

May 15, 1962

G. E. COLLINS ET AL

3,034,940

METALLIZED FABRICS

Filed Nov. 29, 1957

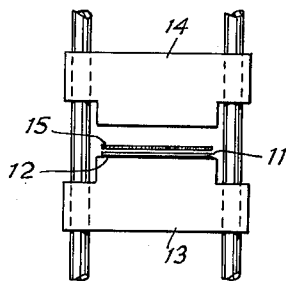


FIG. 1

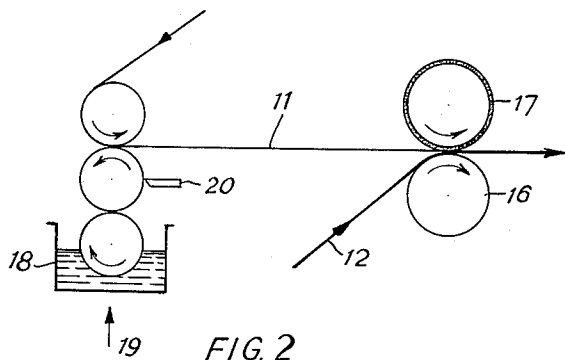


FIG. 2

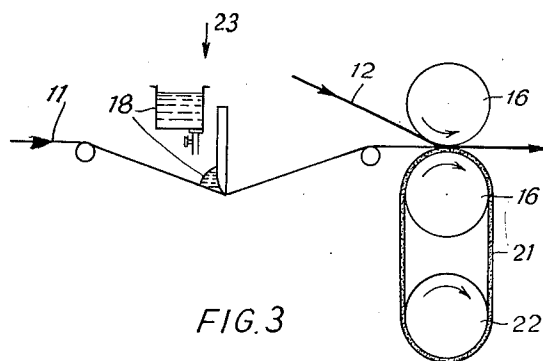


FIG. 3

INVENTORS:

GEORGE ERNEST COLLINS

WILLIAM HOWARD REES

by *Frederick Britenfeld*
Attorney

1

3,034,940

METALLIZED FABRICS

George Ernest Collins, Prestbury, near Macclesfield, and William Howard Rees, Cheadle Hulme, England, assignors to The British Cotton Industry Research Association, Didsbury, Manchester, England, a British association of Shirley Institute

Filed Nov. 29, 1957, Ser. No. 699,847

Claims priority, application Great Britain Nov. 30, 1956
10 Claims. (Cl. 154—44)

This invention concerns metallized fabrics.

Metallized fabrics are known, and have been used for various purposes. For example metallized fabrics have been made by securing a continuous metal foil to a textile fabric by means of a suitable adhesive. Metallized fabrics have also been made by spraying textile fabrics with flaked metal particles suspended in a solution of a film-forming polymer. It is also known how to produce a metallized textile fabric by evaporating metal on to the cloth in vacuo. All these prior fabrics and proposals however suffer from disadvantages. One use for metallized fabrics is to afford protection for persons subject to substantial thermal radiation, and whilst a continuous metal foil, for example of aluminium, has a very high reflectivity for such radiation, it is not porous and seriously interferes with the evaporation of water from the skin of the wearer. For this reason clothing made from such metallized fabrics is not satisfactory as a protection from excessive thermal radiation if worn for other than very short periods. Again, metallized fabrics made by spraying textile fabrics with flaked aluminium particles suspended in a film-forming polymer have been found to have an emissivity for long-wave infra-red radiation which is too high for many purposes. It does not appear that coatings of metal evaporated on to hydrophilic textile fibres are stable to moisture.

The primary object of the present invention is to provide a metallized fabric (textile or otherwise) which has a low surface emissivity and a high reflectivity in respect of thermal radiation, but which is porous. A further object of the invention is to provide a metallized fabric (textile or otherwise) which has improved optical and/or electrical properties.

According to the present invention a porous metallized fabric consists of a porous basic fabric composed of strands defining an inherent multiplicity of interstices between them (the interstices being of sufficient size to impart appreciable porosity to the fabric), and having, adhering to at least one surface thereof, a thin sheet of metal which conforms to the surface contours of the basic fabric, and is ruptured at a sufficient number of the interstices of the basic fabric to give the required degree of porosity, the ruptured parts of the metal sheet extending inwardly of the respective interstices to conform to the wall contours of the latter.

Also in accordance with the present invention a porous basic fabric is provided with a metallized surface by causing to adhere to at least one surface thereof a thin sheet of metal, the sheet being laid on the surface of the fabric, and pressed into place by the direct application thereto of a resiliently deformable material with a pressure which is sufficient to cause the sheet to conform to the surface contours of the fabric, to rupture at a sufficient number of the interstices of the fabric to give

2

the required degree of porosity, and to cause the ruptured parts of the sheet to extend inwardly of the respective interstices to conform to the wall contours of the latter.

It will nearly always be desirable to use an adhesive between the fabric and the sheet, although in some cases (e.g. where the metallized fabric is not to be subjected to hard use, and the sheet is ruptured at substantially all the fabric interstices) sufficient adhesion is obtained without the use of an adhesive.

It will be appreciated that the basic fabric will frequently be a fabric made from a textile material such as cotton, synthetic yarn or glass yarn for example. A basic fabric consisting of a metal, for example, copper gauze is, however, within the scope of the invention. The basic fabric may be in woven or unwoven, knitted, netted or likewise fabricated form. The degree of porosity of the basic fabric will normally be reflected in the final product, although the pressure applied to the metal sheet may be varied to produce varying degrees of porosity in the metallized fabric.

The qualities required in the metal sheet will depend on the final use for the metallized fabric. Normally, a metal which does not deteriorate seriously or rapidly under normal atmospheric conditions is desirable. Gold, silver, aluminium, tin and copper all suggest themselves, and it has been found that aluminium is very suitable for many purposes. It is commercially available in thicknesses of .00025 of an inch upwards, and has a very low emissivity for thermal radiation. It is also light in weight, and reasonable in cost.

The thickness of the metal sheet should be kept as small as possible to achieve suppleness and lightness of the coated fabric and for ease of rupture. We have found that a thickness of .00025 of an inch is satisfactory but we do not exclude thicknesses greater or less than this.

Although the metal sheet can be caused to adhere to the fabric by the use of pressure alone, it is preferable to use an adhesive. It is essential when the metallized fabric is intended to be used as a barrier to thermal radiation that the layer of adhesive should not spread to the outer surface of the metal as this would cause a substantial increase in emissivity.

Rubber is a suitable medium for applying the pressure. Rubbers of a wide range of hardness can be used, but moderately soft vulcanised rubber is preferable and convenient. It is usually necessary to use a thin sheet in order that lateral spreading may be minimized and that the pressure required is not excessive. About one sixteenth of an inch is preferred, but the thickness may be as much as about one eighth of an inch or as little as about one sixty-fourth of an inch. Sponge rubber of greater thicknesses than these could be used but in this case it would almost certainly be necessary to take positive steps to prevent lateral spreading in use. The life of a sponge rubber pressure-applying member would not, however, be expected to be as long as that of a pressure-applying member of moderately soft vulcanized rubber.

Three methods of metallizing fabrics according to our process will now be described, by way of example, with reference to the accompanying drawings in which—

FIG. 1 is a diagram showing one way of producing a porous metallized fabric in accordance with this invention;

FIG. 2 is a diagram showing an alternative method; and

FIG. 3 is a diagram illustrating a further alternative.

In FIG. 1, a sheet of thin aluminium foil 11, previously coated on one face by known methods with a thin layer of adhesive is brought into contact with the fabric 12 which is supported on the lower platen 13 of a flat press. Pressure is then applied by the upper platen 14 through the medium of a sheet of moderately soft rubber 15, e.g. 34 B.S. degrees hardness of thickness about one sixteenth of an inch. Alternatively, the pressure may be applied by the lower platen 13. If desired, the lower platen may be heated (for instance by electrical heating elements) to assist in fixing the adhesive. After processing, the coated fabric may be subjected to any drying or other after treatment necessary to fix the adhesive.

In the second method (see FIG. 2), use is made of a calender or mangle comprising a hard bowl or roller 16 working against a bowl or roller 17 covered with moderately soft rubber, e.g. 34 B.S. degrees hardness of thickness about one sixteenth of an inch. A continuous sheet of thin aluminium foil 11 is coated on one face with a thin layer of the adhesive 18 by being drawn through the roll-coater mechanism 19 with doctor knife attachment 20 and is then fed into the calender or mangle together with the fabric to be coated 12 which is also in continuous length. The uncoated face of the aluminium foil is in contact with the rubber-coated bowl or roller 17 of the calender or mangle, the coated face of the foil is in contact with one face of the fabric, and the other face of the fabric is in contact with the hard bowl or roller 16 of the calender or mangle. If desired, the hard bowl or roller of the calender or mangle may be heated (for example by feeding steam thereto) to assist in fixing the adhesive. After passing through the calender or mangle, the coated fabric may be subjected to any drying or other after treatment necessary to fix the adhesive.

In the third method (see FIG. 3), use is made of a calender or mangle comprising two hard bowls or rollers 16 working against each other. An endless belt 21 of moderately soft rubber, e.g. 34 B.S. degrees hardness of thickness about one thirty second of an inch passes over one of the hard bowls 16 so that the rubber belt passes through the nip in the calender or mangle, the rubber belt being tensioned by a third hard bowl 22. A continuous sheet of thin aluminium foil 11 is coated on one face with a thin layer of the adhesive 18 by means of the floating knife coater assembly 23 and is then fed into the calender or mangle together with the fabric to be coated 12 which is also in continuous length. The uncoated face of the aluminium foil is in contact with the endless belt of rubber 21, the coated face of the foil is in contact with one face of the fabric, and the other face of the fabric is in contact with the uncovered hard bowl or roller of the calender or mangle. If desired, the hard bowl or roller of the calender or mangle may be heated, for example by steam to assist in fixing the adhesive. After passing through the calender or mangle, the coated fabric may be subjected to any drying or other after treatment necessary to fix the adhesive.

If desired, the roller-coater mechanism 19 of FIG. 2 may be substituted for the floating knife coater assembly 23 of FIG. 3, or vice-versa.

Three examples of coated fabrics produced by these methods are as follows:

(1) Plain weave continuous filament viscose fabric weighing two-and-a-half ounces per square yard with seventy-two ends per inch of 150 denier and fifty-four picks per inch of 150 denier coated with aluminium foil .00025 inch thick.

(2) Plain weave cotton fabric weighing three ounces per square yard with one hundred and six ends per inch of 50's counts and fifty-five picks per inch of 50's counts coated with aluminium foil .00025 inch thick.

(3) Copper gauze of forty threads per lineal inch, 30's

S.W.G. coated with aluminum foil .00025 inch thick.

Samples of these fabrics were inspected microscopically and in all cases the foil was observed to be neatly pressed onto the basic fabric and was firmly adhered thereto, conforming closely to the surface contours of the basic fabric, and ruptured at a great number of the interstices, the ruptured part of the metal sheet conforming to the contours of the respective interstices. In the case of the closely woven fabric the number of ruptures was less than in the case of the more openly woven viscose fabric. In the case of the copper gauze the foil was ruptured at each interstice.

An indication of the qualities of the coated and uncoated viscose fabric is given in the following table:

	Viscose Plain Weave Fabric	Aluminised Viscose Plain Weave Fabric
Body-temperature Emissivity (percent)...	98	14
Solar Protection Value (percent).....	50	73
Weight (ozs./sq. yd).....	2.5	3.0
Thickness (inches) under 1 lb./sq. in.	0.007	0.009
Bonding length (cms.).....	2.25	3.58
Flexural rigidity (mgm. cm.).....	95	432
Air Resistance (cc. per sq. cm. per sec. per cm. of water)-1.....	0.014	0.258
Water Vapor Resistance (R.H./gm. metre -2 sec.-1).....	0.6×10^2	14.3×10^2

The body-temperature emissivity is that from the fabric maintained at 33° C.

The solar protection value is the fractional reduction in rate of rise of temperature of a black kata thermometer covered with the fabric compared with that of an uncovered black kata thermometer when exposed to sunlight.

It will be seen that:

(1) A large reduction in the body-temperature emissivity of the fabric has been achieved (from 98% to 14%). Fabrics coated with aluminium particles in a plastic medium show emissivities of about 80%.

(2) The solar protection value of the white viscose fabric has been substantially increased from 50% to 73% by aluminizing. A black cotton fabric of approximately the same thickness was found to have a solar protection value of only 20%. Fabrics coated with aluminium particles in a plastic medium show solar protection values of about 40%.

(3) Both the weight and the thickness of the fabric have been increased by aluminizing, but the magnitude of these increases is not large.

(4) The aluminized fabric does not drape as well as the original fabric and is stiffer to the fingers. It is not unduly stiff however and would be acceptable in this respect as a lining material.

(5) The air resistance and the water vapour resistance of the viscose fabric are increased by aluminizing, but the coated fabric is not impermeable to either air or water vapour. The air resistance of the aluminized fabric is about equal to that of a cotton gaberdine and its water vapour resistance is roughly equal to that of a wool overcoat fabric. (The unruptured metal foil is, of course, impermeable to air and to water vapour.)

Such a fabric, having a low emissivity, can be used in clothing or like protective material to reduce heat losses from warm bodies to cold air or to protect cool bodies from radiation from high temperature sources. Because of the ruptures in the metal coating at the fabric interstices, air and water vapour can pass through from one side to the other and there is not, therefore, the discomfort which is inherent in garments made from fabrics having an impervious layer of metal foil. It will be appreciated that the relative effect of radiation, convection

and conduction on heat transfer through a garment can vary according to the constructions of the garment. In many cases it will be desirable to use the metallized fabric as a spaced lining, any spacing means used being of as open a nature as possible. Netting, of suitable mesh and thickness may be used as spacing means.

Fabrics made according to the invention may also be used when particular visual reflection characteristics are required. The following table gives comparative surface brightness measurements for metallized balloon fabric, filter paper, and the samples described above, made at various angles of viewing, θ , from the normal incident beam of light.

θ	Brightness (foot-lamberts)				
	Metallised Balloon Filter	Fabric paper	Aluminium foil pressed on to threads of		
			Viscose fabric	Cotton fabric	Copper gauze
0°	52.5	28.2	34.7	66.1	15.1
22½°	26.3	22.4	36.3	46.8	11.5
45°	10.2	20.4	36.3	20.0	11.8
60°			12.0	8.9	24.6

It will be seen that:

(1) With the metallized balloon fabric, brightness falls off rapidly with increasing angle of reflection. This is typical of a smooth reflecting surface.

(2) Filter paper, having a matt surface, scatters the light and brightness falls off gradually with increasing angle of viewing.

(3) The aluminium coated viscose fabric reflects light effectively and evenly over a wide angle and at a high level of brightness.

(4) The aluminium foil is not as effectively broken up by the cotton fabric as by the more open fabric. Thus, although at narrow angles its brightness exceeds that of the aluminized viscose fabric, it becomes progressively worse as the angle widens beyond about 30°.

(5) The very open copper gauze is brightest at very large angles of viewing owing to the larger apparent cover at these angles.

It is concluded that for a narrow auditorium, the aluminium coated close weave cotton fabric makes a very effective screen for projected light images and that for a wide auditorium the aluminium coated viscose fabric of more open weave is very effective. It is evident that a wide range of optical reflection characteristics can be attained by appropriate choice of basic fabrics. Furthermore incident light was not depolarized so that such screens are suitable for three dimensional projected images using polarized light. It will be appreciated that in metallized fabric intended for optical uses, the metal constituent should be as pure as possible to prevent tarnishing and the like.

It follows that since the aluminium coated fabric according to the invention possesses a high reflectivity for solar radiation and a low emissivity for long wave radiation, then its heat insulating properties for both short and long wave radiations must be good, and it will be expected to be a good reflector of radar waves.

It may also be mentioned that the coatings of the samples described above were good electrical conductors.

Metallized fabrics of the type described and claimed herein have, or can be made so as to have, other advantageous properties. For example, the rayon based fabric described can show an attractive lustre which makes it suitable for decorative purposes in fashion goods, furnishings, and fancy goods. Again, a metallized fabric

with a suitable basic fabric such as a basic fabric with an "up and down" weave, when illuminated from a small bright source or by direct sunlight, can show an attractive chromatic lustre. Theatrical effects can thus, for example, be obtained. In another extension of the invention, when the heat-reflective properties are not required, the metal sheet can be coated on the outer face with a thin layer of lacquer or the like, which may be clear, opaque, coloured, patterned or printed to give a desired effect.

The term "strand" as used in the appended claims is intended to include within its scope the component strands of a textile fabric whether made from staple fibre or from one or more continuous filaments.

We claim:

1. A porous metallized fabric consisting of a porous basic textile fabric and an adherent thin sheet of metal, the basic fabric being composed of strands defining an inherent multiplicity of interstices between them, the interstices being of sufficient size to impart appreciable porosity to the fabric, the metal sheet being ruptured only in regions directly overlying interstices, the ruptured parts of the metal extending into their respective interstices in form-fitting relation to the walls thereof.

2. A porous metallized fabric as defined in claim 1 there being a ruptured metal sheet of the character described on each face of said fabric.

3. A porous metallized fabric as claimed in claim 2 wherein the basic fabric is selected from the class consisting of woven and knitted textiles.

4. A porous metallized fabric as claimed in claim 1 wherein the basic fabric is selected from the class consisting of woven and knitted textiles.

5. A method of producing a porous metallized fabric which consists in applying a thin sheet of metal to a basic fabric composed of strands defining an inherent multiplicity of interstices between them, and pressing said metal into adherent relation to the fabric by the direct application thereto of a resiliently deformable material with a pressure which is sufficient to cause the sheet to conform to the surface contours of the fabric, to rupture only at a sufficient number of the interstices of the fabric to give the required degree of porosity, and to cause the ruptured parts of the sheet to extend into their respective interstices in form-fitting relationship relative to the walls thereof.

6. A method as claimed in claim 5 in which an adhesive is applied to the surface of the basic fabric before the metal sheet is applied thereto.

7. A method as claimed in claim 6 which includes the further step of applying heat to assist in fixing the adhesive.

8. In an article of clothing a porous heat insulating layer comprising a porous basic textile fabric and an adherent thin sheet of metal, the basic fabric being composed of strands defining an inherent multiplicity of interstices between them, the interstices being of sufficient size to impart appreciable porosity to the fabric, the metal sheet being ruptured only in regions directly overlying interstices, the ruptured parts of the metal extending into their respective interstices in form-fitting relation to the walls thereof.

9. In an article of clothing the porous heat insulating layer defined in claim 8, said layer being an inner lining and there being an outer layer and a reticulate intermediate spacing layer, the latter being of such mesh and thickness as to reduce heat transference by conduction and convection.

10. In a heat insulating screen a porous heat insulating layer comprising a porous basic textile fabric and an adherent thin sheet of metal, the basic fabric being composed of strands defining an inherent multiplicity of interstices between them, the interstices being of sufficient size to impart appreciable porosity to the fabric, the metal sheet being ruptured only in regions directly overlying

interstices, the ruptured parts of the metal extending into their respective interstices in form-fitting relation to the walls thereof.

References Cited in the file of this patent

UNITED STATES PATENTS

631,366	Golding	Aug. 22, 1899	
1,067,991	Kroger	July 22, 1913	
2,051,373	Fitzgerald	Aug. 18, 1936	
2,067,086	Hoffman	Jan. 5, 1937	10
2,332,848	Grabec	Oct. 26, 1943	

5

2,359,250
2,482,981
2,607,712
2,703,772
2,704,730
2,711,380
2,726,977

10

220,913
446,943
1,018,330

Schmied	Sept. 26, 1944
Kamrass	Sept. 27, 1949
Sturken	Aug. 19, 1952
Keithly	Mar. 8, 1955
Glatt	Mar. 22, 1955
Pintell	June 21, 1955
See et al.	Dec. 13, 1955

FOREIGN PATENTS

Great Britain	Aug. 28, 1924
Great Britain	May 8, 1936
France	Oct. 15, 1952