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Brock et al.

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[54] **LAMINATES CONTAINING OUTER PLIES OF CONTINUOUS FILAMENT WEBS**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 14,930, Feb. 27, 1970, abandoned.

[52] **U.S. Cl.** **161/148,** 156/177, 156/178, 156/291, 161/150, 161/156, 161/190, 161/227, 161/228, 161/231, 161/232, 161/249, 161/255, 161/256, 161/265

[51] **Int. Cl.** **B32b 5/12,** B32b 5/26, B32b 7/24, B32b 31/12, B32b 31/06

[58] **Field of Search** 161/148, 153, 155, 156, 161/150; 156/62.4, 176, 177, 178, 291

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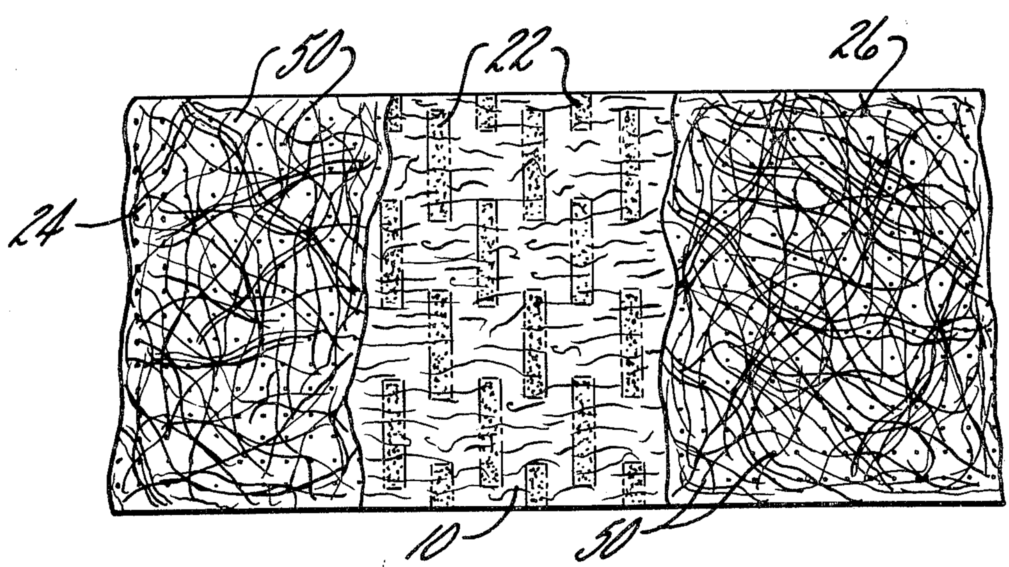
[57] **ABSTRACT**

Laminates comprising outer webs of continuous thermoplastic filaments and an inner cellulose wadding web are disclosed. The laminates aesthetically simulate a woven fabric or textile material and are strong, attractive in appearance and absorb and retain fluid. The continuous filament web can be bonded by means of an intermittent pattern of spot bonds.

8 Claims, 3 Drawing Figures



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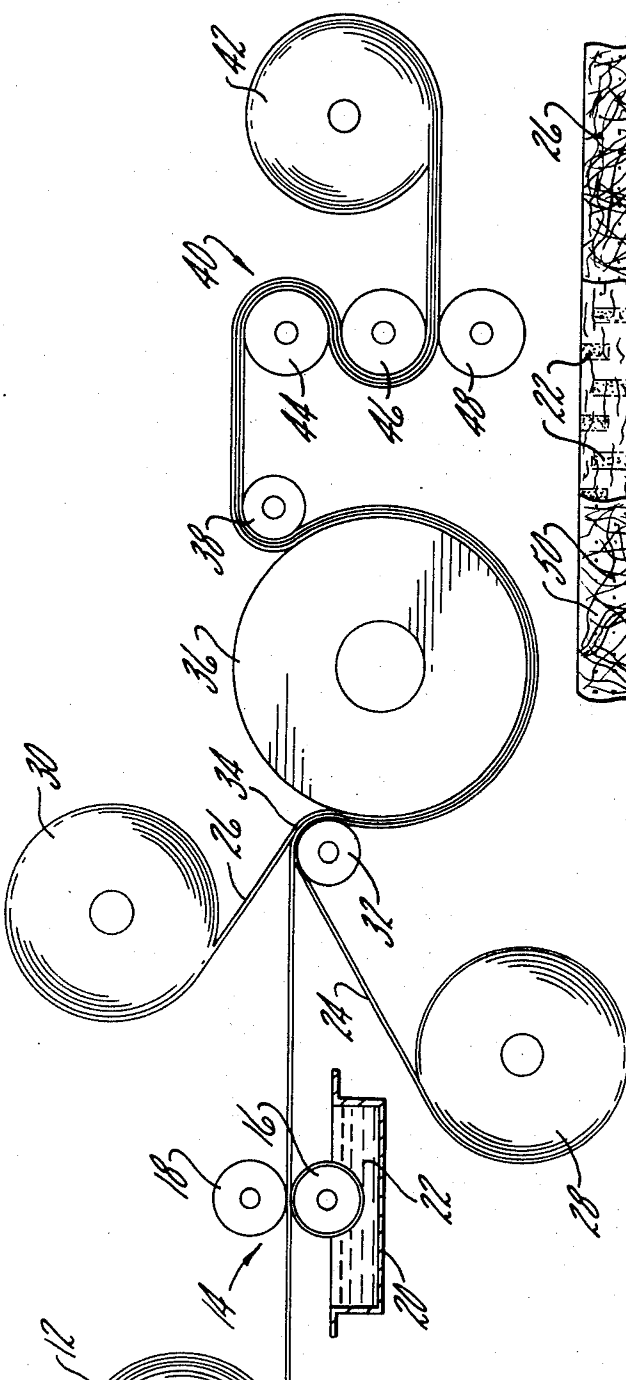

Fig. 1

Fig. 3

Fig. 2

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LAMINATES CONTAINING OUTER PLIES OF CONTINUOUS FILAMENT WEBS

RELATED APPLICATIONS

This is a continuation-In-Part of my earlier filed application, Ser. No. 14,930, filed Feb. 27,1970, entitled Laminates Containing Outer Plies of Continuous Filament Webs and which application is now abandoned.

DESCRIPTION OF THE INVENTION

This invention relates to nonwoven fabrics and, more particularly, to lightweight nonwoven laminates which include webs of continuous thermoplastic filaments and are characterized by their textile-like features.

Nonwoven webs comprised of a plurality of continuous filaments of synthetic polymers are now widely known. As opposed to webs made by conventional spinning, weaving or knitting operations, webs of continuous filaments are generally prepared by continuous polymer extrusion and immediate deposition on a supporting surface in a generally random manner. Ordinarily, in order to achieve fiber tenacity, the filaments are oriented after extrusion and prior to deposition on the supporting surface. U.S. Pats. Nos. 3,338,992 and 3,341,394 to Kinney illustrate known types of continuous filament nonwoven webs.

These webs have been used in a wide variety of product applications. For example, they have been employed as curtain drape material, bookbinding material, insulation, and backings for carpet. However, while the webs are generally suitable for uses such as have been described, there has been so substantial use of these materials in the field of disposable fabric products, such as clothing, bed sheets, pillow cases, and the like. While products in these areas have employed nonwoven webs, the nonwovens have been prepared from staple length fibers that are either resin bonded or bonded to tissue. Also, scrim-reinforced materials, i.e., — crossed sets of threads bonded at their points of intersection and employed as a reinforcing layer for one or more plies of tissue, have been used as disposable nonwovens. The optimum suitability of these nonwovens for disposable fabric uses is generally restricted with respect to either their appearance, their strength characteristics, or their ability to absorb energy under strain. In addition, there is room for improvement in their surface feel characteristics.

The use of continuous filament nonwoven webs for disposable fabrics has been limited because of the need for a desirable "hand" in combination with a pleasing appearance and adequate strength characteristics. In this respect, it has been found that continuous filament webs possessing a desirable hand such that they would be suitable for uses such as bed sheets, hospital gowns and the like, do not possess the necessary uniform and functional opaque appearance required in such applications. On the other hand, while the opaqueness can be increased by using webs with higher basis weights, the webs do not have the required desirable hand particularly if subsequent softening techniques such as embossing are not employed. In this respect, it should be noted that the webs of the aforementioned Kinney patents as well as other are principally high weight webs possessing an accompanying undesirable hand. Other methods for improving the opacity of low basis weight webs, such as by using lower denier filaments, have processing drawbacks since, for practical purposes, it is difficult to extrude such low denier filaments.

Moreover, even if a continuous filament web was prepared will an acceptable combination of hand, opacity, and strength, such a web would still be lacking in one very important characteristic. Because such webs are comprised predominantly of hydrophobic thermoplastic polymers having an inherently low capacity for absorbing and retaining fluids such as water, the webs themselves also have such low capacity and retentiveness. This behavior is particularly troublesome where it is desirable to treat the web with an agent such as a flame retardant, a necessity for any type of a disposable product where the user comes into direct contact with the material. Customarily, flame retardants are inexpensively applied with an aqueous carrier. Accordingly, the inability to easily absorb and retain water is a serious drawback necessitating complicated and expensive treating methods to achieve the desired flame retardancy, and which methods can adversely affect the physical properties of the fiber. Also, because of this same characteristic, fabrics prepared from the continuous thermoplastic polymer webs do not acquire a high moisture content from the atmosphere, and this detracts from a natural fabric feel as well as presenting potential static problems.

Robinson application, Ser. No. 15,033 entitled "Laminates of Tissue and Random Laid Continuous Filament Web," filed on Feb. 27, 1970, which application has been abandoned in favor of continuation-in-part application, Ser. No. 240,754, filed Apr. 3, 1972 illustrates useful structures of continuous filament webs having a good hand and appearance, and also possessing good fluid absorbency and retention. In addition, the structures exhibit substantially isotropic stress and strain characteristics. The structures therein disclosed comprise a laminate of lightweight cellulose wadding and a lightweight web comprised of a plurality of continuous filaments of a thermoplastic polymer. The laminate is prepared by bonding the continuous filament web to the cellulose wadding by means of a spaced pattern of adhesive. Preferred structures illustrated in Robinson comprise outer plies of cellulose wadding and a single inner ply of the continuous filament web.

It is accordingly an object of the present invention to provide a lightweight, nonwoven laminate having the above-described characteristics and which additionally simulates a woven cloth or fabric. A related object is to provide a material which can be suitably used in a wide variety of applications as a replacement for a woven cloth or fabric.

A more specific object lies in providing a nonwoven material of the above-described type which is characterized by superior textile-like properties, i.e., — the lack of a papery feel, the presence of a dead sound on crumpling, and good hand. A related object is to provide such a material that may be washed a number of times and possesses superior wrinkle recovery, abrasion resistance, and resistance to puncture.

A still further object is to provide a nonwoven material which can be prepared in an economical manner.

Other objects and advantages of the present invention will become apparent by reference to the following description and the accompanying drawings in which:

FIG. 1 is a schematic illustration of apparatus and showing one means for forming the nonwoven materials of the present invention;

FIG. 2 is a schematic, cross-sectional view of a laminate in various stages of preparation and showing levels of adhesive penetration therein; and

FIG. 3 is a fragmentary plan view of a material and with sections broken away to illustrate the individual layers of the material of the present invention.

While the present invention is susceptible of various modifications and alternative constructions, there is shown in the drawings and will herein be described in detail the preferred embodiments. It is to be understood, however, that it is not intended to limit the invention to the specific forms disclosed. On the contrary, the intention is to cover all modifications, and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

Briefly, the process to be hereinafter described with reference to the drawing, involves preparing a laminate comprised of outer plies of webs of continuous thermoplastic polymer filaments and an inner ply of cellulose wadding. The outer continuous filament webs provide the laminate with a very desirable fabric-like surface feel while the inner cellulose wadding contributes to the appearance and fluid absorbency characteristics of the laminate. Lamination is accomplished in a manner such that the desirable attributes of the laminated product are not detrimentally affected.

Turning now to the drawings, FIG. **1** schematically illustrates apparatus which can be used in preparing laminates of the present invention. As shown, a web of cellulose wadding **10** is unwound from a roll **12** and passed to an adhesive printing station **14.** The prime requirements of the cellulose wadding are that it provide the desired opacity for the product laminate and that it have sufficient absorbency to retain any aqueous-borne additives such as flame retardants, printing inks, etc. that might be necessary for a particular application. Similarly, the basis weight of the cellulose wadding web can be varied within wide limits. Generally, however, the web will have a basis weight of from about 0.3–0.7 oz./yd.^{2}.

At the printing station **14**, the web **10** is printed with a discontinuous pattern of adhesive on its bottom surface. Thus, as is shown, the web of cellulose wadding **10** passes between printing roll **16** and back-up roll **18.** The printing roll **16** is partially submerged in the tank **20** containing adhesive **22.** The surface of the printing roll **16** is provided with a series of grooves which serve to pick up the adhesive from the tank **20** and transfer the adhesive to the bottom surface of the web **10.**

The grooves can be in any patterned configuration; however, it is important that the pattern be substantially open and the total area of the web **10** which is occupied by adhesive be not more than about 25% of the total area, and preferably only about 15% or less of the area. The selection of the appropriate groove pattern on the roll **16** and the effect thereof on the characteristics of the resultant laminate is well known in the art.

While other types of adhesives such as hot melts, latexes, and the hereinafter described thermoplastic polymer filaments themselves can be employed in the process described herein, it is preferred to employ a plastisol adhesive because of the ease of application and the ability to cure without adversely affecting the desirable laminate characteristics. For example, a plastisol comprised of a polyvinyl chloride resin plasticized with dioctyl phthalate or any other well known plasticizer can advantageously be used so long as curing can be accomplished at a temperature which does not adversely affect the components of the laminate. At application, the viscosity of the plastisol is generally about 800–6000 cps. and, preferably 1,200–3,200 cps., in order to obtain satisfactory transfer to the web.

Following the adhesive addition at the printing station **14,** the continuous filament webs **24** and **26,** unwound from rolls **28** and **30** are brought into contact with the adhesively printed web **10** at the roll **32** to form the laminate **34** having outer layers of the continuous filament webs and an inner cellulose wadding layer.

The manner of formation of the continuous filament webs **24** and **26** is not particularly important, and a variety of well known techniques can be used. In general such techniques involve continuously extruding a polymer through a spinneret, drawing the spun filaments, and thereafter depositing the drawn filaments on a continuously moving surface in a substantially random fashion. Drawing serves to give the polymer filaments tenacity, while substantially random deposition gives the web desirable isotropic strength characteristics. The aforementioned Kinney patents as well as other patents, such as Levy, U.S. Pat. No. 3,276,944, illustrate useful techniques of initial web formation.

In addition to presently known methods of initial web formation, a particularly useful technique is described in copending application Ser. No. 865,128, titled Continuous Filament Non-Woven Web and Process For Producing the Same, filed on Oct. 9, 1969, and now U.S. Pat. No. 3,692,618. Use of the method therein disclosed permits high rates of web formation. In general, the disclosed method involves conventional spinning of continuous filaments of a synthetic polymer by, for example, extruding the polymer through a multiple number of downwardly directed spinning nozzles preferably extending in a row or multiple number of rows. The filaments as they are spun are gathered into a straight row of side-by-side, evenly spaced apart, untwisted bundles each containing at least 15 and preferably from 50 to 150 filaments. These filament bundles are simultaneously drawn downwardly at a velocity of at least 3,000 meters per minute, and preferably from 3,500 to 8,000 meters per minute, in individually surrounding gas columns flowing at a supersonic velocity and thus directed to impinge on a substantially horizontal carrier.

The gathering of the filaments into the bundles and their drawing and directing to impinge on the carrier is preferably effected by passing the bundles through air guns which surround the filaments with a column or jet of air which is directed downward at supersonic velocity. The air guns are arranged so as to extend in a straight row in a direction extending across the carrier at right angles to its direction of movement, so that the bundles contained in the gas columns as they strike the moving carrier extend in a line or row at right angles across the carrier. In order to enhance intermingling of the bundles, the air guns can be made to oscillate, the plane of oscillation being transverse to the direction of carrier movement. The carrier can be a conventional carrier used in the nonwoven art, such as an endless carrier or belt screen or the upper portion of a drum, as for example a screen drum.

When prepared as described above, the filament bundles containing a number of parallel filaments are laid down on the carrier in a loop-like arrangement with primary loops extending back and forth across the width of a section defined by the impingement of the air column from one air gun on the carrier. Before and as the parallel filament bundles impinge the carrier, they are broken up into sub-bundles containing a lesser number of parallel filaments and forming secondary smaller loops and swirls. The secondary loops and swirls overlap each other, and those of adjacent sections, to result in substantially complete intermingling with the overlapping portions of adjacent sections. Thus, the laid-down filament bundles form a continuous uniform nonwoven web.

Referring again to FIG. 1, the thermoplastic polymer used in preparing the continuous filament webs **24** and **26** must be crystallizable and spinnable. Due to its cost, predominantly isotactic polypropylene is preferred; however, other polymers such as other polyolefins, e.g., — linear polyethylene, polyisobutylene, polybutadiene, etc., polyurethanes, polyvinyls, polyamides, and polyesters can also be used. In addition, mixtures of the above polymers and copolymers prepared from monomers used in preparing the above polymers are useful.

For use in the process illustrated in FIG. 1, the webs **24** and **26** generally can have a basis weight of about 0.3–1 oz./yd.^{2} with the filaments thereof having a denier of about 0.5–6. Fabrics with an especially suitable combination of strength and aesthetic characteristics can be prepared with webs having basis weights of 0.3–0.7 oz./yd.^{2} and filament deniers of about 0.8–2.5.

In order to optimize laminate strength and resistance to abrasion as well as for eace in handling, the webs **24** and **26** should preferably be bonded prior to lamination with the web **10**. While overall bonding techniques can be used, the most useful webs, particularly with respect to desirable "hand," are those which contain an intermittent pattern of bond are as distributed substantially uniformally throughout the web. Webs wherein the total bonded area is about 5–50% of the web area and wherein the density of individual bonds is about 50–3,200 per square inch possess a desirable combination of "hand" and tensile strength. Higher bond densities are employed with higher total bonded areas. Particularly preferred webs are those having a total bonded area of about 8–20% and a bond density of about 100–500 per square inch.

Moreover, a particular type of intermittently bonded web is preferred for use herein. As set forth in copending Brock et al. application, Ser. No. 14,943, entitled "Nonwoven Laminate Containing Bonded Continuous Filament Web," filed on Feb. 27,1970, which application has been abandoned in favor of continuation-inpart application, Ser. No. 177,078, filed Sept. 1, 1971, and now U.S. Pat. No. 3,788,936, laminates containing a continuous filament web can be prepared with high energy absorption when the continuous filament web is "release" bonded. As explained therein, energy absorption effects the ability of a web to deform without failure under stress. A fabric with low energy absorption will tend to fail at natural stress areas, such as the elbow and knee areas in wearing apparel whereas a fabric with high energy absorption will resist failure. Accordingly, by using release bonded webs in the laminates described herein, not only do the laminates possess the advantages discussed previously in connection with the objectives of the present invention, but additionally they have good energy absorption. The preparation of release bonded webs is described in Hansen et al. application, Ser. No. 15,034, entitled "Pattern Bonded Continuous Filament Web," filed on Feb. 27, 1970 and in continuation-in-part application, Ser. No. 121,880, filed Mar. 8, 1971, both of which applications have been abandoned in favor of continuation-in-part application, Ser. No. 177,077, filed Sept. 1, 1971.

Referring again to FIG. 1, after the laminate **34** is formed at the roll **32**, it is passed around the heated drum **36** in order to cure the plastisol adhesive. The roll **32** and the take off roll **38** serve to maintain contact between the laminate **34** and the heated drum **36**.

In order to obtain a laminate which is both aesthetically pleasing and possesses high delamination resistance, the manner in which the laminate is formed is important. Thus, laminate formation is accomplished such that the adhesive used in bonding sufficiently penetrates the layer of cellulose wadding and the continuous filament webs to assure good laminate strength and yet adhesive strike-through to the outer surfaces of the webs and adhesive spreading within the laminate is avoided. Adhesive strike-through adversely affects laminate appearance, while adhesive spreading gives rise to an undesirable increase in laminate stiffness.

With reference to FIG. 1, suitable laminate bonding with a plastisol adhesive can be accomplished by appropriately coordinating the temperature of the heated drum, the time during which the laminate is in contact with the drum (dwell time), and the pressure exerted on the laminate in the nip formed between the drum and the roll **32**. In understanding the manner in which these parameters are coordinated, reference is directed to FIG. 2. Embodiment (a) shows the plastisol adhesive **22** on the bottom surface of the web **10** prior to the time at which the web **10** is united with the webs of continuous filaments at the roll **32**. The viscosity of the adhesive at this time is about the same as its application viscosity and thus is low. Consequently, on bringing the web **10** into contact with the webs **24** and **26**, and subsequently bringing the laminate in to contact with the drum, care must be exercised to avoid excessive adhesive penetration and spreading. Nip pressures between the roll **32** and the drum on the order of about 70–100 pli. are sufficient to achieve a desirable penetration as illustrated in embodiment (b) of FIG. 2.

On the other hand, as the laminate travels on the drum surface, plastisol temperature and viscosity rise, and the problem of excessive adhesive penetration becomes less significant. Regarding travel on the drum surface, the laminate must reamin in contact with the surface for a sufficient time to permit the plastisol to cure and thus develop maximum strength characteristics. For drum temperatures of 250°F.–300°F., dwell times of 0.5–3 seconds are usually sufficient. Embodiment (c) of FIG. 2 depicts a cross-section of the finished laminate with the plastisol substantially cured. As can be seen, little additional adhesive penetration occurs during curing on the drum surface.

Referring again to FIG. 1, after leaving the drum **36**, the laminate can be passed through the calender stack **40** to provide a smooth surface finish and then wound up on the roll **42**. Typically the calender stack **40** comprises three rolls, **44**, **46**, and **48**, with the top roll **44** generally being at about the same temperature as the drum **36** in order to assure complete plastisol curing. Pressures about equivalent to the nip pressure between the roll **37** and the drum are useful calender pressures.

FIG. 3 illustrates a laminate prepared by the method described above. As shown, the laminate has outer plies of continuous filament webs **24** and **26** and a single inner ply of cellulose wadding **10.** The individual filaments in the webs **24** and **26** are bonded together by means of the intermittent pattern of bonds **50.** The layers **24, 10** and **26** are united together by means of the spaced pattern of plastisol adhesive **22.**

The following Example illustrates the invention. All parts and percentages are by weight unless otherwise indicated. As reported in the Example, Wrinkle Recovery (WR), Abrasion Resistance (AR), and Opacity (Op) are measured using the following standard procedures:

(WR) = A²TC² 66 - 1959T
(AR) = STOLL - ASTM D 1175-64T
(Op) = TAPPI T 425M-60

EXAMPLE I

A laminate having an inner ply of creped tissue wadding (12 inches wide and having a basis weight of 13 g/yd.²) and outer plies of intermittently bonded continuous filament polypropylene webs (12 inches wide with basis weight of 15 g/yd.² — bonded according to Example 5 of Hansen et al.) was prepared in a manner described above with reference to FIG. **1.** The conditions of preparation were as follows: Web Speed = 50 ft./min.; Roll **32** = 6.5 inch dia., 200 pli. pressure against drum **36**; Drum **36** = 30 inch dia., 285°F.; Rolls **44, 46,** and **48** = 10 inch dia., roll **44** at 225°F., calender pressure at 200 pli; Laminate wrap on drum surface = 4.25 feet. The adhesive applied at the printing station **14** was a plastisol of 100 parts polyvinyl chloride (Geon 130 × 100), 100 parts dioctyl phthalate plasticizer (BFG 264) and 10 parts mineral spirits (Number 17). The plastisol was applied to the web in an amount of 7 grams./yd.². and at a Brookfield viscosity of 1,400 cps. (Number 4 spindle, 20 rpm's 30°C.). After printing, the plastisol occupies 10% of the web area and was disposed thereon in a rectangular block (0.02 inch × 0.20 inch) pattern with 43,200 blocks/yd.².

The laminate, prepared as above described, was tested with respect to the properties previously discussed. The results are presented in Table 1.

TABLE 1

Test	
Wrinkle Recovery (°)	270
Abrasion Resistance (top) (cycles to pill)	713
Opacity (% light ab.)	64

In addition to the above properties, the laminate is quite isotropic in stress and strain behavior and has a very desirable cloth-like surface feel and good hand. It can also be washed several times without adversely affecting the desirable product attributes discussed herein.

Reference is also directed to copending Beaudoin et al. application, Ser. No. 228,349, filed on Feb. 22, 1972 and now U.S. Pat. No. 3,793,133. Therein, it is disclosed that a laminate comprised of an intermittently bonded continuous filament web and a web of cellulose wadding can be fashioned with especially desirable energy absorbing and strength characteristics by appropriately controlling the intensity of the intermittent bonds and the ply attaching adhesive.

We claim as our invention:

1. An absorbent, substantially opaque nonwoven material having desirable isotropic strength characteristics and simulating in hand and feel a woven cloth or fabric comprising, in combination,

a. a web of cellulose wadding having a basis weight of about 0.3 — about 0.7 oz./yd.²,

b. disposed on either side of said cellulose wadding, a low basis weight nonwoven web of substantially continuous and randomly deposited, molecularly oriented filaments of a hydrophobic thermoplastic polymer, each of said webs having a basis weight of up to about 0.7 oz./yd.² and the filaments thereof having a denier of about 0.5 — about 6, and

c. patterned areas of adhesive disposed between said webs which penetrate into said cellulose wadding web at spaced open areas in a manner so as to provide delamination resistance in combination with fabric-like flexibility, the placement of said nonwoven webs on either side of said web of cellulose wadding providing a desirable degree of wrinkle recovery and permitting the material to be washed several times without deterioration thereof.

2. The material of claim **1** wherein the nonwoven webs have a basis weight of about 0.3 – about 0.7 oz./yd.², the thermoplastic polymer is polypropylene and the filaments have a denier of about 0.8 — about 2.5.

3. The material of claim **1** wherein the continuous filament webs are bonded by the application of heat and pressure at intermittent areas occupying about 5 – 50% of the web area and in a density of about 50–3,200 per square inch.

4. The material of claim **3** wherein the nonwoven webs have a basis weight of about 0.3 — about 0.7 oz./yd.², the thermoplastic polymer is polypropylene and the filaments have a denier of about 0.8 — about 2.5.

5. The material of claim **4** wherein the nonwoven webs contain an intermittent pattern of bond areas in a density of about 100–500/inch² and occupy 8–20% of the web area.

6. An absorbent, substantially opaque nonwoven material having desirable isotropic strength characteristics and simulating in hand and feel a woven cloth or fabric comprising, in combination,

a. a web of cellulose wadding having a basis weight of about 0.3 — about 0.7 oz./yd.²,

b. disposed on either side of said cellulose wadding, a low basis weight nonwoven web of substantially continuous and randomly deposited, molecularly oriented filaments of a hydrophobic thermoplastic polymer selected from polyolifins, polyurethanes, polyvinyls, polyamides and polyesters, each of said webs having a basis weight of up to about 0.7 oz./yd.² and the filaments thereof having a denier of about 0.5 — about 6, and

c. spaced areas of adhesive occupying less than about 25% of the area of cellulosic web and penetrating each surface of said cellulosic web and the adjacent nonwoven webs to bond the webs together, the placement of said nonwoven webs on either side of said cellulose wadding web providing a desirable degree of wrinkle recovery and permitting the material to be washed several times without deterioration thereof.

7. The material of claim 6 wherein the nonwoven webs have a basis weight of about 0.3 – about 0.7 oz.-/yd.^{2}, the thermoplastic polymer is polypropylene and the filaments have a denier of about 0.8 — about 2.5.

8. The material of claim 7 wherein the continuous filament webs are bonded by the application of heat and pressure at intermittent areas occupying about 8 – 20% of the web area and in a density of about 100 – 500/inch^2.

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