Feb. 17, 1970 J. D. McCLUER 3,496,057

ALUMINIZED FABRIC AND METHOD OF FORMING THE SAME

Filed May 24, 1966 2 Sheets-Sheet 1

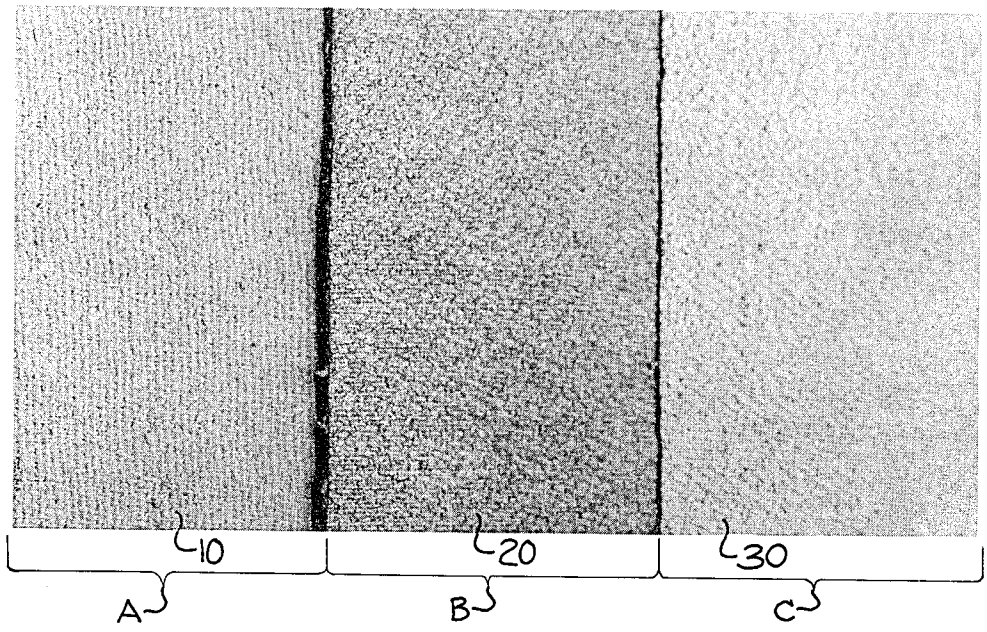


Fig-1

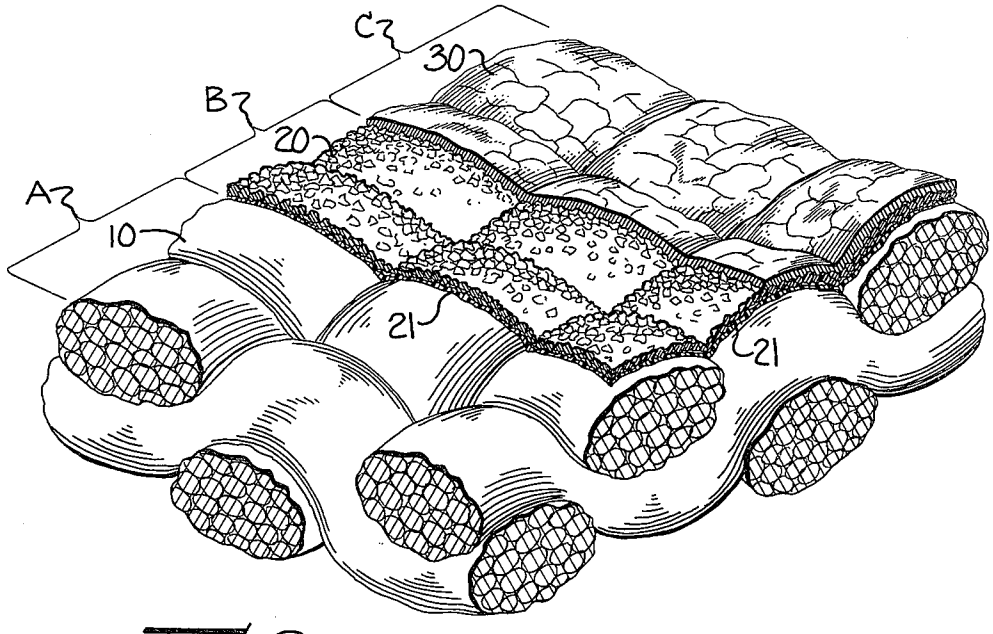


Fig-2

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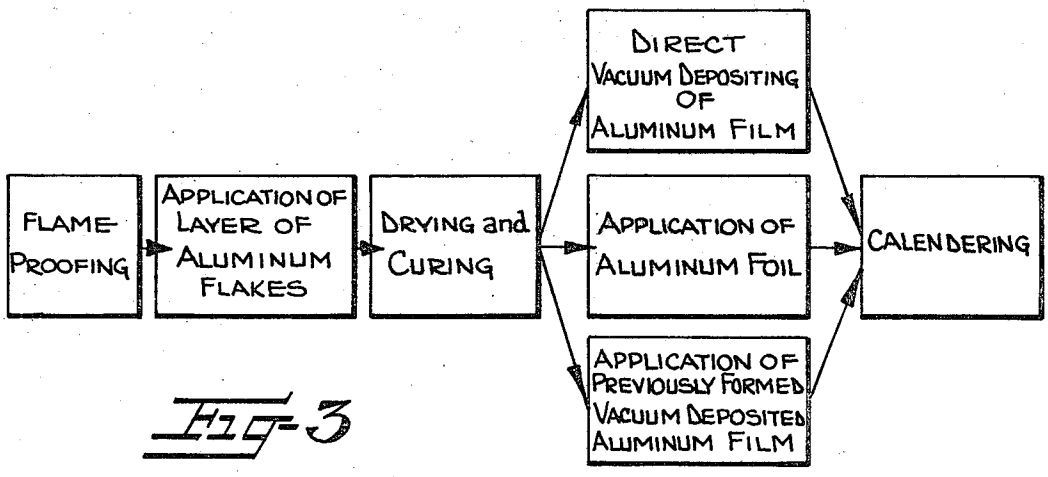


Fig-3

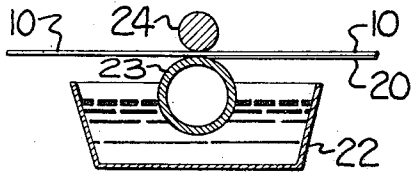


Fig-4

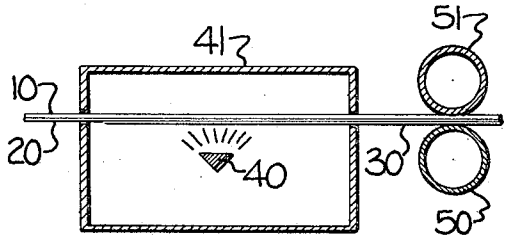


Fig-5

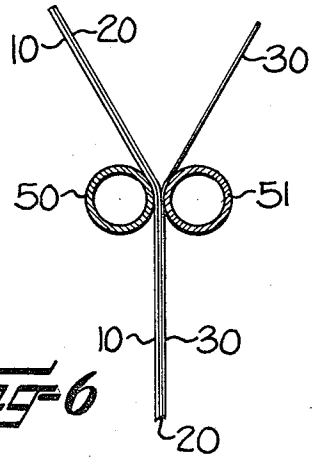


Fig-6

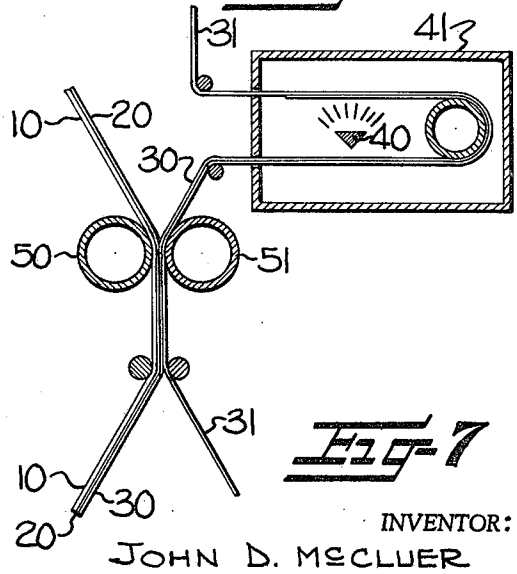


Fig-7

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ALUMINIZED FABRIC AND METHOD OF FORMING THE SAME

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Int. Cl. B32b 5/16
U.S. Cl. 161—87 11 Claims

ABSTRACT OF THE DISCLOSURE

An aluminized fabric and method of making the same wherein discrete, finely divided, aluminum flakes are anchored to an asbestos-base fabric with a resinous binder to form an intermediate surface layer of exposed aluminum flakes of high heat resistance to which layer there is cohesively bonded a highly reflective film of aluminum to provide high heat reflectance to the fabric.

This invention relates to protective fabrics, and more particularly to aluminized fabrics provided with a highly reflective aluminum surface and having high heat resistance and heat reflectance.

Aluminized fabrics having reasonably reflective surfaces are generally well known for use as protective fabrics because of their ability to reflect heat back toward a heat source, rather than allowing the heat to penetrate therethrough. Thus, by deposing such fabric with an aluminized side toward the heat source, the back side of the fabric remains relatively cool. There are many uses for these fabrics in steel mills, foundries and other similar places, such as for protective clothing, coverings, blankets, curtains, and the like.

Heretofore, such fabrics have possessed one or more deficiencies, such as low flame retardance, low tensile strength, low abrasion resistance, or no resistance to molten metal splash, and as such, these fabrics have been limited in their versatility.

In accordance with the present invention, I have overcome these deficiencies heretofore encountered and have produced a highly reflective aluminized fabric which has properties of flame retardance, abrasion resistance, tensile strength and resistance to molten metal splash much superior to previously known aluminized fabrics. Briefly, I accomplish this by first forming an adhesively bonded layer of exposed discrete aluminum flakes on a surface of a suitable base fabric and thereafter cohesively bonding a highly reflective aluminum film directly to such layer of discrete aluminum flakes.

In the accompanying drawings:

FIGURE 1 is a photograph of a fabric as it appears during various stages of processing in accordance with the present invention, portion A depicting a base fabric, portion B depicting such fabric after forming the layer of exposed discrete aluminum flakes thereon, and portion C depicting the final aluminized fabric of the invention after the addition of the highly reflective film of aluminum;

FIGURE 2 is a fragmentary, greatly enlarged, isometric schematic representation of a portion of a fabric produced in accordance with the present invention with layers broken away to illustrate the nature of various coatings applied to the fabric and with portions marked to correspond with the photograph of FIGURE 1;

FIGURE 3 is a flow diagram illustrating the preferred sequence of method steps utilized in forming the fabric of the present invention;

FIGURE 4 is a schematic vertical sectional view of a coating apparatus such as may be employed with the present invention;

FIGURE 5 is a schematic vertical sectional view of a vacuum metallizing chamber such as may be employed in connection with the present invention in applying the highly reflective film of aluminum;

FIGURE 6 is a schematic vertical sectional view of a calendering apparatus which may also be employed in connection with the present invention in applying the highly reflective film of aluminum; and

FIGURE 7 is a schematic vertical sectional view of a vacuum metallizing chamber and calendering apparatus which may still further be employed in connection with the present invention in applying the highly reflective film of aluminum.

Referring now to the figures, the aluminized fabric of the present invention basically comprises a suitable base fabric **10**, a layer of discrete, finely divided, aluminum flakes **20**, adhesively bonded to a face of a fabric **10** with a suitable binder **21**, and a highly reflective surface film of aluminum **30** cohesively bonded directly to the layer **20**.

In FIGURE 1, the photographed portion A depicts fabric **10** as it appears prior to the application of the layer **20** thereto; the photographed portion B depicts such fabric after the addition thereto of the layer of aluminum flakes **20**; and photographed portion C depicts the completed aluminized fabric after the further addition of a highly reflective film of aluminum **30**. All three specimens A–C of FIGURE 1 were photographed simultaneously with the axis of camera lens perpendicular to the fabrics using ten 200 watt light bulbs spaced 2½ feet from the right side of the fabrics at a 45 degree angle with respect thereto. It must be understood that the limitations of black and white photography prevent an accurate photographic reproduction of the reflective nature of the layer **20** and film **30**. However, as can be observed from the photographs, the reflectivity of the fabrics is somewhat increased upon the addition of the layer of the discrete aluminum flakes **20** (portion B of FIGURE 1) as evidenced by the highlights, and such reflectivity is then substantially increased upon the addition of the highly reflective aluminum film **30** (portion C of FIGURE 1) as evidenced by the virtual totality of highlighted areas.

FIGURE 2 is a schematic representation of the fabrics of FIGURE 1 greatly enlarged to illustrate the nature of the layer **20**, and the nature of the film **30** with portions A–C corresponding to the similarly designated portions in FIGURE 1.

In the preferred embodiment of the invention, the fabric **10** is a woven "asbestos-base" fabric—that is, a woven fabric containing at least 50% by weight asbestos fibers which will, of course, possess good flame-retardance properties. Further, in order to further enhance the flame-retardance qualities of the product of the present invention, I preferably subject the fabric **10** to a flame-proofing treatment prior to the addition of the layer **20**, as, for example, in accordance with the teachings of United States Patent No. 2,948,641, issued Aug. 9, 1960.

Referring now to FIGURE 3, I show there a representative flow chart of the prefered method of forming aluminized fabrics in accordance with the present invention. As previously stated, the fabric **10** is preferably first coated with a flame-retarding composition and is thereafter allowed to dry. Such flame-proofing treatment not only enhances the flame-proof qualities of the final product, but also, when performed in accordance with the above-mentioned patent, tends to fill the interstices of the fabric thereby presenting a much smoother surface to the fabric **10** for reception of the subsequent layer **20** and film **30**.

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The layer of the discrete aluminum flakes **20** is next applied to a face of the fabric **10** in such a manner that such flakes will be distinctly exposed on the surface thereof. Preferably, this is accomplished by first dispersing flake aluminum in a resinous binder matrix and thereafter applying a thin coat of such aluminum flake-resin mixture to the fabric surface with a conventional roller-coater type coating machine, schematically illustrated in FIGURE 4 and comprising an open container **22** adapted to hold the coating material, a rotatable applicator roll **23** for supplying the coating material to the surface of the fabric **10**, and a pressure roll **24** for maintaining the fabric **10** in engagement with the applicator roll **23**. Of course, other coating techniques could be employed, such as knife-coating, spraying, or the like.

The physical properties of flake aluminum are such that the individual flakes will not "wet out" to any appreciable degree in the resinous binder matrix. Thus, the flakes will tend to move to the surface of the coating of the aluminum flake-resin mixture and be distinctly disposed thereon while being firmly embedded to some degree in the resinous binder which, in turn, firmly bonds to the surface of the fabric **10**.

As is well known, the particle size of aluminum flakes is directly related to the degree of reflectivity presented by a layer of such flakes and, generally, an increase in flake size results in an increase in luster or reflectivity. Preferably, the finely divided aluminum flakes used in performing the present invention are of such small particle size that 90% will pass through a 325 mesh screen, thus presenting a somewhat dull luster to the layer **20**.

In formulating the aluminum flake-resin binder mixture, the various resins or combinations thereof can be used, such as acrylic resins, vinylidene chloride resins, chloro-butadiene polymer resins, and chloro-butyl resins. Further, I prefer to add a small amount of a flame-retarding compound, such as antimony trioxide, to the mixture to give flame-retardance properties to the resin component, and a small amount of mica or other inert material to impart a smoothness of texture to the coating.

Some specific, non-limiting formulations suitable for the aluminum flake-resin binder mixture are as follows:

EXAMPLE NO. 1

	Parts by weight
Water	50
Deceresol (American Cyanamid) (wetting agent)	1
Aluminum powder (325 mesh)	10
Daran (vinylidene chloride)	25
CL–301 (Rohm & Haas) (acrylic resin)	75
Mica (300 mesh)	4
Sb_2O_3 (flame retardant)	5

EXAMPLE NO. 2

	Parts by weight
Water	50
Deceresol (American Cyanamid) (wetting agent)	1
Aluminum powder (325 mesh)	10
Geon 652 (Goodyear) (vinylidene chloride)	70
HA–8 (Rohm & Haas) (acrylic resin)	30
Mica (300 mesh)	5
Chloro wax (diamond alkali) (flame retardant)	4

EXAMPLE NO. 3

	Parts by weight
Water	50
Aeresol (American Cyanamid) (wetting agent)	1
Aluminum powder (325 mesh)	10
HA–8 (Rohm & Haas) (acrylic resin) (high tack)	75
HA–12 (Rohm & Haas) (acrylic resin) (low tack)	25
Mica (300 mesh)	8
Oncor 23A (National Lead) (Sb_2O_3) (flame retardant)	15

EXAMPLE NO. 4

	Parts by weight
Water	50
Wicatex 20 (Wica) (wetting agent)	1
Aluminum powder (325 mesh)	10
Geon 576 (Goodyear) (vinyl chloride)	35
Wicacril T. B. (Wica) (high tack acrylic resin)	65
Mica (300 mesh)	4
NH_4Cl (anti tackifier)	0.25
Oncor 23A (National Lead) (Sb_2O_3) (flame retardant)	5

EXAMPLE NO. 5

	Parts by weight
Chloro butyl rubber (40% in aqueous emulsion)	100
(40% in aqueous emulsion)	100
Aluminum powder (325 mesh)	10
Mica (300 mesh)	4
Chloro wax (diamond alkali) (flame retardant)	4
Water	50

After applying the aluminum flake-resin mixture, the thus coated fabric is subjected to relatively low heat to dry the resinous binder, and then to a higher temperature sufficient to cure the resin. Care must be taken to drive off all of the volatile constituents of the resinous binder during this drying period and before curing to prevent blistering of the resin.

Having been cured, the resinous binder forms an intermediate layer **21** (FIGURE 2), serving to adhesively bond the layer of exposed discrete aluminum flakes **20** to the face of the fabric **10**, and the thus coated fabric has an appearance such as that depicted by portion B of FIGURE 1 and schematically illustrated by portion B of FIGURE 2.

Next, the highly reflective film of aluminum **30** is applied to the exposed layer of aluminum flakes **20**. As shown in the flow chart (FIGURE 3), this can be accomplished in at least three different ways:

(1) By subliming vaporized aluminum onto the layer **20**. A schematic illustration of a vacuum chamber **41** suitable for such purpose is shown in FIGURE 5 wherein the aluminum flake layer **20** bonded to the fabric **10** is exposed to an aluminum source **40** positioned within a vacuum chamber **41**.

(2) By applying aluminum foil onto the layer **20**. A schematic illustration of such an operation is shown in FIGURE 6 wherein aluminum foil **30** is brought into pressure contact with the aluminum flake layer **20** on the fabric **10**.

(3) By first subliming vaporized aluminum onto a suitable carrier substrate **31**, such as polyethylene sheet material, to form a releasable, highly reflective aluminum film **30** thereon. The film **30** is then transferred from the carrier substrate **31** to the aluminum flake layer **20** of the fabric **10**. A schematic illustration of such method is shown in FIGURE 7 wherein a carrier film **31** is exposed to an aluminum source **40** positioned in a vacuum chamber **41** to form the aluminum film **30** on the so-exposed surface of the carrier **31**. Upon leaving the chamber **41**, the aluminum film **30** so deposited on the carrier **31** is brought into pressure contact with and transferred to the aluminum flake layer **20** of the fabric **10** with the carrier **31** being split away therefrom, as shown.

Preferably, after applying the aluminum film **30** in each instance, the fabric is subjected to a calendering operation, as by passing the same through the nip of calender rolls **50, 51** (FIGURES 5–7) to insure the bond between the layer **20** and the film **30**.

I have found that there is a natural attraction between the relatively dull-luster layer of aluminum flakes **20** and the highly reflective film of aluminum **30**, and though the nature of the two differs vastly, they form a tight bond between themselves and, in effect, become as one, except that the film **30** retains its high reflectivity. I believe that the tightness of this bond is partially explainable from

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the fact that the layer of aluminum flakes **20** presents a slightly roughened surface with small interstices between individual flakes, thereby providing initial anchoring points for the subsequently applied aluminum film **30**. Since the aluminum film **30** partially penetrates into the layer of aluminum flakes **20**, the cohesive bonding between the two is greatly increased by virtue of this increased surface-to-surface contact between the metals of the two.

The degree of reflectivity of the aluminized fabric produced in accordance with the present invention will, of course, vary with the texture of the fabric **10**, as well as the reflectivity of the aluminum film **30**. Likewise, the degree of reflectance of the underlying aluminum flake layer **20** will vary with the particle size of aluminum used. However, I have found that the best results are obtained when the aluminum film **30** has a percentage reflectivity of at least 75% and the aluminum flake layer **20** has a percentage reflectivity of about 50% for a given source of light, as measured with the photographic light meter.

Although the relative amounts of the respective constituents of the aluminized fabric of the invention will vary depending upon the end use requirements of flexability, texture, etc., I have found that excellent results are generally obtained when (1) the fabric **10** is a flame-proofed asbestos-base fabric constituting about 77% to 83% of the total weight of the product, (2) the aluminum flake layer **20** is composed of finely divided or fine mesh aluminum flakes constituting about 0.8% to 1.9% of the total weight of the product, and (3) the aluminum film **30** has high reflectivity on the order of 75% or more and constitutes about 0.4% to 1.8% of the total weight of the product. As such, these aluminized fabrics are flame-proof, they resist molten metal splash, and they have high tensile strength and excellent abrasion resistance. Further, with respect to the abrasion resistance, even after the highly reflective film of aluminum **30** wears off, the underlying aluminum flake layer is still present to provide heat resistance and some degree of heat reflectance.

In the drawings and specification there has been set forth a preferred embodiment of the invention and, although specific terms are employed, they are used in a generic and descriptive sense only, and not for purposes of limitation, the scope of the invention defined in the claims.

I claim:

1. An aluminized fabric having high heat resistance and high heat reflectance comprising:
- (a) a base fabric,
- (b) a thin layer of discrete, finely divided, aluminum flakes bonded to a face of said base fabric with a resinous binder with the flakes of aluminum being exposed and forming a roughened surface substantially overlying the resinous binder, and
- (c) a substantially continuous, highly reflective surface film of aluminum overlying and cohesively bonded with said layer of discrete aluminum flakes, whereby the layer of aluminum flakes serves to firmly anchor the film of aluminum thereto while also serving to provide high heat resistance to the fabric, and the film of aluminum serves to provide high heat reflectance to the fabric.

2. An aluminized fabric according to claim **1** in which said base fabric is an asbestos-base fabric.

3. An aluminized fabric according to claim **2** in which said asbestos-base fabric is coated with a flame-retarding composition whereby said aluminized fabric is rendered substantially flame-proof.

4. An aluminized fabric according to claim **1** wherein about 90% of said discrete, finely divided, aluminum flakes are of a particle size such that they will pass through a 325 mesh screen.

5. An aluminized fabric according to claim **1** wherein:
- (a) said base fabric is an asbestos-base fabric coated with a flame-retarding composition,
- (b) about 90% of said discrete, finely divided, aluminum flakes are of a particle size such that they will pass through a 325 mesh screen,
- (c) said resinous binder is selected from the group consisting of acrylic, vinylidine chloride, chloro-butadiene polymer and chloro-butyl resins, and
- (d) a flame-retarding compound is admixed with said resinous binder.

6. A method of forming an aluminized fabric having high heat resistance and high heat reflectance comprising the steps of:
- (a) coating a face of a base fabric with finely divided, aluminum flakes dispersed in a resinous binder matrix to form a roughened surface layer of distinctly exposed, discrete aluminum flakes anchored in the resinous binder,
- (b) drying the resinous binder,
- (c) curing the resinous binder to bond the layer of distinctly exposed aluminum flakes to the fabric, and
- (d) cohesively bonding a substantially continuous, highly reflective surface film of aluminum with the layer of exposed discrete aluminum flakes, whereby the layer of aluminum flakes serves to firmly anchor the film of aluminum thereto and also serves to provide high heat resistance to the fabric, and the film of aluminum serves to provide high heat reflectance to the fabric.

7. A method according to claim **6** wherein the highly reflective surface film of aluminum is deposited onto the layer of exposed discrete aluminum flakes by sublimation of vaporized aluminum.

8. A method according to claim **6** wherein the highly reflective surface film of aluminum is first deposited on a transfer film by sublimation of vaporized aluminum and then placed into direct contact with and transferred to the layer of exposed discrete aluminum flakes.

9. A method according to claim **6** wherein said base fabric is an asbestos-base fabric and which includes the step of first coating the base fabric with a flame-retarding composition to thereby render the same substantially flame-proof.

10. A method according to claim **6** which includes the further step of calendering the aluminized fabric to strengthen the bond between the surface film of aluminum and the layer of exposed discrete aluminum flakes.

11. A method according to claim **6** wherein said base fabric is an asbestos-base fabric and which includes the further steps of:
- (a) first coating the base fabric with a flame-retarding composition to render the same substantially flame-proof, and
- (b) calendering the aluminized fabric to strengthen the bond between the surface film of aluminum and the layer of exposed discrete aluminum flakes.

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M. A. LITMAN, Assistant Examiner

U.S. Cl. X.R.

117—31, 71, 170; 156—62.2, 233, 276; 161—93, 403

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