

[54] MANUFACTURE OF FLAME-
RESISTANT NONWOVEN FABRICS

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[57] ABSTRACT
Nonwoven fabrics are impregnated first with a conventional binder and then with a polyvinyl chloride-antimony trioxide binder. After the second impregnation the fabric is longitudinally stretched while it is being dried, rewetted with water, and then transversely stretched while it is being dried. Further there is disclosed a novel impregnant composition which is useful in fireproofing nonwoven fabrics.

8 Claims, 2 Drawing Figures

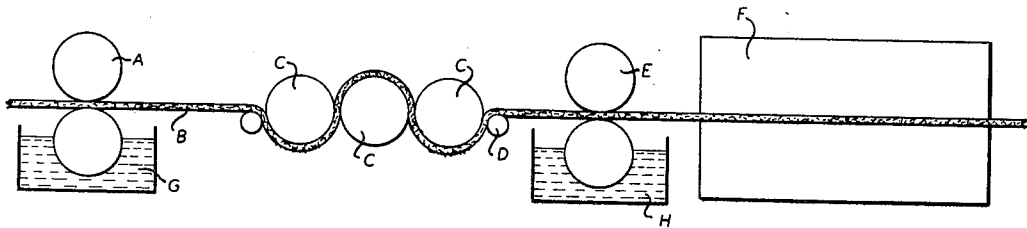


FIG. 1.

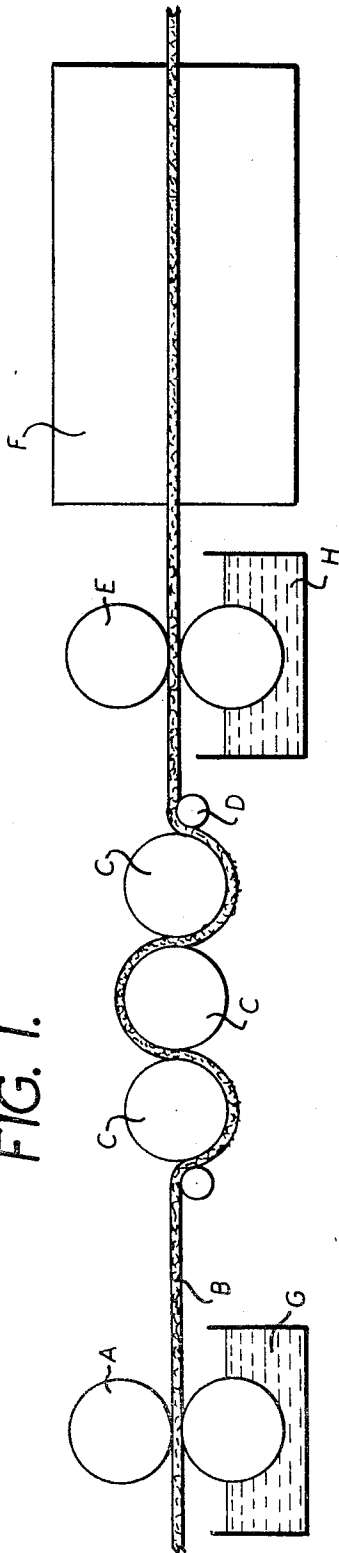
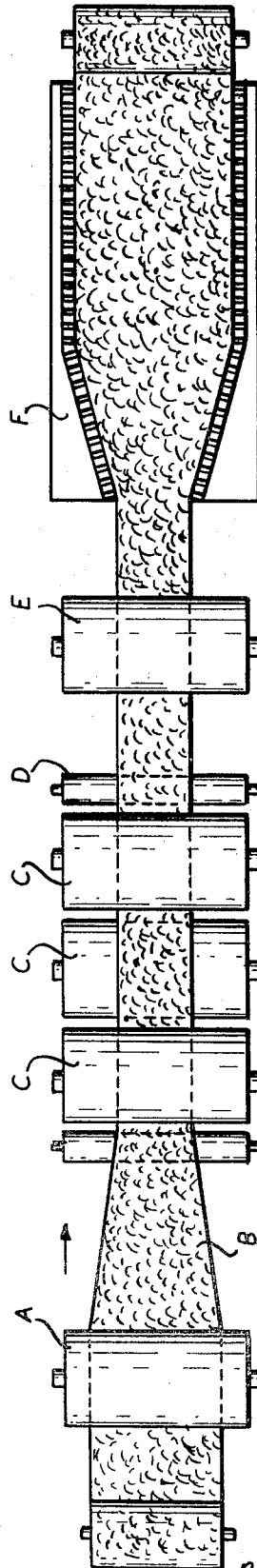


FIG. 2.



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MANUFACTURE OF FLAME-RESISTANT NONWOVEN FABRICS

This invention relates to production of nonwoven fabrics. It more particularly refers to a novel method of producing such nonwoven fabrics which are substantially flameproof or at least significantly flame resistant.

It is old in the prior art to flameproof fibrous sheet materials, such as nonwoven fabrics, by a post treatment with a solution or dispersion of paraffins, waxes, fatty acids, postchlorinated polyvinyl chloride and antimony trioxide. Despite these statements in the prior art, as a practical matter such substances are suitable only for flameproofing woven materials and nonwoven fabrics that are free of binding agents.

If it were desired to flameproof nonwoven fabrics containing bonding agents, especially such as those made according to British Pat. No. 1,055,187 and sold commercially as "spin-bonded fabrics," considerable difficulties would be encountered. Nonwoven fabrics bonded with a bonding material are, to a certain extent, already provided with a flame retardant from the outset in the form of the bonding agent. They catch fire less easily than the same fiber matting containing no bonding agent. However, once such a material has been subjected to fire, the bonding agent contained in it melts. It is then no longer possible to put out the fire by beating with the hands or throwing blankets over it. Furthermore, if such a fabric were compressed in such a manner, the melted plastic of the bonding agent would be pressed against the skin of the wearer, thus causing very severe burns.

Therefore, although nonwoven fabrics bonded with bonding agents are relatively difficult to set on fire, once they have caught on fire, it is extremely difficult to extinguish the fire, particularly because of the dripping, molten, and sometimes burning, bonding agent.

It is therefore an object of this invention to provide a novel nonwoven fabric having flame-retarding properties.

It is another object of this invention to provide a novel method of producing such a nonwoven fabric.

It is a further object of this invention to provide a novel impregnating composition.

Other and additional objects of this invention will become apparent from a consideration of this entire specification, including the drawing and claims hereof.

In accord with and fulfilling these objects, one aspect of this invention resides in a novel flameproof composition impregnant suitable for use in combination with the nonwoven fabrics to bond such and to render such substantially flame resistant. This impregnant composition includes water, a vinylidene chloride resin, a dispersant, and antimony trioxide.

As is the usual practice when working with polyvinylidene chloride materials, stabilizers and inhibitors of the usual, conventionally known and used type are suitably provided in the impregnant composition so as to be incorporated in the bonding agent and therefore in the bonded nonwoven fabric. Exemplary of this type of materials are oxidation inhibitors, heat stabilizers, ultraviolet and visible light stabilizers, etc. Further, there may be included fillers, dispersing agents, dyes, pigments and/or other materials conventionally used in this art, which materials are incorporated in their conventional proportions for their conventional purposes.

It is further within the scope of this invention to provide a flame-resistant, bonded, nonwoven fabric by forming a bonded batting of substantially continuous filaments by the so-called "spin bonded" method. This method utilizes the inherent tackiness and weldability of certain spun continuous filaments so that when such filaments are laid down upon a suitable substrate into a nonwoven fabric batting, the filaments bond to each other through their inherent tackiness, substantially at the points where the filaments cross each other. This bonded fabric is suitable for use in the second impregnation process set forth above wherein a flameproofing bonding agent comprising vinylidene chloride polymer and antimony trioxide are impregnated into a prebonded nonwoven fabric.

In accord with and fulfilling the above objects, another aspect of this invention resides in a novel process of producing a flameproof or flame-resistant nonwoven fabric which process comprises producing a conventional nonwoven batting; impregnating said batting with a conventional binder in smaller proportion than is conventionally used; drying this first impregnant; impregnating the thus partially bonded fabric with a second impregnant containing vinylidene chloride polymer and antimony trioxide; drying this second impregnant while longitudinally stretching the impregnated fabric; wetting the longitudinally stretched, dried fabric with water; and drying such wet fabric while stretching such in a transverse direction; whereby to achieve final fabric dimensions substantially the same as those of the unimpregnated fabric.

Thus the fabric made according to this invention is flame retardant and is substantially free of the hot binder melting and dripping problems of prior art fabrics.

Nonwoven fabrics, according to this invention, contain considerable amounts of bonding agent. Proportions of bonding agent of 8 to 70 percent of the total fabric weight are customary. The conventional bonding agents which are used are mainly of the natural and synthetic rubber latex type, as well as acrylic resins. The first impregnation of the batting referred to above is with only about half of the required amount of bonding agent (i.e., latex or acrylic resins).

Then the mat is dried and impregnated in a second procedure with a dispersion whose principal components are polyvinylidene chloride and antimony trioxide. At the same time, this flame-retardant bonding agent impregnant must contain optical brighteners, light stabilizers, heat stabilizers, oxidation inhibitors and/or whatever other known materials are considered necessary adjuvants for use with vinylidene chloride polymer resins.

The amount of polyvinylidene chloride applied to the fabric that gives optimum fire drip resistance has to be selected according to the particular thermoplastic filaments in the fabric and according to the amount of binding agent in the fabric. It can be said, however, that it is often found satisfactory to have from about 5 to 25 parts by weight polyvinylidene chloride per 100 parts by weight synthetic thermoplastic fibers. Best results are often obtained when the amount is from about 10 to 20 parts per 100 by weight fibers. When the fabric contains fibers other than synthetic thermoplastic filaments the total amount of polyvinylidene chloride applied to the fabric may be greater than about 25 parts by weight, based 100 parts by weight of all the fibers in the fabric, since the presence of polyvinylidene chloride may additionally be useful to increase the fiber resistance of other fibers in the fabric.

It is often found that optimum results are obtained when the relationship between the amounts of polyvinylidene chloride and binding agent are such that there are from about 20 to 40 parts by weight polyvinylidene chloride per 100 parts by weight binding agent, particularly when the binding agent is polyacrylate. It is often found that the best results are obtained when the amount of polyvinylidene chloride is from about 25 to 33 parts by weight per 100 parts by weight binding agent, i.e., a proportion of about one to three.

Antimony oxide is included to increase the fire-resistance of the fabrics and various other additives can be included with the polyvinylidene chloride. It is generally desirable to include one or more optical brightening agents in the dispersion containing the polyvinylidene chloride, since otherwise the fabric is liable to have rather poor fastness to light.

A fabric that contains binding agent and also polyvinylidene chloride impregnant may sometimes have a rather poor hand, i.e., feel rather coarse, although conditions can be chosen so that fabrics with a good hand are obtained. If the use of polyvinylidene chloride and binding agent along in the amounts desired to give optimum fire properties do result in a fabric having a rather poor hand, this hand can be considerably improved by subjecting the fabric to the additional step of mechanically dislocating polymer films in the fabric, i.e., of breaking up any films of polyvinylidene chloride or

binding agent that have formed. This can be done by, for example, rubbing the fabric but the most satisfactory way appears to be to stretch the fabric first in one direction and then in a direction substantially at right angles to the first direction of stretching. When carrying out this process on a very long or continuous length of fabric the stretching is best conducted by first stretching the fabric longitudinally while allowing the fabric to contract laterally and then stretching the fabric laterally, usually while allowing the fabric to contract longitudinally.

Another way of ensuring that a fabric having a very soft hand is obtained is to include plasticizer with the polyvinylidene chloride. The amount of plasticizer used must, however, be selected carefully, since if too little is used no great advantage is obtained, and if too much is used it markedly reduces the drip resistance of the polymeric materials in the fabric. It is highly surprising, in fact, that one can select an amount of plasticizer that improves the hand without substantially affecting the fire drip resistance. The exact amount depends, of course, upon the grade of polyvinylidene chloride and upon the particular plasticizer. The preferred plasticizer used is didecyl phthalate and this is preferably used in an amount substantially of four parts didecyl phthalate to three parts polyvinylidene chloride by weight.

It is additionally surprising that it is possible to plasticize polyvinylidene chloride by applying to the fabric a single medium containing both polyvinylidene chloride and the plasticizer. Polyvinylidene chloride is normally oil repellent and therefore plasticizer repellent. However, this repulsion has been overcome by forming emulsions of the polyvinylidene chloride and plasticizer and mixing the emulsions together.

The process of this invention is preferably performed under special conditions which will be described with reference to the accompanying drawing in which:

FIG. 1 is an elevation of a schematic view of the process of this invention; and

FIG. 2 is a plan view of the schematic diagram of FIG. 1.

Referring now to the drawing, there is shown a padding machine of the kind customarily used for the impregnation of fiber mats. The padder consists (as can also be seen from Austrian Pat. No. 217,000) of three rolls, which can be covered with felt. The lower roll is partially immersed in a liquid containing the impregnating agent. The impregnating agent is absorbed by the felt covering of the lower roll. As a nonwoven mat runs through the gap between the padder rolls, the bonding agent mixture is simultaneously pressed into the mat by the wet felt covering.

The fabric shown in the drawing at the start of the depicted process has already been partially impregnated with conventional binder and dried.

At A the already partially bonded mat passes through the gap of a pair of rolls of a padding machine. The lower roll plunges into a dispersion G whose main components are polyvinylidene chloride and antimony trioxide. These components (together with optical brighteners and suitable inhibitors and stabilizers) thus get into the mat.

The mat is then passed over hot steel rolls C (so-called cylinder dryers) to dry it. D represents auxiliary rolls which aid in the guidance of the mat B. It is of decisive importance that the cylinder rolls C rotate more rapidly than the rolls of the padder A. In this manner the mat is drawn longitudinally, while its width is simultaneously diminished.

This is best shown in FIG. 2, where it can be seen how the web B is pulled lengthwise between the padder A and the drying rolls C and thus becomes narrower. After passing through the drying rolls C, the mat is dry. However, it is then again moistened in a second padder E (in padder E, the lower roll is immersed in plain water). Then it is dried again in a chamber F in a so-called hot-air tenter frame. But as the mat passes through the drying chamber F, the tenter frame draws it apart again, but this time in width, so that it reattains its original breadth.

This remoistening in the second padder E and the tenter frame stretching and drying in the chamber F can be seen clearly in FIG. 2. It can be seen how the mat which has been wetted in the second padder E is pulled wide again.

As a result of the twofold drawing action (first longitudinally and then transversely) after the second impregnation, the bonding agent is broken many times in the mat, so that even in case of high percentages of bonding agent, the final product has a very soft and textilelike hand.

The following examples illustrate embodiments of this invention:

EXAMPLE I

A mat prepared according to example 2 of British Pat. No. 1,055,187 and having a weight of 30 g./m.² is given a preliminary impregnation with an acrylic resin (commercial name PRIMAL) in such a manner that, after drying at 140° C., the weight increases to 50 g./m.². A mat thus impregnated is then postimpregnated with the following mixture:

	Solid	Liquid
25 Diofan 230 (a polyvinylidene chloride copolymerized with an acrylate supplied by BASF)	100	200
Antimony oxide addition (consisting of 48 parts antimony oxide and 2 parts of a pigment)	50	100
30 Blankofor (an organic complex molecule supplied by Farbenfabriken Bayer as an optical brightener)	2	2
Hoesch EP 35 stabilizer (an epoxy compound supplied by Hoesch AG and used as a light stabilizer)	2.5	2.5
35 Emulsifier EP (an emulsifier for the epoxy compound)	0.25	1
Water	—	487
Aerosil (silica white pigment)	4.78	—

The addition mentioned in the above composition consists in turn of:

	Solid	Liquid
45 Sb ₂ O ₃	480	
Pigment	20	
50 Dispersing agent A	20	66
Water		453

Impregnation with the above mixture is performed in a felt padding machine. Both rolls are pressed together so that the mat weight, after drying at 120° C., increases from 50 to 58 g./m.². Drying takes place on three hot metal cylinders. The metal cylinders rotate at a speed of 45 r.p.m., while the padding rolls rotate with a speed of only 30 m./min. In this manner the original mat 1.70 m. wide is stretched in length so that its width amounts to only 100 cm.

After leaving the cylinder drying machine (surface temperature 140°) the web is saturated with water again in padding machine E. The wet web then runs into a tentering frame dryer F having a clip and pin tenter frame chain. At a temperature of 140° the mat is then stretched back out to 170 cm. in width.

A mat dried with a twofold draft in this manner is not only flameproof but is also very soft.

The process of example I was also repeated using a single impregnation, i.e., the acrylic resin being impregnated at the same time as the polyvinylidene chloride impregnant, and it was found that the resultant fabric did not have such a good hand.

EXAMPLE II

The process described in example I was repeated except that the initial fabric, before any impregnation, had a weight of 25 grams per square meter and after impregnation with the acrylic resin had a dry weight of 44 grams per square meter and after impregnation with the polyvinylidene chloride containing dispersion it had a dry weight of 61 grams per square meter. The dispersion used was the same as that given in example I except that it additionally contained 13 parts didecyl phthalate as a plasticizer, this being introduced into the dispersion with 100 parts water. This fabric has fire drip resistance at least as good as that of the fabric produced in example I and had a particularly satisfactory hand.

In one operation using this apparatus and using the fleece, impregnating compositions and amounts all as described in example I, the initial rolls are rotated at a peripheral speed of 30 meters per minute while the takeoff rolls all rotate at a peripheral speed of 45 meters per minute. This causes a fleece that is initially 170 centimeters wide to be stretched so that its width is only 100 centimeters. The degree of stretching is between one-third and one-half. In the tenter frame drier the fleece is stretched out again to 170 centimeters. The fleece increases in length considerably as a result of the initial stretching, 300 meters being extended, for example, to 400 meters, but is only partially restored to its original length during the second stretching, for example going back to 380 meters.

The fabrics to which the invention may be applied are usually nonwoven fabrics, but may be woven or knitted fabrics. The fabrics may be of staple fibers or of continuous filaments, or of mixtures of both, and in this specification we use the term "fiber" to cover both staple fibers and continuous filaments except where the context demands otherwise. The fabrics may be wholly of fibers of synthetic thermoplastic material or they may be of mixtures of such fibers with other fibers.

The invention is of particular value when applied to fabrics consisting entirely of continuous thermoplastic synthetic filaments such as the fabrics made by the processes described in British Pat. specification No. 1,055,187. Such fabrics can be made very thin and of very light weight and very porous, with the result that they are very prone to burn rapidly. As a result of the invention, their fire and fire drip resistance is increased greatly.

What is claimed is:

1. In the process of producing a bonded nonwoven textile fabric comprising forming a batting of substantially randomly disposed textile fibers and bonding the fibers of said batting together predominantly at their crossing points; the improvement whereby rendering said nonwoven textile fabric substantially flame retardant, which comprises impregnating said bonded nonwoven textile fabric with a liquid form impregnant containing a flame retardant consisting essentially of vinylidene chloride polymer bonding agent and antimony trioxide; simultaneously drying and unidirectionally stretching said impregnated bonded fabric; impregnating said dried, unidirectionally stretched fabric with water; and simultaneously drying and stretching said water-impregnated fabric in a direction transverse to said unidirectional stretching, wherein said stretching is in an amount sufficient to break at least many of the bonding agent bonds between fibers of said fabric.

2. Process claimed in claim 1 wherein said flame retardant impregnant contains an optical brightener and a light stabilizer for the vinylidene chloride polymer.

3. Process claimed in claim 1 wherein said stretching is to an extent sufficient to impart to the final product substantially the same dimensions as the initial unimpregnated batting.

4. Process as claimed in claim 1, wherein said flame-retardant impregnant contains sufficient vinylidene chloride polymer to produce a final fabric having about 20 to 40 parts by weight of vinylidene chloride polymer to 100 parts of said conventional bonding agent and about five to 25 parts by weight per 100 parts of fiber.

5. The improved process claimed in claim 1 wherein said batting is bonded by impregnating thereinto a liquid form first bonding agent composition containing sufficient first bonding agent to provide the bonded fabric with 8 to 70 percent thereof; and drying and vulcanizing said first bonding agent containing batting, whereby bonding together said fibers predominantly at their crossing points, to form a bonded nonwoven textile fabric ready for said vinylidene chloride impregnation.

6. Process claimed in claim 5 wherein said first bonding agent is an acrylic polymer.

7. Process claimed in claim 1 wherein said bonded batting is formed of substantially continuous filaments.

8. Process as claimed in claim 7, wherein said filaments are integrally, thermally bonded together at their crossing points during batting formation.

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