible shield for protection against attack by destructive penetrating rays such as X-rays and the like, which process includes the steps of providing a flexible fibrous and porous sheet of a substance normally permeable to the destructive rays, a body of water which has the property of readily penetrating the pores in said sheet, and a quantity of solid lead particles in fineness of the order of at least 300 mesh, dispersing said lead particles in said body of water to provide a concentrated suspension of lead particles suspended in water, thereafter tumbling the sheet in a volume of the suspension exceeding that which the sheet can absorb, thus causing the suspension of water and lead particles to thoroughly permeate the porous sheet so that the lead particles are physically entangled within and throughout the interfibrous pores of the sheet, and thereafter removing the water from the sheet thereby leaving the lead particles physically entangled within and throughout the thickness of the sheet.

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