Aug. 31, 1943. L. J. STROBINO 2,328,105

X-RAY SHIELD

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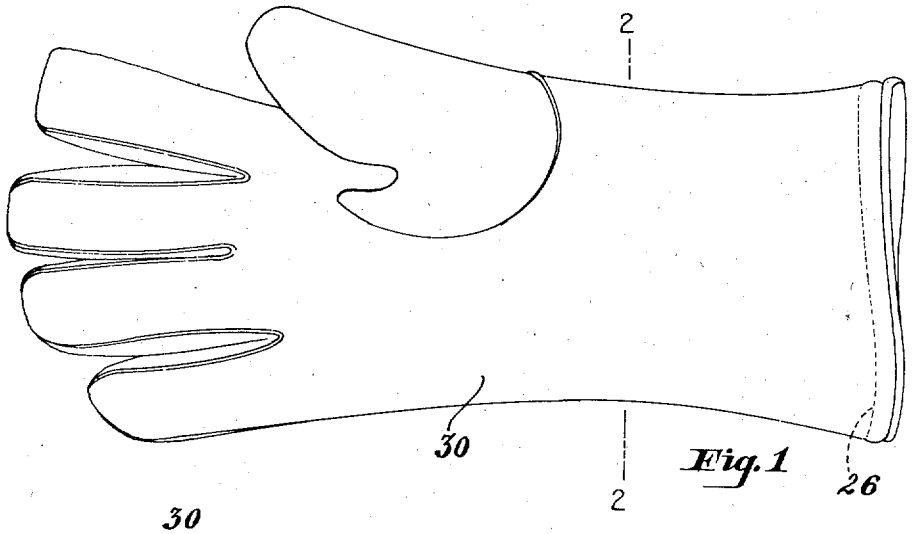


Fig. 1

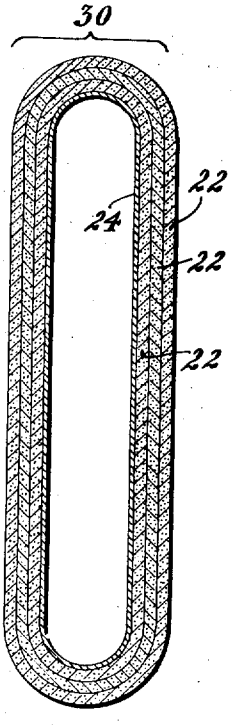


Fig. 2

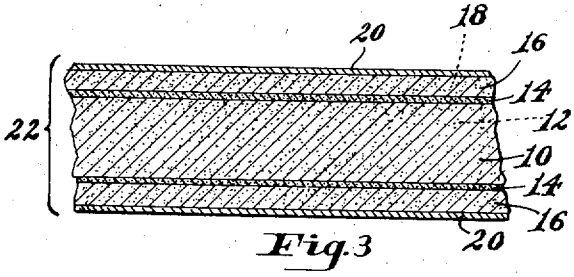


Fig. 3

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X-RAY SHIELD

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Application December 28, 1940, Serial No. 372,160

6 Claims. (Cl. 250—108)

This invention relates to improvements in X-ray shields and processes for making X-ray shields.

Particularly it relates to flexible shields, such as are especially needed by operators whose hands are more or less in a field of X-rays repeatedly in the course of their work.

Deficiency of flexibility, in a shielding glove, dulls the sensitivity of the operator's touch, affects his operative skill and slows his action. Also it interferes with his continuity of procedure, in cases where he has to write notes of his observations, intermittently, for which he must remove his hand from the glove because he cannot write while wearing the glove. It would be very helpful to be able to make such notes, as also to be able to handle instruments, with more facility than is possible while wearing a shielding glove of any type hitherto available.

Efforts to make a shield which an operator's hand can wear with some degree of flexibility have previously been made by fastening small plates of sheet lead in overlapping relation on a glove; also by making the glove of a thick sheet of rubber, vulcanized with sulfide of lead; but so far as I am aware no adequate hand-shield has heretofore been known which combines in itself the requisite opacity to X-rays and the degree of flexibility needed for satisfactory use.

The present invention attains this desired result by starting with a duly flexible sheet—which may be of leather or of any woven or felted fabric, or of other porous material—and rendering that flexible sheet opaque by filling it with finely divided opaque material; also, if desired, coating it with such. It will be understood that the term "opaque" as herein used refers only to opacity to X-rays, or to whatever other rays outside of the visible spectrum are to be stopped by the shield. From the opaque composite sheet thus produced any desired articles can be made; and it is found that gloves thus made can have the adequate flexibility and opacity above indicated.

According to the invention the desired results are attained by making a dispersion of a very finely divided opaque material, of which metallic lead is an example, throughout the body of a porous flexible sheet. The kind of material of the sheet may be selected from among tissues of any suitably porous and strong sort, examples being leather, and woven or felted fabrics. The flexible sheet taking on such a dispersion becomes opacified without too great loss of flexibility. If the dispersion in the body of the sheet is to be supplemented by a superficial dispersion, the latter is held in place by an adhering flexible film, such as is used in other relations for carrying and holding pigment, rendered flexible by admixed glycerine or other non-drying substance. Exteriorly a thin film of lacquer, or other substance which when dry is flexible with a firm surface, will provide a smooth confining finish. Or, a superficial dispersion of opaque material may be held to the impregnated tissue by an adhesive coating such as latex, sprayed over the tissue, and having the opaque dispersion sprayed over the latex; but as the latex dries to a somewhat stiff form the product ultimately is less flexible.

The extreme fineness of the dividing of the lead accompanied by the holding of its fine particles in the microscopic pores throughout the sheet holds together the opaque elements in a sheet form, and that sheet has a flexibility which the opaque element would not have if it were an ordinary solid lead sheet. From the close propinquity of the finely divided particles, it results that in a sheet of ordinary thickness each minute space between particles becomes many times covered by other particles which stand at various other levels in the total thickness of the dispersion. Thus opacity of the composite sheet is attained. During a flexing of the sheet the particles move, relative to each other, but the perfection of covering continues, because some or other particles are always standing over each minute space between particles, in position to prevent that space being reached by any rectilinearly approaching X-ray.

The tissue at present preferred for thus carrying the dispersion of opaque matter is sheepskin or split pigskin. Skins of these varieties are receptive, having good tensile strength to hold the material well, and have strength to resist wear. The flexibility of such a skin when thus impregnated is comparable to and not much less than that of the leather of ordinary gloves.

But the opaque filling which can be contained in a single glove skin is not enough to protect one's hand completely from the penetration of an X-ray beam. The invention attains the desired protection by making gloves of several different sizes, for example three or four, capable of being nested one within another. The inmost of these gloves preferably has another glove fitted within it, made of silk, rayon, or other slippery synthetic textile fabric. Thus completed, the composite glove slips easily on and off a person's hand. When the wearer's hand or fingers are bent, as in writing, the several plies of impregnated material slip over each other with ease and freedom.

The subdivision, of the total thickness necessary for the opacity, permits the internal compression and expansion, which occur when a thick sheet bends, to be accommodated by mutual adjustment of the several plies, relative to each other, so that in the whole there is flexibility in all directions, as well as a high degree of opacity in all directions.

For the opaque material, finely divided lead appears to be the substance most inexpensively and abundantly available at the present time. This can be introduced in either of several ways indicated below, or in them cumulatively, by a process including a mechanical step which is economical of human labor. Thus the cost of the product falls at a level low enough to permit of the flexible opaque product being purchased and enjoyed by those whose occupation gives rise to the need for X-ray protection. The invention is not limited to using lead for the opaque substance, for any substance opaque to the rays which are to be excluded can be used, if capable of being introduced in finely divided form, or of being produced in the tissue by chemical action of reagents introduced in solution.

The sheet material thus produced, herein described as it can be utilized for the making of flexible gloves, is available for other purposes, whether or not a high degree of flexibility is desired. Such uses may be for protecting the regions adjacent to one where a person is being treated with X-rays; or may be used as aprons, enwrapments or shields of any sort for protecting a person, animal or thing exposed to X-rays, in any of the many hospital, laboratory and industrial processes in which X-ray emanations are used.

A tissue fabricated of woven or felted animal or vegetable fibres, as wool or cotton, will ordinarily absorb and carry more of the dispersion of opaque material than will pigskin, per unit of thickness; and can be thicker; but such ordinarily will not hold it as strongly as leather will. A good opaque flexible composite glove is made by a series nesting of two or more opacified skin gloves, one within the other, with one or more opacified gloves of woven or felted fabric intervening in the series; and an inmost glove of thin slippery fabric which need not be opacified.

The dispersing of the opaque material can be done by tumbling the skins, fabrics or other pieces of tissue in a drum or other container, in a liquid which either carries insoluble opaque material into the body of the tissue, or is a potential contributor to the making of a deposit of the opaque material in that body. In a process which I have found good the tumbling can be executed, in a drum such as tanners use, and the material to be tumbled with the skin is very finely divided lead. Lead is insoluble in water. Specific material found satisfactory is metallic lead, fine enough to go through a 300-mesh screen. In this fineness it appears to be almost in a colloidal state of fluidity. The test however is that it be fine enough so that it works its way into the interior of the skin when thus tumbled. When mixed with water in the tumbling drum lead of this fineness goes into flotation or suspension, and soaks into the tissue with the water. A material which can be introduced similarly, not quite so good, is lead oxide.

But the internal depositing can be effected by other means. One is to impregnate the tissue successively with solutions which react so as to precipitate the opaque substance within the body of the tissue. Illustratively, such two solutions may be aqueous solutions of lead acetate and sodium bromide, either solution being introduced by tumbling the tissue in it, then removing its excess above what is absorbed; then doing likewise with the other solution, causing reaction resulting in precipitation of insoluble lead bromide in finely divided form. This process may be repeated several times, until the skin will absorb and hold no 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 which the leather or other tissue can thus be made to carry.

Then washing, fat liquoring and drying may follow in the usual manner of tanners, or in any suitable way; and after the leather is finished the surface coatings of opaque matter and their sealing films may be added. The flexible opaque composite sheet material is then ready to be made into any suitable article, or to be used in simple sheet form.

Other salts which precipitate a deposit opaque to X-rays may be used, a great number of substances which are opaque to X-rays being known. Among such, in addition to lead, are barium; bismuth; tungsten; mercury; and many other of the heavy metals, which are all in some degree opaque to X-rays; and some of the non-metals, among which are the halides. The method for introducing other substances may be similar to that herein illustratively described for lead.

The accompanying drawing represents an embodiment 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 embodiments which are herein shown for illustration of the principles involved.

It is intended that the patent shall cover, by suitable expression in the appended claims, whatever features of patentable novelty exist in the invention disclosed except that the improvements in processes herein disclosed are claimed in my co-pending application Serial No. 419,012, filed November 13, 1941, relating to Processes for making flexible protective shields.

In the accompanying drawing:

Figure 1 is a view of the palm side of a glove embodying 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; and

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

In Figure 3, the middle element 10 represents an animal skin, but may be a 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 substance 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 ma-

terial 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 glove 30, the glove has a plurality of plies 22, each being such as the whole of the unit shown in Figure 3. 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 the 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.

If one or more units 22 have large-pored woven or felted fabric, the setting of such between units 22 having skin makes a total structure in which the loosening of the opaque powder from the fabric becomes harmless because the skins, having closer texture, prevent its escape from the glove. If necessary to prevent migration of loosened opaque matter within the glove, lines of stitching like 26 can be arranged in various parts of the glove, dividing the glove wall interiorly into separate compartments between the skins. In this case the tougher flexible material would be at the outside and the inside of the glove where wear is received, and would hold the contents of the fabric in place, with less deterioration from frequent rubbing. The unit of closely woven textile material 24, arranged interiorly, is also a safeguard against abrasive loosening and escape of the opaque powder; and there may be a similar exterior (not shown) glove ply, thin and closely woven, with like effect. Both of these prevent the glove from crocking when touched, without too seriously diminishing its flexibility.

In place of the latex or lacquer suggested for holding additional opaque powder on the surface of the leather or other tissue, any suitable synthetic resinous or rubber-like compound which is flexible when dry may be used, illustrations of which are found among vinyl resins and among synthetic rubbers and rubber hydrochloride compositions.

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, the 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 powder of lead or other opaque substance is held entangled physically within the sheet of tissue; 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.

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.

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 suspended in it has fully penetrated, which may be in a half hour, or less, as the pounding loosens and moves about the fibres in the skin, somewhat, relative to each other, and thus makes spaces into which the solution goes more readily than if the leather were merely immersed. 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 excess of fluid, not entering the skin, facilitates the tumbling and helps avoid injury of the skin. The precipitated lead salt coats the leather fibres and is adsorbed thereon rather strongly. 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 tannage may be by any method, but preferably is by 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 fatliquor to keep the leather soft, because of the tendency of finely divided powders to absorb oils and fatliquors; and this augmentation of fatliquor increases the strength of the product by counteracting the weakness which would otherwise be introduced by the abnormal separation of the leather fibres by inert particles.

I claim as my invention:

1. A flexible shield against X-rays and other rays of the class described, comprising a sheet of material which inherently is porous, flexible, and penetrable by said rays, combined with a substance which is of a nature opaque to the said rays and is insoluble in water; said substance being in finely divided condition dispersed in pores of the said material.

2. A flexible shield against X-rays and other rays of the class described, comprising a sheet of material which inherently is porous, flexible and penetrable by said rays, combined with metallic lead in finely divided condition dispersed in pores of the said material.

3. A flexible ray-shield as in claim 1, further characterized in that a woven textile sheet is secured over the surface of said porous sheet and its opaque contents.

4. A shield against X-rays and other rays of

the class described comprising the combination of a dispersion of a finely divided substance, of a nature opaque to the said rays, and a flexible sheet of solid material, chemically distinct from the said substance, but having relatively large pores holding that substance as a powder in the midst of the sheet body; a wearing surface of leather, having relatively small pores, covering one or both surfaces of the powder-holding sheet and confining the powder against escape, and additional opaque powder carried by the leather.

5. A flexible ray-shielding glove, being a plural-ply glove whose plies are flexible porous sheets which overlie each other loosely, with freedom to slip relatively to each other, each being of material inherently penetrable by the rays, but having within its pores a substance which is opaque to the kind of rays against which the glove has a shielding effect.

6. A flexible ray-shielding glove in which a primary material of the glove is split pigskin throughout which there is metallic lead in finely divided form.

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