United States Patent

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[54] **IMPREGNATION OF A NONWOVEN FABRIC**
2 Claims, 1 Drawing Fig.

[52] **U.S. Cl.** ..... **117/7,** 117/68, 117/137, 117/140 A
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[50] **Field of Search** ..... 117/7, 137, 140 R, 135.5

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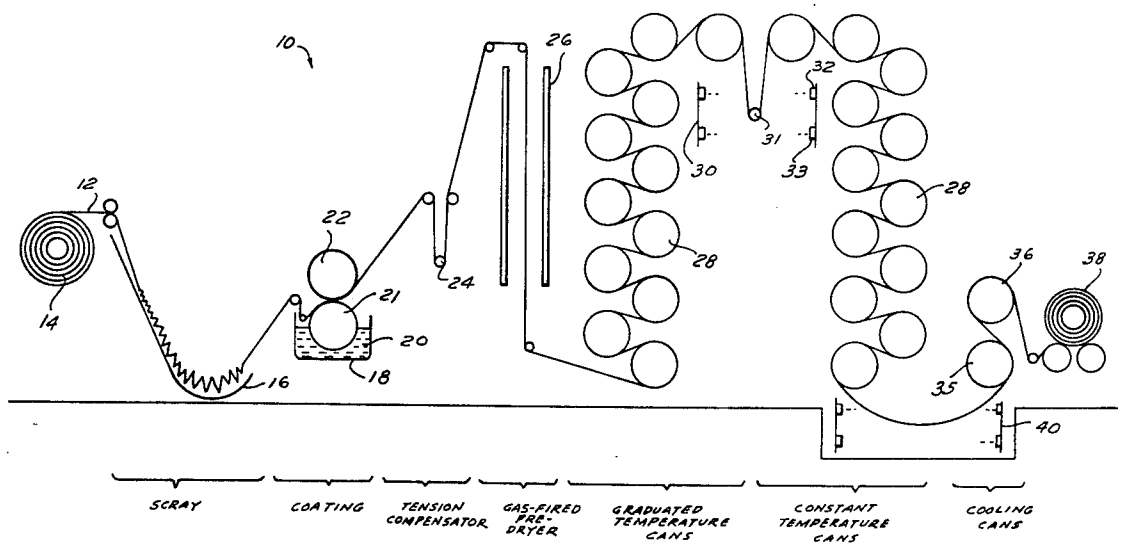
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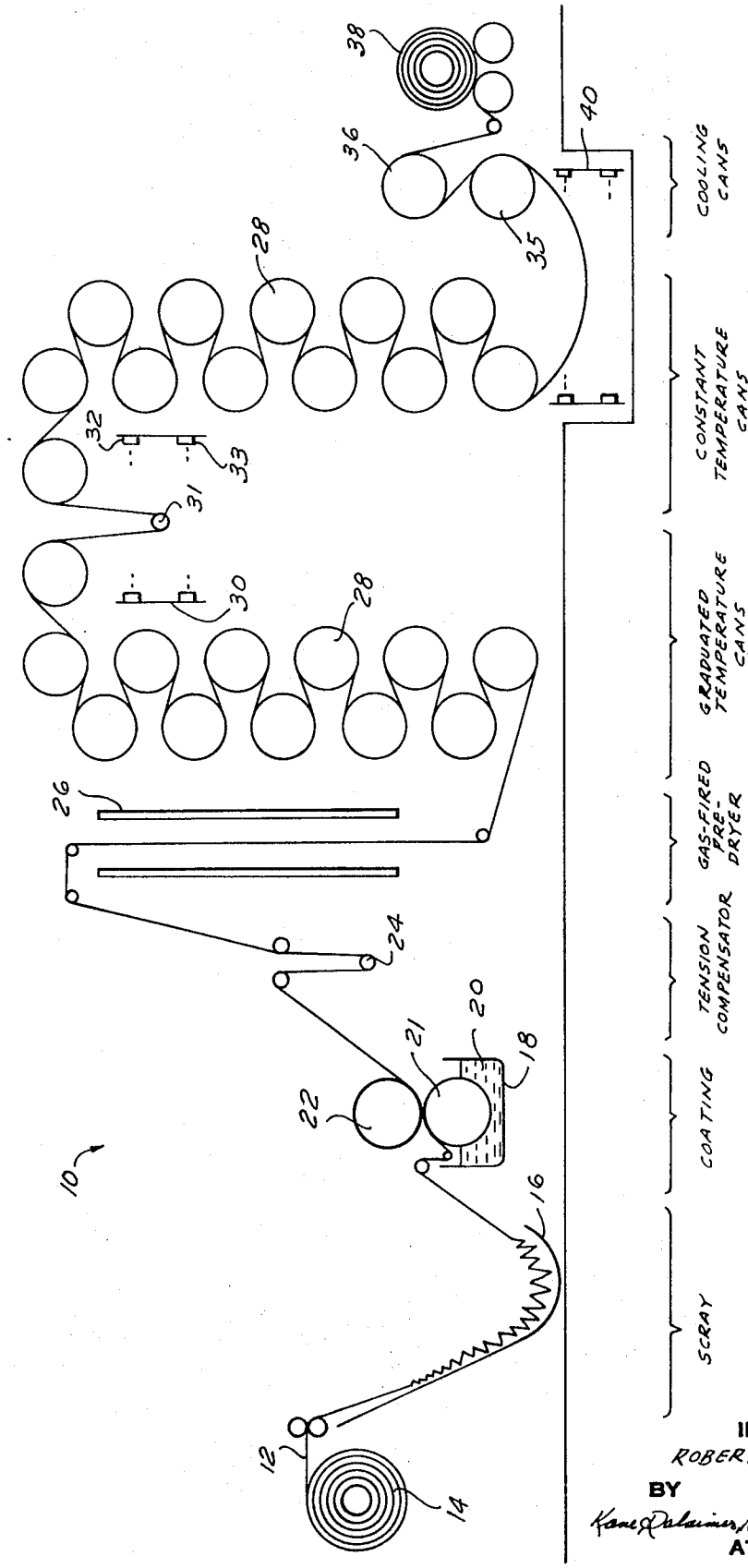
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ABSTRACT: A coating composition which imparts certain desired properties, such as opacity, water repellency, and fire resistance, to a nonwoven fabric comprising randomly arranged continuous filament polymeric fibers. The ingredients of the coating not only impart the desired properties but also are compatible with one another. The coating is applied on an apparatus wherein the tension and the temperature of the fabric are controlled to prevent elongation thereof.





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IMPREGNATION OF A NONWOVEN FABRIC

BACKGROUND AND SUMMARY OF THE INVENTION

This invention relates to a coating process for improving the properties of certain nonwoven fabrics, and to the solutions for use in such a process. More particularly, the invention relates to a process for imparting certain desired physical properties to a nonwoven fabric of the type comprising a plurality of randomly arranged continuous polymeric fibers.

In recent years, nonwoven fabrics have generated a great deal of interest in the textile industry. Typically, these fabrics comprise a coherent sheet of entangled and/or bonded fibers without the fibers being first spun into yarns and interlaced by weaving, knitting, or other similar process. The anticipated large scale use of these fabrics for apparel and other commercial uses has not been realized however since the nonwoven fabrics lack high tensile strength and resistance to tear.

More recently, nonwoven fabrics having superior tensile and tear strength have been developed which comprises continuous filament polymeric fibers distributed in the fabric web in a homogeneous random manner. A fabric of this type is described in the U.S. Pat. to Kinney, No. 3,341,394 and is sold by E. I. duPont de Nemours and Company under the trademark "Reemay." While these continuous filament fabrics provide significantly improved strength, they lack several properties which are essential to most commercial uses. In particular, these nonwoven materials lack sufficient opacity to permit use as a garment, they are not sufficiently flameproof, and they lack water repellency.

Various coating solutions for these high-strength nonwoven fabrics have been proposed and tested in an effort to improve the physical properties of the material. However, the known coating solutions have proven to be unsatisfactory since the various ingredients necessary to impart the desired characteristics have been found to be incompatible with each other. It was not until the present invention that a coating solution has been found which both imparts the necessary properties to the fabric and which has compatible ingredients.

It is therefore an object of the present invention to provide a method of treating a high-strength nonwoven fabric of the described type to produce a product suitable for use in wearing apparel.

It is also an object of this invention to provide a specific formulation for a coating solution to be applied to the nonwoven fabric and which imparts certain desired physical properties to the material. More particularly, it is an object of this invention to provide a specific formulation which imparts opacity, water repellency, fire resistance, and various combinations of these properties to a material of the described type.

In addition, it is an object of this invention to provide a method for applying specific coatings to a nonwoven substrate which is compatible with the coating solution and which does not injure the fabric substrate by excess heat or tension.

These and other objects and advantages of the present invention will readily suggest themselves to one skilled in the art from the following detailed description.

BRIEF DESCRIPTION OF THE DRAWING:

FIG. 1 of the drawing is a schematic representation of the equipment utilized in the coating operation of the subject invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawing, the coating apparatus utilized with the present invention is indicated generally at **10**. The fabric **12** is initially fed from its roll **14** at one end of the machine to the scray **16**, and then to the coating station **18**. There are several methods presently available for applying coating solutions to a textile substrate, and subject to the specific parameters mentioned below, any of these known methods can be adapted for use with the present invention. In the present embodiment, the "kiss" roll method is illustrated. Here, the coating **20** is applied from an applicator roll **21** as the fabric is drawn between the roll **21** and a backup roll **22**. In this manner, the coating penetrates the fabric and is applied evenly on both the top and bottom surfaces.

Once coated, the fabric is passed through a conventional tensioning device **24** to a dryer where the excess solvent and/or water is evaporated. A suitable dryer for this purpose typically comprises a gas fired predryer **26** positioned in series with a plurality of steam heated cylinders or cans **28**. In this instance, the fabric is initially heated in the predryer to prevent an abrupt temperature change when the first can is reached. It will be noted that each side of the fabric receives heat alternatively as the fabric travels from one drying can to the next.

The steam pressure in the cylinders or cans **28** is preferably graduated from a pressure of approximately 5 to 10 pounds per square inch and a temperature of approximately 100° F. in the initial cans, to approximately 45 pounds per square inch and 300° F. in the middle and subsequent cans. By this arrangement, a gradual increase in temperature is obtained along the first half of the cans and a constant elevated temperature is maintained in the second half of the cans.

Since the substrate utilized in the present invention is of light weight and somewhat sheer, it is necessary to use care to deliver the fabric under as little tension as possible in order to eliminate elongation or tearing which might otherwise occur. In practice, it has been found that it is necessary to control the tension to a range below approximately 1 pound per square inch during the coating and drying operations. Automatic feed controls are therefore incorporated in the machine to permit overfeeding or underfeeding different portions of the fabric so that proper tensioning can be assured.

In addition to accurately controlling the fabric tensioning, it is also important that the applied heat be accurately controlled. In particular, exposure of the fabric to a temperature above approximately 310° F. Will result in the loss of tensile strength and thus permit the material to stretch or elongate. In addition, a fabric of this type is sensitive to an abrupt temperature change which may similarly cause the material to lose tensile strength.

To accurately control fabric tension during the drying operation, one or more tensioning devices are strategically positioned in the system. Thus in the illustrated apparatus, a tensioning device **30** is positioned midway along the length of the heated drums. The device **30** includes a weighted tensioning roller **31** which is designed to be positioned between the electric eyes **32** and **33** when the proper degree of tensioning is present. If the tension is too great, the roller **31** will rise until the eye **32** is actuated which in turn causes a compensating correction by varying the speed of an appropriate number of the drums. If the tension is too low, the eye **33** is actuated which in turn causes a reverse compensation by the variable speed drums.

Since the fabric lacks tensile strength when heated, it is passed across the cooling cans **35** and **36** before being positioned on the takeup roll **38**. Also, an electric eye tensioning device **40** may be positioned between the drying cans and the cooling cans to prevent undue tensioning during this critical period. The electric eye **40** functions in a manner similar to that of the eye **30** and acts to control the speed of the takeup roll **38**.

As indicated above, it is a primary object of the present invention to provide a coating composition which imparts the desired properties of opacity, water repellency, and flame resistance to a nonwoven fabric of the described type. The following examples illustrate preparations of specific coating compositions which have been found to impart the indicated properties and wherein the individual ingredients are compatible with one another.

FORMULATION NO 1

To impart opacity to the fabric, the following formulation for the coating composition is employed:

Ingredient	Percent By Weight

1. An inert filler	10 to 70
2. An emulsion consisting of one part natural gum ether to approximately 11 parts water	8 to 15
3. An acrylic emulsion binder	15 to 40
4. Diammonium phosphate	10 to 15
5. Water	5 to 20

In the above composition, the inert filler is provided to furnish the desired opacity to the fabric, and may comprise a titanium dioxide pigment such as is sold by Interchemical Corporation, Hawthorne, N.J. under the trademark AQUA PRINT 5159. The filler may also consist of a suitable clay or calcium carbonate.

The natural gum ether is designed to act as a thickener for the mixture, and is defined in the book "Textile Chemicals and Auxiliaries, " by Speel and Schwarz, Reinhold, 1957, at page 270 as a cold water-soluble locust bean gum prepared by etherification. A suitable ether of this type is manufactured by Polymer Industries, Inc., Springdale, Conn., under the trademark POLYGUM 272. The emulsion is prepared by sifting the POLYGUM 272 into water using one part POLYGUM 272 to 11 parts water.

An acrylic emulsion binder of the type utilized in the above formulation is sold by Rohm and Haas Co., Philadelphia, Pa., under the trademark RHOPLEX HA-8.

The diammonium phosphate acts as a catalyst to facilitate cure of the binder. It is noted that while diammonium phosphate is normally a fire retardant, it is not present in sufficient quantity in the present formulation to provide this property in any measurable degree.

The indicated amount of water may be added to the above formulation to give desired consistency to facilitate application of the coating to the fabric.

FORMULATION NO. 2

To provide an opaque and water repellent finish, the following formulation is employed:

Ingredient	Percent By Weight
1. An inert filler	15 to 50
2. A vinyl chloride emulsion binder	8 to 15
3. A melamine based resin dispersion	20 to 30
4. Water	1 to 10

In the above formulation, the inert filler may comprise a titanium dioxide pigment, clay, or calcium carbonate as further described under Formulation No. 1.

A vinyl chloride emulsion binder suitable for use with the above formulation is sold by the National Starch & Chemical Corp., New York, N.Y. under the trademark BINDER 78-5159.

The melamine based resin dispersion is designed to add water repellency to the fabric. A suitable composition is sold by American Cyanamid Co., Bound Brook, N.J. under the trademark PERMEL B. which is identified by the manufacturer as a water-repellent aqueous melamine aldehyde resin dispersion used to provide a soft finish and increase the tear strength of cotton, rayon, wool and synthetic fabrics.

FORMULATION NO 3

The following formulation is designed to provide opacity, fire resistance, and water repellency to a nonwoven fabric of the described type:

Ingredient	Percent By Weight
1. An inert filler	15 to 50
2. A phosphate plasticizer	10 to 20
3. A vinyl chloride emulsion binder	8 to 20
4. A melamine based resin dispersion	20 to 30
5. A flame retardant salt	15 to 25

In the above formulation, the inert filler, the vinyl chloride emulsion binder, and the melamine based resin dispersion are all similar in composition and function to the corresponding ingredients in Formulation No. 2. Water may also be added to the formulation to provide the desired consistency.

The phosphate plasticizer may consist of a variety of phosphate materials such as tricresyl phosphate, trioctyl phosphate or cresyl diphenyl phosphate. A suitable plasticizer of this type is sold by the Stauffer Chemical Company, Los Angeles, Cal., under the trademark LINDOL which is tricresyl phosphate.

The flame retardant salt typically comprises an inorganic phosphorous compound. A compound of this nature is sold under the trademark FLAMEPROOF No. 736 by the Apex Chemical Company, Elizabethport, N.J. which is described by the manufacturer as an inorganic phosphate which is soluble in water.

While the resins employed in the above formulation are capable of curing with heat alone, a catalyst may be added to lower the temperature at which they will cure. Acid catalysts based on ammonium salts or free acid catalysts such as oxalic or citric acid are commonly employed for this purpose.

FORMULATION NO. 4

The following formulation may be utilized to provide an opaque and fire retardant finish to a nonwoven fabric of the described type:

Ingredient	Percent by Weight
1. An inert filler	15 to 50
2. Phosphate plasticizer	10 to 25
3. An emulsion of a thermoplastic resin	2 to 25
4. A flame retardant salt	1 to 20
5. An acrylic polymer	10 to 30
6. Water	5 to 20

The inert filler, the phosphate plasticiser, and the flame retardant salt, are similar to the corresponding ingredients described above in Formulation No. 3.

The emulsion of a thermoplastic resin employed in the above formulation is copolymer of vinyl chloride and vinyl acetate and this emulsion is sold by the Apex Chemical Company under the trademark APEX BINDER No. 3.

The acrylic polymer is provided to give added thickness or viscosity to the formulation and this polymer is sold by Rohm & Haas Co. under the trademark ACRYSOL ASE-60.

I claim:

1. A method of impregnating a nonwoven fabric consisting of randomly arranged continuous filament polymeric fibers which are bonded together at crossover points to provide an opaque fire-resistant product, comprising:

applying to said fabric an aqueous composition containing a thickened emulsion resin binder in which the resin is selected from the group consisting of a polymerized acrylic resin and copolymer of vinyl chloride and vinyl acetate, and an inert opacifying finely divided filler selected from the group consisting of titanium dioxide, clay, and calcium carbonate;

tensioning said impregnated fabric while applying said coating and feeding the fabric to a heat-curing station at a uniform tension of slightly less than about 1 pound per square inch, whereby the fabric does not undergo excessive elongation or tearing; and,

subjecting said impregnated fabric to a gradually increasing temperature of from approximately 100° F. to a temperature below 310° F. for a time which is sufficient to set the coating and cure the fabric.

2. A method as claimed in claim 1, wherein said coating is applied from an applicator "kiss" roll on both the front and back surfaces of the fabric, said inert filler is used in an amount of 10-70 percent by weight of the coating composi-

tion and is titanium dioxide, said resin thickened emulsion is thickened with etherified locust bean gum ether in an amount of 8–15 percent, said emulsion binder is an emulsion of a polymerized acrylic resin, and said composition contains diammonium phosphate in an amount of 10–15 percent.

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