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RADIANT-ENERGY-OPAQUE FABRIC

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1

The present invention in general relates to woven radiopaque fabrics, and more particularly to protective fabrics opaque to radiant energy emissions comprising a flexible web of woven lead glass fibers or filaments.

A paramount problem occurring in activities associated with use of X-ray and radiant energy generators, is that of minimizing the quantity of scattered radiation incident to the activity that may possibly reach the bodies of the technicians, attendants, and those required because of the nature of their duties to be exposed to the scattered radiation for long periods of time.

For example, in the course of present day medical practice and procedure, technicians, attendants, and doctors are often required to remain in an enclosure in which X-rays are being generated for purposes of X-ray fluoroscope examination of the human body throughout a substantial portion of the day. Many protective measures are generally taken as a precaution against X-ray exposure. Normally, the X-ray generator used in such fluoroscopic examinations is controlled to emit X-radiation over only a very short fraction of the total time such operators and attendants are in the fluoroscopic examination room. Generally, protective shielding is provided in the walls and about the generator to confine the emitted X-radiation to a very small, highly directive area, and in many cases the attendants and apparatus are encased in protective cells or housings in which they remain throughout the major portion of the time that the X-ray generator is in operation. Notwithstanding this, large quantities of scattered X-radiation have been found to occur in even these protected areas.

Evidence of the seriousness of this problem is found in the fact that the percentage of occurrences of anemia and the number of fatalities from anemia among members of the medical profession are extremely high among the group employed for any length of time in X-ray rooms. As a matter of fact, the medical profession now generally recognizes that scattered X-radiation and other radiant energy emission is probably one of the principal causes of anemia.

Due to the tremendous increase in activity in various fields of atomic research, particularly those involving atomic bombardment by high energy particles, isotopic investigations, and other activities involving generation of emergent high energy radiation products, the problem of providing suitable protection for those engaged in such activities against scattered radiation is particularly acute.

2

Conventionally, protection against such scattered radiations has been sought through the use of protective barriers of considerable thickness, such as lead walls, or concrete block impregnated with large quantities of lead or lead compounds. For example, the entire working area immediately surrounding the products from which such radiations may be emitted has been encased in large lead or lead-concrete housings, and remote means for handling and controlling the products have been provided for the operators, or the operators are confined to cells or protective enclosures of similar design and composition. Obviously such protective means impose severe restriction upon the movement, freedom of activity of those engaged in such work, and the degree of control over the product. It is apparent, therefore, that there is a particular need for some means by which such scattered radiant energy emissions can be effectively excluded from those required to be in the vicinity of and exposed to the scattered emissions, while still permitting them to move freely about the area and exercise a high degree of control over the work, particularly to permit substantial freedom of movement of the body members of the workers.

The desirability of providing such protection in the form of protective clothing for the workers required to be exposed to such scattered radiation should, therefore, be apparent, as such protective clothing, if maintained in a reasonably flexible and resilient state, would afford the desired freedom of movement. Incorporation of some type of lead or other protective coating in the clothing, or similar protective inserts in the clothing, would render the clothing difficult to work in. The more desirable solution to the problem would appear, therefore, to be in the provision of a protective fabric incorporating in the thread or fibers, or as an inherent and integral characteristic of the material itself, the medium or composition opaque to such radiant energy emission. As the radiopaque element or medium should be incorporated in threads or fibers suitable for ordinary spinning, plying and weaving operations on conventional textile machinery, coating of existing textile fibers or threads with the radiopaque composition would seem to be eliminated as a practical solution. This is because the known radiopaque compositions are substantially brittle and unyielding in nature, and would prevent the textile fibers from having the necessary characteristics to render them suitable for such spinning and weaving operations. In order to prevent the cost of such a protective fabric from being pro-

hibitive to those classes most in need of such protection, the components from which the fabric is to be produced must still be susceptible of the conventional mass production textile operations. The radiopaque composition or medium, therefore, must be incorporated in the composition of the textile thread or fiber itself, so that the protective thread or fiber will retain the characteristics of uniform strength throughout, high tensile strength, and be highly flexible and stretchable.

An object of the present invention is the provision of a protective fabric opaque to radiant energy emissions.

Another object of the present invention is the provision of a protective fabric opaque to radiant energy emissions, which is sufficiently flexible to permit substantially unrestricted freedom of movement when fabricated into garments to be worn by persons exposed to such radiant energy emission.

Another object of the present invention is the provision of a radiopaque woven fabric formed of woven thread or fiber elements having a high tensile strength and the necessary characteristics of flexibility and stretchability necessary to permit spinning and weaving of the threads on conventional textile machinery.

Another object of the present invention is the provision of a radiopaque woven fabric formed of a web of threads or fibers suitable for conventional textile operations and having a high lead content.

Another object of the present invention is the provision of a protective woven fabric opaque to radiant energy emissions comprising a flexible web of densely woven lead glass fibers suitable for fabrication into protective garments.

In the preferred embodiment of the present invention, a glass thread which has incorporated in its composition a material which is radiopaque, is spun and plied, by methods commonly known and used in the textile arts, and woven into a web to form a fabric suitable to be tailored into garments. The glass fiber from which the finished product is to be produced is formed by mechanical drawing of glass or the like in accordance with methods and with the use of apparatus known to the glass art and commonly employed in the production of spun glass, to form relatively continuous threads of siliceous fibers. The production of glass or siliceous fibers by the mechanical drawing processes has been commonly employed for providing drawn glass fibers of sufficiently small diameter and high tensile strength and flexibility suitable for use in connection with conventional textile spinning and weaving machinery for the production of women's dresses and like garments.

The method conventionally employed in effecting this mechanical drawing of the glass into continuous uniform siliceous fibers comprises, in general, the melting of a batch of lime glass or other glass compounds in a receptacle. The receptacle is provided with a very small orifice having a refractory ceramic bushing, or a metal bushing or thimble provided with a series of nipples of extremely small diameter of the order of a few microns, and the molten glass is continuously drawn through such orifices into the atmosphere and cooled by means of cool air jets to provide the spun glass filament. These drawn filaments are wound about a continuously driven pulling means in the form of a drum or spindle in much the same manner that cotton or other textile fibers are wound.

Sizings or coating such as oil, wax, cellulose derivatives, resins, starches, fats, fatty acids and other suitable known substances may be applied to the fibers by spraying or other means as they are being cooled to reduce discontinuities or fissures along the periphery of the fibers, thereby increasing the uniformity of size and strength throughout the length of the fibers. Normally, series of transversely spaced orifices or nipples are provided from which the molten glass fibers are drawn and the individual fibers combined after they have been cooled and before they reach the drum or spindle upon which they are being wound, to provide a single thread made up of several individual filaments to permit a large number of individual filaments or threads to be drawn from the orifices.

The multiplicity of spun glass fibers drawn from the thimble or orifice and wound onto the cylindrical drum or spindle may be further wound or plied into threads on conventional textile spinning and plying machines, or may be employed in the wound thread form in which they occur on the drum or spindle, for weaving fabric webs on conventional textile looms.

In the production of the finished protective fabric the subject of the instant application, the radiopaque substance or medium providing protection against radiant energy emission is integrally incorporated into the composition of the glass thread by drawing the thread from a glass of very high lead content. This is accomplished by substituting for the conventional lime glass or similar glass compositions forming the supply body or batch of molten glass, a lead glass of the type normally employed in the production of fine crystal and the like comprising a potash-lead-silicate combination. Specifically the glass making up the molten supply body from which the glass fibers are drawn contains approximately 60% lead oxide, 34% silica, and 6% potash.

The glass fibers formed from this lead glass by means of the above-described mechanical drawing process, when the lead glass fibers are drawn to exceedingly small diameters of the order of a few microns or smaller, are of very high tensile strength, are relatively flexible and stretchable, and have other desirable characteristics rendering them suitable for the various conventional textile spinning and weaving operations. This is important in preventing the finished protective fabric from being of a relatively prohibitive cost to those groups who are most in need of such a fabric, as the thread or filament from which the fabric web is to be woven must be capable of being woven by conventional mass production textile methods.

The fabric web woven from the drawn lead glass filaments or threads is very closely woven, and 3 to 4 ply thicknesses of the finished woven fabric employed in the tailoring of the garment. The flexibility and strength of the finished woven fabric is such that considerable freedom of movement is permitted for the body members of the person wearing such protective apparel, while still providing them with a lead equivalent of approximately 0.19 millimeter, this being sufficient to reduce the percentage transmission of scattered radiant energy emissions to the body inside the protective garment substantially below a level where such emissions would be considered dangerous to health.

From extensive tests run on the lead glass from which the glass fibers were drawn, and on the finished woven lead glass fabric, to determine the

absorption measurements thereof relative to X-radiation and beta radiation, a 4 ply thickness of the fabric woven from the drawn lead glass filaments was found to transmit approximately only 3.0% of the beta radiation relative to the amount transmitted in air, as compared with percentage transmission measurements of 75% to 98% for various commercially used drawn glass cloths. Specifically, from the series of beta radiation absorption measurements of the protective fabric, it was determined that a single ply of the fabric had a beta radiation percentage transmission of 46% relative to transmission through air, a 2 ply thickness of the fabric had a percentage transmission of 20%, a 3 ply thickness had a percentage transmission of 8.2%, and a 4 ply thickness of the fabric a percentage transmission of 3.0%. Likewise, from a series of X-ray absorption measurements of the protective fabric composed of the mechanically drawn lead fiber glass, it was determined that a single ply of the fabric had a percentage transmission of 17.9% relative to transmission through air, a 2 ply thickness of the fabric had a percentage transmission of 7.75%, and a 4 ply thickness of the fabric a percentage transmission of 2.4%. From these figures, it is apparent that a 3 or 4 ply garment tailored from the fabric woven from the drawn lead glass fibers provides substantially complete protection to bodies therein from incident radiant energy emissions which would otherwise be extremely harmful to the body.

It will be apparent, therefore, that applicant has provided a novel woven protective fabric substantially opaque to radiant energy emissions, which is capable of being readily fabricated into protective garments suitable for persons required to remain in areas normally subject to large amounts of scattered radiant energy emission, which is sufficiently flexible to permit substantially unrestricted movement of the body members of such workers, and which provides them with a protective covering permitting transmission of such scattered radiant energy emissions to the bodies of such persons of the order of 2.0% to 5.0% relative to the transmission of such radiation through air.

The term "web" used throughout the foregoing description is intended to extend to woven cloths, felting, matting, and similar forms of fabrics wherein the lead glass fibers may be disposed in indiscriminantly oriented fashion as well as arranged along pre-selected axes.

It will be understood that the proportions and the ingredients as disclosed in the preferred embodiment are merely for the purpose of illustration, and changes and modifications may be made without departing from the spirit of the invention or the scope of the appended claims.

What is claimed is:

1. A protective fabric substantially opaque to X-rays and beta rays comprising a web of lead glass fibers.
2. A protective fabric substantially opaque to X-rays and beta rays comprising a web of woven lead glass fibers.
3. A protective fabric substantially opaque to X-rays and beta rays comprising a flexible web of densely woven lead glass fibers.
4. A protective fabric substantially opaque to X-rays and beta rays comprising a flexible web of densely woven spun lead glass fibers.
5. A woven fabric substantially impenetrable by X-rays and beta rays comprising threads of twisted and plied mechanically drawn lead glass filaments.
6. A fabric substantially impenetrable by X-rays and beta rays comprising threads of spun glass filaments mechanically drawn from a potash-lead-silicate compound.
7. A fabric substantially impenetrable by X-rays and beta rays comprising a web of threads of spun glass filaments mechanically drawn from a potash-lead-silicate compound.
8. A fabric substantially impenetrable by X-rays and beta rays comprising a web of woven threads of spun glass filaments mechanically drawn from a potash-lead-silicate compound.
9. A fabric substantially impenetrable by X-rays and beta rays comprising a flexible web of woven threads of spun glass filaments mechanically drawn from a potash-lead-silicate compound.
10. A woven fabric substantially impenetrable by X-rays and beta rays comprising threads of twisted and plied mechanically drawn glass filaments containing more than 50% lead oxide.
11. A woven fabric substantially impenetrable by X-rays and beta rays comprising threads of twisted and plied mechanically drawn glass filament containing approximately 60% lead oxide, 34% silica, and 6% potash.

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