Feb. 9, 1954 A. F. SCHRAMM, JR 2,668,787

METHOD OF MAKING A BONDED PERMEABLE ARTICLE

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Fig. 1

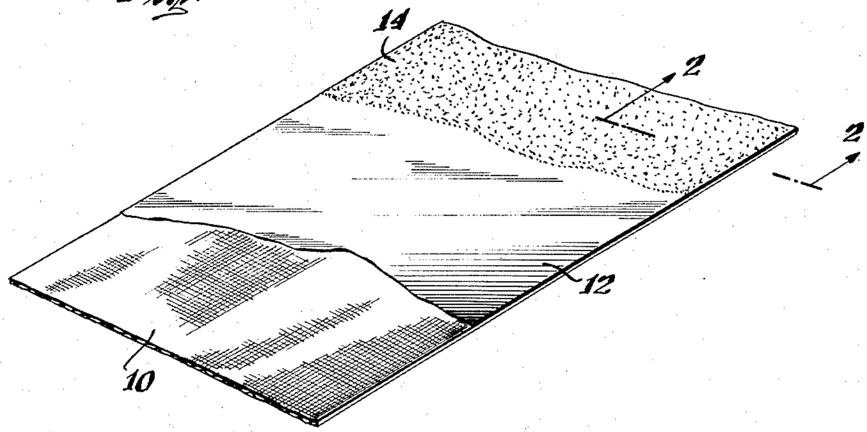


Fig. 2

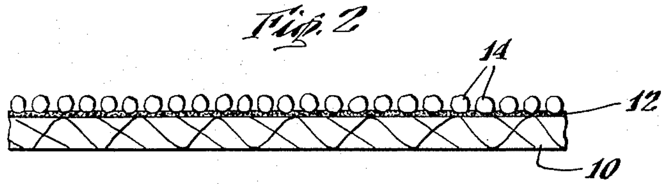


Fig. 3

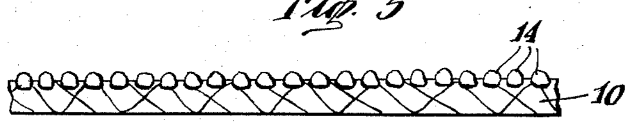
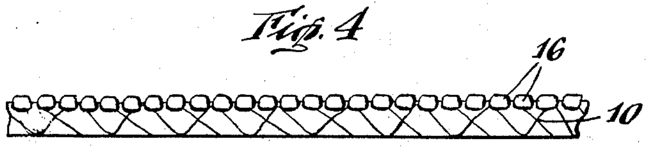


Fig. 4



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METHOD OF MAKING A BONDED PERMEABLE ARTICLE

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Fig. 5

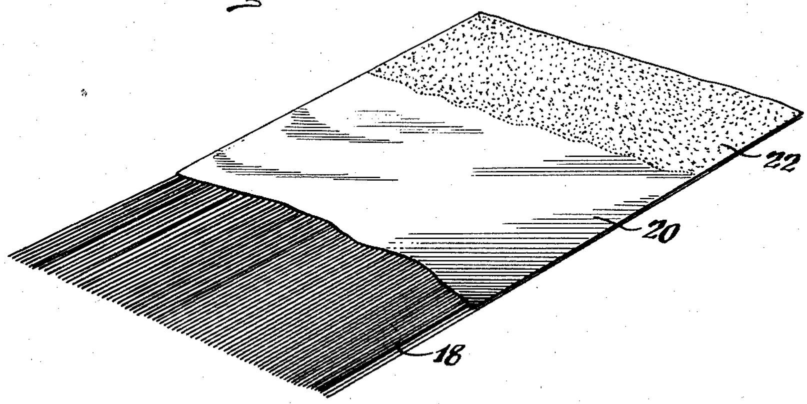


Fig. 6

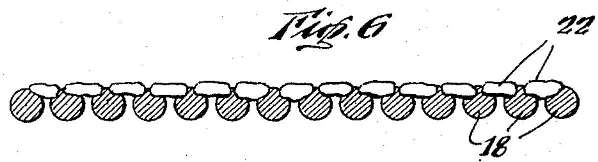
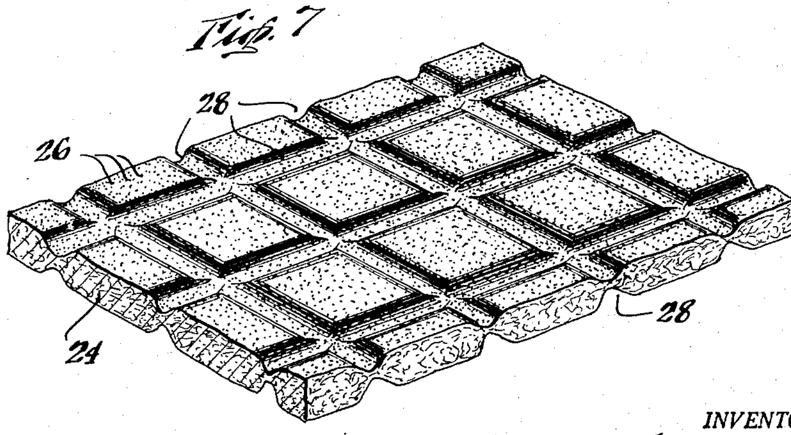


Fig. 7



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METHOD OF MAKING A BONDED PERMEABLE ARTICLE

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6 Claims. (Cl. 154—92)

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This invention relates to coated sheeting and the method of making it. The invention relates more particularly to the application of spaced particles of thermoplastic material to a textile fabric or the like, with simplification and shortening of the treatment required to produce an air and moisture permeable coating.

Interest has existed for a long time in the application of plastic coating material to fabrics, as in the making of material for shoes, collars, and other clothing that require breathing properties permitting the passage of air and moisture through the coated sheet material. I have previously developed a method in which a fabric is wet through with water before the application of the plastic particles. The water decreases the penetration and diffusion of the particles during the subsequent warming step. The water serves in fact to prevent the passage of plastic particles through the cloth and thus preserves in one face of the fabric the original texture and appearance.

When this pretreatment with water is used, it is necessary finally to subject the cloth containing the water and the applied particles to an elevated temperature for a period of time sufficiently long not only to soften the plastic particles but also to evaporate the considerable content of water in the fabric.

I have now discovered a method of eliminating the holding period required for the evaporation of the water in the previous method. I now confine the pretreating water to an extremely thin film over the face of the fabric to be coated. In this manner I prevent actual penetration of the water through the fabric. As a result, I decrease the water to be evaporated to about 10% or so of the water required in my earlier method in which the water penetrated the fabric. I decrease correspondingly the time required for the subsequent drying in the heating step, the exact percentage decrease in the proportion of water and drying time varying with the thickness of the fabric treated. The percentage decrease in water content and subsequent drying time over the previous method is greater the thicker the fabric selected for the treatment.

Briefly stated, my invention comprises spreading over a permeable sheet an aqueous gel, of such high viscosity as to be non-penetrating through the sheet, as a thin film over the face only of the sheet, applying fine free-flowing solid particles of thermoplastic material over the wet film of gel, removing those of the particles not directly in contact with the said film, and then warming the product until the water of the film is evaporated, until discontinuity develops in the film due to the evaporation, and finally until the thermoplastic particles are softened by the heat so that they become fluid and penetrate through the discontinuities of the now ruptured film into surface portions of the permeable sheet originally used, the term "fluid" meaning flowable as a liquid or semi-liquid mass. In the preferred embodiment, the resulting coated sheet is subjected to a hot ironing step. This improves the anchorage of the thermoplastic particles in the face of the cloth and smooths or flattens somewhat the exposed surface of the particles.

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The invention will be illustrated by description in connection with the attached drawings to which reference is made.

Fig. 1 is a perspective view of my product in the development or manufacturing stage with parts broken away for clearness of illustration.

Fig. 2 is a sectional view on line 2—2 of Fig. 1.

Fig. 3 is a sectional view of the product subsequent to the warming step.

Fig. 4 is a similar sectional view of the product after being subjected to pressure plates or rolls.

Fig. 5 is a perspective view broken away for the purpose of illustration of a modification of the invention.

Fig. 6 is a sectional view of an assembly of parallel threads bonded according to the invention.

Fig. 7 is a perspective view of a quilted form of my product.

The permeable sheet material selected for illustration is a woven textile fabric 10 in Figs. 1-4, an assembly 18 of warp threads only in Figs. 5 and 6, and a felt 24 in Fig. 7. The applied aqueous film or gel is shown at 12 and at 20 and the thermoplastic particles at 14, 16, 22, and 26, the scale varying in the several drawings and the drawings being in part diagrammatic.

The discontinuous residue of the gel left after the evaporation of water is not shown as the residue is practically invisible.

The various elements of the structure are exaggerated in certain dimensions in the drawings, the extent of the magnification being particularly large in the case of the size or spacing of the particles shown at 14, 16, 22, and 26 and the thickness of the film 12.

The thermoplastic particles as used are about 20 to 200 mesh in average size.

The film 12 is so thin as to be invisible over the surface of the fabric except as wetness affects the appearance of the material. It is considered that on a reasonably finely woven fabric the film thickness of the wet gel shown at 12 will average not more than about .001 inch, the film increasing in average thickness with coarseness of the weave affording low spots into which the gel may be forced by the method of application to be described.

The permeable sheet material selected for coating is one that is highly absorbent and suitably is a textile fabric, paper, closely spaced unwoven parallel threads, felt, or the like. Parallel threads are used to advantage in the form of warp threads without any woof. Such an assembly of warp threads bonded by my particles 24, as shown in Fig. 5 is suitable for ribbon stock. The felt depressed at intervals as at the troughs 28, in the manner of quilting and bonded by the thermoplastic particles is particularly adapted for use in snow suits and other forms of warm clothing.

The material of the thermoplastic particles is solid and free flowing at room temperature, stable on aging, without deteriorating effect upon the organic fibers to which it is to be applied, and softenable to flowable (fluid) condition at temperatures within the range 300° to 400° F. but preferably not at temperatures as low as 212° F. The particles may be pigmented or mixed with dyes in conventional manner to establish the color desired.

Examples of thermoplastic material that meets these general requirements and that may be used are vinyl chloride resin, an example being a copolymer of vinyl chloride and vinyl acetate in the proportion of about 95 parts of the former to 5 of the latter, polyvinylbutyral, cellulose acetate, and methylmethacrylate.

Included in the thermoplastic material is a plasticizer, if any is required to impart thermoplasticity, selected from the plasticizers employed commercially for the particular plastic used. The plasticizer selected is preferably one that is both non-toxic under the conditions of use and substantially non-flammable. Examples of such plasticizers that may be used are tributoxyethyl phosphate, dimethoxyethyl phthalate, and an alkylaryl phosphate, as, for instance, butyl cresyl phosphate (Santicizer 141), and tricresyl phosphate. When the plastic material is cellulose acetate, I prefer to use the dimethoxyethyl phthalate or one of the phosphates as a plasticizer.

To promote free-flowing characteristics in solid condition of the combination of plastic and plasticizer constituting together the thermoplastic material of the particles 14 and 16, I preferably include the plasticizer in the particles in special form. I prefer to include the plasticizer in latent plasticizing condition. Thus, I absorb the plasticizer in the minute macroscopically invisible pores of the particles 14 without being distributed therethroughout in such manner as to soften the entire particle to a condition interfering with the free-flowing properties of the solid particles at room temperatures. This condition of the plasticizer is effected in accordance with technique now known. In this technique, thermoplastic particles are tumbled under an extremely fine spray of plasticizer in liquid condition, the plasticizer being so finely atomized as to enter the microscopic pores within the particles 14. It is retained therein, in sufficient quantity ultimately to plasticize the particles when subsequent distribution of the plasticizer throughout the entire mass of the particles is effected by warming and softening of the particles.

As the water gel which is used to supply the film 12, I use water and any usual thickening agent for water that is effective in extremely small proportions, such as ½% to 5% of the thickening agent on the weight of water, in giving a viscous semi-solid gel that may be buttered onto a fabric but that is so difficultly flowable as not to penetrate and wet through the fabric. Examples of organic thickening agents that may be used are carboxymethyl cellulose, gelatine, sodium alginate such as "Kelco," and agar agar.

Carboxymethyl cellulose is available in large quantities, is effective for the purpose, and is resistant to development of objectionable odor or appearance on long exposure to air containing moisture and common bacteria. For this reason, I prefer to use carboxymethyl cellulose. I find no advantages which offset the disadvantages of poor aging properties in some of the other thickening agents.

Dyes, pigments and resin stabilizers may be used in accordance with usual manner, to establish the desired color and to stabilize the resin.

As to proportions, I use such a ratio of water to selected thickening agent, in the gel of film 12, that the gel may be buttered on with a knife or the usual doctor blade coating operation without flowing through the cloth. A suitable proportion is that which gives a viscosity equal to that of about a 2% dispersion in water of high viscosity carboxymethyl cellulose such as Hercules Type 90.

The plasticizer is used in proportions that are known, for each combination of chosen plasticizer and plastic, to give a composition that is softenable to flowable fluid condition at temperatures within the range 300° to 400° F. but not at a temperature as low as 212° F. Ordinarily I use 20 to 70 parts of the plasticizer for 100 parts of the plastic in the thermoplastic composition, proportions here and elsewhere herein being expressed as parts by weight.

The method of the invention will be largely evident from the description that has been given above.

In applying the gel of the thickening agent in water to the permeable sheet material such as the fabric 10, the preferred method is spreading on of the gel as with a doctor blade. On a commercial scale this is done by drawing the fabric under a bank of the gel at ordinary temperature and in advance of a doctor blade set to rub at its lower edge against or approximately against the upper surface of the fabric. As the fabric passes in contact with the bank of gel thereupon and then under the doctor blade, the blade smooths out the gel as an invisible film that wets continuously the upper face of the fabric and the upper face only.

The thermoplastic particles are then applied over the wet film of aqueous gel. They are applied by sifting or otherwise placing a layer of particles upon the wet film. The layer may be continuous and several particles deep. The cloth is then reversed so that the applied particles are below the face of the fabric and below the film of gel. In this position, the fabric is lightly tapped at close intervals or blown with a mild air stream, to remove those of the particles that are not directly in contact with and adhered lightly at least by the wet film of gel.

Because the water present in the film is in the form of a very viscous gel, the water does not flow by capillarity or otherwise through the layer of particles in direct contact with the film. As a result there is no bonding to the film of those particles which are kept by other particles from direct contact with the film. The use of the viscous film and the subsequent knocking off or blowing off operation remove the particles out of direct contact with the film and leave on the film a layer of single particle thickness. The particles in this layer define between them spaces somewhat larger than those required for breathing in the finished product.

The fabric with the wet film and spaced particles thereon is next subjected to the warming step. The fabric and applied materials are passed through a radiant heat oven of standard design. In this oven, radiant heat is reflected directly upon the surface of the fabric carrying the wet film and the thermoplastic particles. No mechanical part contacts the applied particles. The water is removed by an evaporation at a speed that approaches flash evaporation, because only a very thin film of water is present.

An alternative form of heating for the fabric, wet film, and applied particles is dielectric heating.

When the water has been evaporated, then the additional radiant energy which is received raises the temperature to 300°—400° F., the temperature of softening of the thermoplastic particles to a flowable fluid condition.

During the evaporation step, the film **12** of gel becomes discontinuous. In fact it disappears. The thickening agent representing the residue from the drying of the gel, containing originally only 2% or so of the agent, either cracks or shrivels into small flakes so that there is discontinuity, that is, a large proportion of free space at close intervals through what was originally a continuous film of the gel.

To improve the anchorage of the thermoplastic particles after completing the heating operation described above, the product is suitably ironed. This may be done by passing the product through rollers at ironing temperature, as, for instance, when the product first issues from the warming step described. Under such circumstances, the thermoplastic material is forced by the pressure upon it to penetrate somewhat more than formerly within the fabric, with resultant better anchorage, and to assume leveled upper surfaces as shown at **16** in the drawings. When it is desired to impress a pattern on the thermoplastic particles, the rollers may be provided with the negative of the desired pattern. Also the rollers may be replaced by pressure plates of suitable surface smoothness or pattern, as desired.

The procedure of the method illustrated above is repeated with the substitution of paper or felt in sheet form for the fabric.

The treatment may be applied to both face and back of the sheet material, with plastic particles of the same or different colors.

The overall effect of my method is the prevention of penetration of water through the permeable sheet material in the initial treatment with the aqueous gel, the provision on the sheet of a wet film which adheres lightly the thermoplastic particles directly in contact with the film but which does not penetrate through or between the particles to those which are out of direct contact with the film, the development in the film of discontinuity by the drying operation, and anchorage of the thermoplastic particles in spaced relationship to each other. The final product, therefore, is one having a thermoplastic but permeable coating which permits the passage therethrough of water vapor and air.

A treated sheet with the particles applied as described may be used in effecting lamination. Thus a second sheet may be laid upon the treated surface with particles **22** and adhered thereto by pressure against the said particles in heat softened condition.

The invention will be further illustrated by description in connection with the following specific examples of the practice of it.

Example 1

A woven cotton fabric is moistened on its face with a solution of carboxymethyl cellulose in the proportion of 2 parts of the carboxymethyl cellulose to 100 parts of water. The moistening is made to advantage by spreading and just enough of the solution is applied to wet the entire surface of the fabric.

Over the wet film of the carboxymethyl cellulose on the fabric there is then dusted a thin layer of particles of vinyl chloride resin containing 20% of dimethoxyethyl phthalate os plasticizer.

The assembly is then reversed, so that the applied layer of particles is down. The fabric is then tapped slightly on the back to dislodge those of the particles which are not in direct contact with the wet surface of the fabric.

The product with the spaced particles adhering is then passed through an infrared heating system maintained at such a temperature as to establish within the particles a temperature of about 325° F. The product with the thus softened thermoplastic particles is then sent through cold ironing rollers which flatten out the particles and press them to an appreciable distance within the surface portion of the fabric.

Example 2

In making a product of the kind shown in Figs. 5 and 6, a series of parallel closely spaced unwoven threads such as warp threads are laid in one plane. Upon this assembly of threads a wet film of the carboxymethyl cellulose and then thermoplastic particles are applied, warmed and pressed, all by the technique described. The particles bridge the spaces between adjacent ones of the fibers. The result is a bonding of the spaced threads without the need of the cross or woof strands.

Example 3

The procedure of Example 1 is followed except that the sheet material treated is the relatively thick felt **24** of matted fibers, such as a sheet of cotton batting, both sides of the felt are treated, and special press plates are used in place of the smoothing rollers of the earlier example.

The press plates are provided with spaced elevations of surface which form the negative of the pattern desired in the finished article. When the elevations are a series of cross ridges, then the press plates on the two sides of the assembly impress the troughs and cause compression of the felt at the positions shown at **28** in Fig. 7.

The plastic particles are caused to penetrate the felt, the penetration being particularly deep at the said positions. This causes a quilting effect preventing displacement of the matted fibers without the need of stitching. A facing fabric may be applied to one or both sides of the felt material at the same time that the compression takes place.

It will be understood that it is intended to cover all changes and modifications of the examples of the invention herein chosen for the purpose of illustration which do not constitute departures from the spirit and scope of the invention.

What I claim is:

1. In making a coated sheet material that is permeable to air and moisture, the method which comprises applying to the face of a permeable sheet a thin film of a viscous aqueous dispersion of an organic thickening agent in the proportion of 0.5 part to 5 parts of the thickening agent for 100 parts of the dispersion, the said dispersion remaining on the face of the sheet, then applying directly upon the said film in wet condition a free-flowing mass of fine particles of normally solid thermoplastic material that are insoluble in the said dispersion and are softenable individually to flowable fluid condition at a temperature of 300°–400° F., removing those of the said particles not directly in contact with the said film, this removal developing spaces between the remaining thermoplastic particles, and heating the sheet, film and remaining spaced thermoplastic particles to the temperature of softening of the said particles to flowable fluid condition, this heating causing loss of water and development of discontinuity of the film residue so produced and finally causing softening of the remaining thermoplastic particles and penetration of them within the surface portion of the said sheet.

2. The method of claim 1 in which the said permeable sheet is a band of closely spaced unwoven parallel textile threads.

3. The method of claim 1 in which the said permeable sheet consists of closely spaced, unwoven, generally parallel threads and the spacing between adjacent threads is less than the diameter of the said particles of thermoplastic material, so that particles of the thermoplastic material are retained on the parallel threads and, after the said heating, bond the threads.

4. The method described in claim 1, the said permeable sheet being a textile fabric.

5. The method of claim 1 in which the thickening agent used in the gel is carboxymethyl cellulose.

6. The method of claim 1 in which the product of the heating is subjected to a pressing operation to increase the extent of penetration of the thermoplastic particles within the permeable sheet and to shape the exposed surfaces of the said particles.

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