NONWOVEN TEXTILE FABRICS AND METHODS OF MAKING THE SAME

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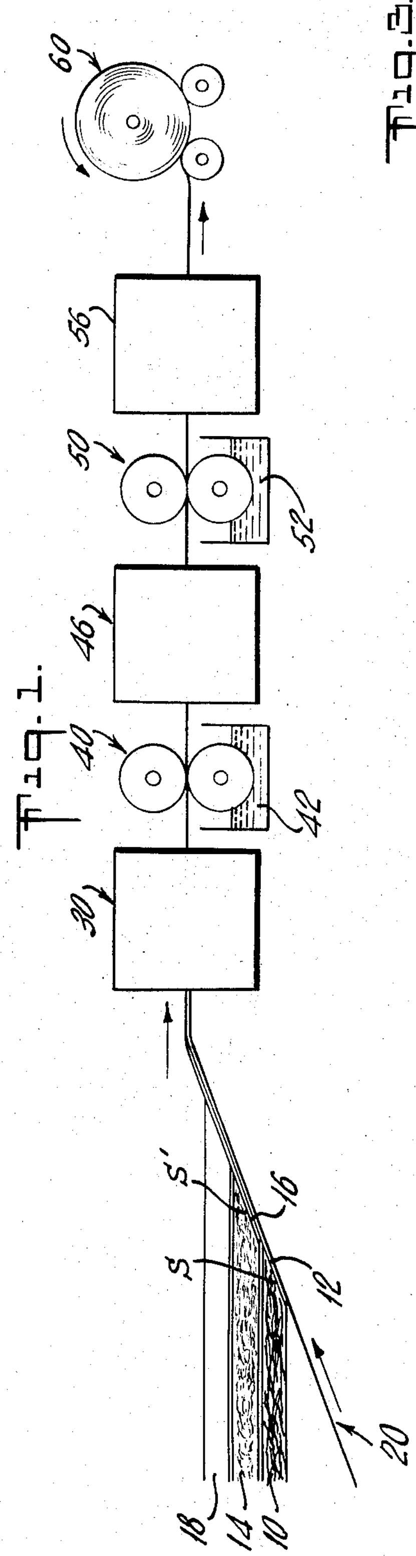

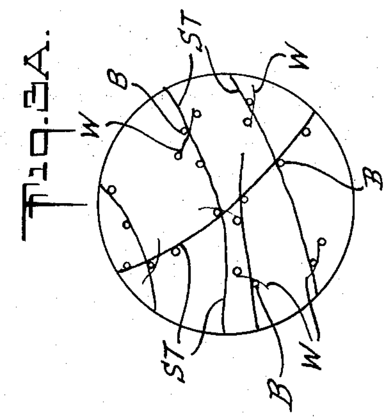

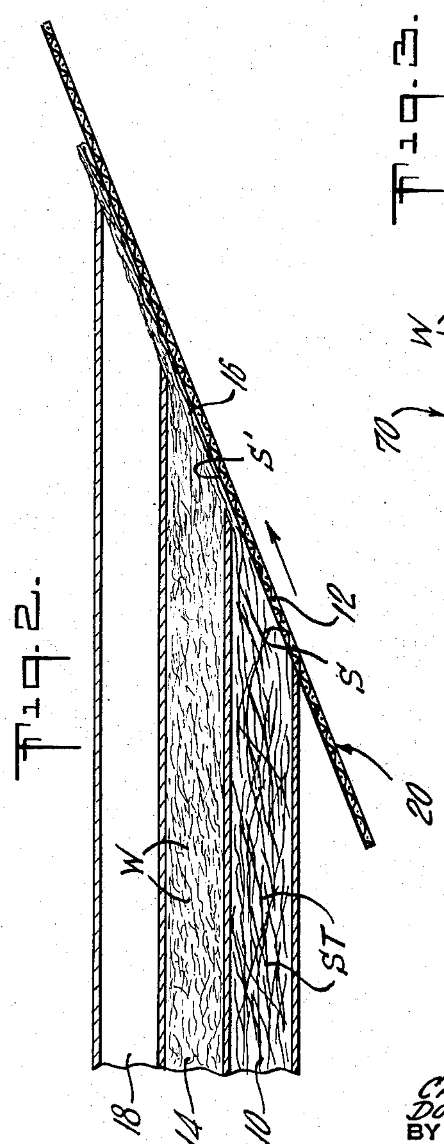

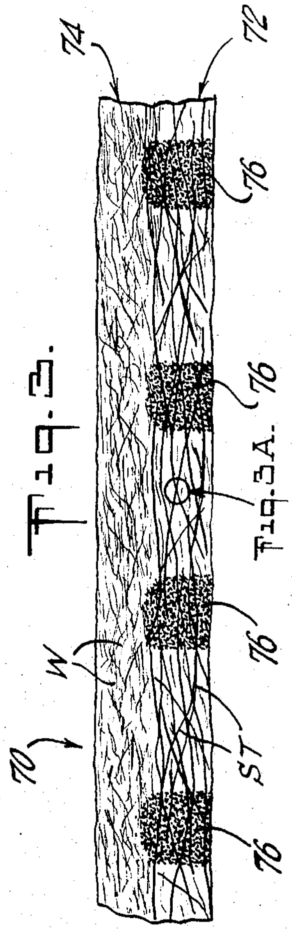

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ABSTRACT OF THE DISCLOSURE

A nonwoven textile fabric having excellent softness, drape, and hand, as well as excellent tensile, burst, and tear strengths and stitch-like qualities of comprising: (1) a relatively flat, sheet-like fibrous portion of overlapping and intersecting structural textile fibers having an average length of from about ¼ inch to about 1¼ inches or more, in which structural fibrous portion there may be included relatively short fibers having an average length of from about ⅙ inch to about ¹⁄₂₅ inch or less; and (2) a relatively flat, sheet-like fibrous portion of relatively short fibers having an average length of from about ⅙ inch to about ¹⁄₂₅ inch or less, the individual fibers of each fibrous portion, as well as the fibrous portions themselves, being adhered and bonded to each other by inter-fiber entanglement and by discrete resin binder materials adhered to the individual fibers thereof, the individual fibers of the structural fibrous portion being additionally bonded to each other by an intermittent print pattern of discrete synthetic resin binder areas, whereby a nonwoven textile fabric is obtained having excellent softness, drape and hand, as well as excellent tensile, burst, and tear strengths and stitch-tear qualities. Methods of making such nonwoven textile fabrics and particularly methods involving the use of wet-forming manufacturing techniques are also included.

BACKGROUND

Many people have been engaged for many years in the manufacture of nonwoven textile fabrics which can be made without resorting to the spinning, twisting, and twining of individual fibers into yarns and strands, and the subsequent weaving, knitting, or other fabricating of these yarns and strands into fabrics.

Such nonwoven textile fabrics have usually been manufactured by laying down one or more fibrous layers or webs of textile length fibers by dry textile carding techniques which normally align the majority of the individual fibers more or less generally lengthwise of the fibrous layer or web being prepared. The individual textile length fibers of these carded fibrous webs are then bonded by conventional bonding techniques, such as, for example, by intermittent print pattern bonding, whereby a unitary, self-sustaining nonwoven textile fabric is obtained. Such manufacturing techniques, however, are relatively slow and it has always been desired that manufacturing processes having greater production rates be devised. Additionally, it is to be noted that such dry textile carding and bonding techniques are normally applicable only to fibers having a textile cardable length of at least about ½ inch, and preferably longer, and are not applicable to short fibers such as wood pulp fibers. And, it is also to be noted that the surfaces of such nonwoven textile fabrics made by dry textile carding processes utilizing textile length fibers are not sufficiently tight, nor are the individual fibers sufficiently close, as to provide a good substrate suited to receive certain finishing treatments, such as a water-repellent or a water-proofing finishing treatment.

More recently, people have been engaged in the manu-

facture of nonwoven textile fabrics by wet-forming techniques on conventional or modified papermaking or similar machines. Such manufacturing techniques have much higher production rates and are applicable to very short fibers such as wood pulp fibers which have very short lengths of from about ⅙ inch (0.167 inch) down to about ¹⁄₂₅ inch (0.040 inch), or even less. Unfortunately, difficulties are often encountered in the use of the longer textile length fibers in such wet-forming manufacturing techniques.

Additionally, it has been found that such conventional wet-forming manufacturing techniques, when combined with conventional saturation or over-all bonding techniques, are normally incapable of producing nonwoven textile fabrics which have the necessary softness, hand, drape, and esthetic qualities of woven textile fabrics, along with the required tensile, burst, and tear strengths and stitch-tear qualities, properties, and characteristics required for nonwoven textile fabrics. This is particularly true when the nonwoven textile fabrics are to be used in the single-use or limited re-use disposable field, such as for disposable apparel, linens, cleaning and wiping cloths, bandages, dressings, pads, surgical drapes and gowns, etc.

THE INVENTIVE CONCEPT

It has been found that nonwoven textile fabrics having excellent softness, drape, and hand, as well as excellent tensile, burst, and tear strengths and stitch-tear qualities can be made by:

(1) Forming a relatively flat, sheet-like fibrous portion of structural textile fibers having an average length of from about ¼ inch to about 1¼ inches or more, in which structural fibrous portion there may be included relatively short fibers having an average length of from about ⅙ inch to about ¹⁄₂₅ inch or less, said structural fibrous portion being capable of having incorporated therein discrete synthetic resin binder materials;

(2) Depositing on said structural fibrous portion relatively short fibers having an average length of from about ⅙ inch to about ¹⁄₂₅ inch or less, whereby a relatively flat, sheet-like short fiber portion is formed in intimate and interentangled fiber relationship with the structural fibrous portion, said short fiber portion also being capable of having incorporated therein discrete synthetic resin binder materials;

(3) Drying said structural fibrous portion with the short fiber portion deposited thereon and interentangled therewith, whereby all of said fibers become bonded into a unitary structure; and

(4) Additionally bonding said structural fibrous portion with an intermittent print pattern of discrete binder areas, whereby a nonwoven textile fabric is obtained having excellent softness, drape and hand, as well as excellent tensile, burst, and tear strengths and stitch-tear qualities.

In the following specification and accompanying drawings, there is described and illustrated a preferred embodiment of the invention but it is to be understood that the inventive concept is not to be considered as limited to the embodiment disclosed except as determined by the scope of the appended claims. More specifically, the illustrative embodiment relates to wet-forming methods but it is to be appreciated that other equivalent manufacturing processes can be used in the application of the principles of the present inventive concept. Referring to the accompanying drawings:

FIG. 1 is a schematic drawing showing a typical flow chart of a wet-forming manufacturing process, representing a preferred embodiment of the present inventive concept;

FIG. 2 is a magnified detail drawing showing on a larger scale greater details of the wet formation of the various relatively flat, sheet-like fibrous portions;

FIG. 3 is a schematic drawing showing in cross-section the internal construction of the finished nonwoven textile fabric of the present invention; and

FIG. 3A is an enlarged magnified schematic drawing of a portion of the nonwoven textile fabric of FIG. 3, showing textile length structural fibers, short wood pulp fibers, and discrete resin binder particles.

In the drawings and with particular reference to FIGS. 1 and 2, there is schematically shown the discharge portion **10** of a papermaking machine headbox associated with a conventional stock chest (not shown) wherein the fibers are formed into a slurry in the presence of discrete resin binder particles or like materials and a deposition aid, if required or desired.

Stock chest preparation

The concentration of the fibers in the stock chest slurry is on the order of from about 1/20 percent by weight to about 1½ percent by weight, on a dry fiber weight basis. Preferably, such range of fiber concentration in the aqueous slurry is from about 1/10% by weight to about 1% by weight.

The concentration of the resin binder particles or like materials in the stock chest slurry depends on the amount of resin binder particles which are intended to be deposited on the individual fibers. The range extends from about 5 percent by weight to about 100 percent by weight of dry resin solids, based on the total dry fiber weight in the stock chest, and preferably extends from about 15 percent by weight to about 40 percent by weight.

The concentration of the deposition aid in the stock chest slurry should be enough to bring about satisfactory deposition of the resin particles on the fibers in the aqueous slurry. Normally, such concentration is in the range of from about ½ percent by weight to about 1½ percent by weight, based on the total dry resin solids in the stock chest. Less than ½ percent by weight of a deposition aid may be used, particularly in the case of nonionic or cationic resin emulsions. More than 1½ percent may be used, particularly when the cationic charge on the particular deposition aid is low. This is basically not desired inasmuch as a low cationic charge deposition aid will necessitate greater concentrations of its use which is commercially undesirable.

Fibers used

The dispersed fibers in the stock chest leading to the discharge portion **10** comprise structural textile length fibers having an average length of from about ¼ inch to about 1¼ inches or more and, if desired or required, relatively short fibers having an average length of from about 1/6 inch (0.167 inch) to about 1/25 inch (0.040 inch) or less.

Structural fibers

The structural textile length fibers S may be selected from a large group of natural, synthetic or man-made fibers such as: the cellulosic fibers, notably cotton, regenerated cellulose (both viscose and cuprammonium processes), cellulose acetate, and cellulose triacetate; the noncellulosic fibers such as: the polyamide fibers, notably nylon 6,6 and 6; the polyesters, notably "Dacron," "Fortrel" and "Kodel"; the acrylics, notably "Creslan," "Acrilan" and "Orlon"; the modacrylics, notably "Dynel" and "Verel"; the polyolefins, especially polypropylene and polyethylene, notably "Vectra" and "Herculon"; the spandexes, notably "Lycra" and "Unel"; the fluorocarbons, notably "Teflon" TFE and FEP; etc. These fibers may be used by themselves, or in various combinations and blends of two or more species in varying percentages, as desired or required.

The denier of the synthetic or man-made structural fibers S may be varied relatively widely, depending on the circumstances, and vary from about 1½ denier to about 6 denier, with lower deniers to about 1 or less, and higher deniers to about 9, 15, or more being of use in special circumstances.

Short fibers

The remaining fibers of the structural fiber portion, if other fibers are used, are wood pulp fibers or other short fibers W.

Unbeaten or unrefined wood pulp fibers W, or at least relatively unbeaten or unrefined wool pulp fibers are preferably used inasmuch as beating and refining are rather severe mechanical treatments, and beat and macerate the fibers whereby enhanced hydration bonding is obtained which is not desired in the present inventive concept and which leads to a product which undesirably has increased stiffness, harshness and a papery hand.

Although unbeaten hardwood sulfite pulp will be disclosed as the preferred type of wood pulp fiber used in the application of the present invention, substantially any type of wood pulp, either hardwood or softwood, is of use. Examples of other types of wood pulp are: sulfite pulps in which the cooking liquor, calcium or magnesium bisulfite, is acid, or sodium sulfite which is neutral or slightly alkaline; soda pulps in which the cooking liquor, caustic soda, is alkaline; kraft or sulfate pulps in which the cooking liquor, sodium hydroxide and sodium sulfide, is alkaline, etc.

Although wood pulp fibers W are preferred in the application of the present inventive concept, other short fibers or fibrous materials are of use. Examples of such short fibers or fibrous materials having lengths of from about 1/6 inch to about 1/25 inch or less are: cotton linters, bagasse, flax, flax straw, jute, straw, bamboo, esparto grass, rayon, and rags, and the like, as well as industrial waste products such as macerated or particulate materials from rag, cotton seed hulls, corn stalks, bamboo stalks, etc.

The proportions of the various fibers in the aqueous slurry leading to discharge portion **10** may be varied within generally broad ranges and normally is as follows:

Viscose rayon fibers are the preferred structural fiber which comprise from about 20 percent by weight to about 100% by weight of the total fiber weight. Other structural textile length fibers, as listed herein, may be included in amounts up to about 30 percent by weight of the total fiber weight. The relatively short fibers which are usually wood pulp fibers may be included in amounts up to as high as about 80 percent by weight of the total fiber weight and preferably from about 10 percent by weight to about 75% by weight.

It is essential that all these fibers be dispersible, or at least be capable of being dispersed, substantially uniformly in the aqueous slurry. Dispersion aids may be used to assist or promote such uniformity of dispersion.

Resin binder particles

During the dispersion of the fibers in the stock chest, the structural fibrous portion may have incorporated therein from about 5% by weight to about 100% by weight, and preferably from about 15% by weight to about 40% by weight, based on the weight of the dry fibers, of discrete particles of a synthetic resin binder B.

The particular resin binder B which is incorporated in the fibrous portion is selected from a relatively large class of synthetic resins well known in the art for bonding or adhering fibers or fibrous materials together. Such resins may be of the internal or self cross-linking type, the cross-linkable type which are cross-linked by added cross-linking agents, of the non-cross-linked or non-cross-linkable type. Examples of such synthetic resins include: polymers and copolymers of vinyl ethers; vinyl halides such as plasticized and unplasticized polyvinyl chloride, polyvinyl chloride-polyvinyl acetate, ethylene-vinyl chloride, etc.; polymers and copolymers of vinyl esters such as plasticized and unplasticized polyvinyl acetate, ethylene-vinyl acetate, acrylic-vinyl acetate, etc.; polymers and copolymers of the polyacrylic resins such as ethyl acrylate, methyl acrylate, butyl acrylate, ethyl-butyl acrylate, ethyl hexyl acrylate, hydroxyethyl acrylate, dimethyl amino ethyl acrylate, etc.; polymers and copolymers of the polymethacrylic resins such as methyl methacrylate, ethyl methacrylate, isopropyl methacrylate, butyl methacrylate, etc.; polymers and copolymers of acrylonitrile, methacrylonitrile, acrylamide, N-isopropyl acrylamide, N-methylol acrylamide, methacrylamide, etc.; vinylidene polymers and copolymers, such as polyvinylidene chloride, polyvinylidene chloride-vinyl chloride, polyvinylidene chloride-ethyl acrylate, polyvinylidene chloride-vinyl chloride-acrylonitrile, etc.; polymers and copolymers of polyolefinic resins including polyethylene, polypropylene, ethylene-vinyl chloride and ethylene-vinyl acetate which have been previously listed; the synthetic rubbers such as 1,2-butadiene, 1,3-butadiene, 2-ethyl-1,3-butadiene, high, medium and carboxylated butadiene-acrylonitrile, butadiene-styrene, chlorinated rubber, etc., natural latex; the polyurethanes; the polyamides; the polyesters; the polymers and copolymers of the styrenes including styrene, 2-methyl styrene, 3-methyl styrene, 4-methyl styrene, 4-ethyl styrene, 4-butyl styrene; natural latex; phenolic emulsions; etc.

These resins may be used either as homopolymers comprising a single repeating monomer unit, or they may be used as copolymers comprising two, three, or more different monomer units which are arranged in random fashion, or in a definite ordered alternating fashion, within the polymer chain. Also included within the inventive concept are the block polymers comprising relatively long blocks of different monomer units in a polymer chain and graft polymers comprising chains of one monomer attached to the backbone of another polymer chain.

Resin deposition aids

The deposition of the synthetic resin binder particles on the individual fibers may be accomplished in many ways at various points in the manufacturing process but, preferably, is accomplished by stock chest deposition techniques. Such techniques generally include the formation of a substantially uniform, aqueous slurry of the fibers which will make up the fibrous web and the inclusion in the aqueous slurry of the synthetic resin particles which are to be deposited on and adhered to the individual fibers. Deposition aids may be used, if necessary, to promote the deposition and adherence of the synthetic resin particles on the individual fibers. Examples of such deposition aids are Rohm & Haas Deposition Aid S-243, polyethylene imine, alum, polymeric amines, polymeric amides, cationic starch, etc.

Formation of the structural fibrous portion

Returning to the drawings and particularly FIGS. 1 and 2 therein, the aqueous slurry containing the structural fibers and the short fibers which have incorporated therewith the discrete particles of resin binder is discharged through discharge portion **10** onto the open screen-like surface of a moving forming surface **20** which is provided with underlying conventional suction boxes (not shown) whereby a considerable part of the water is drained rapidly from the aqueous slurry to form a relatively flat, sheet-like fibrous structure S in the area **12** of the forming surface **20**.

A rectilinearly moving forming surface **20** is disclosed herein but it is to be appreciated that this is merely illustrative of the present inventive concept, and that other forming surfaces such as Fourdrinier wires, inclined wires, screens, belts, rotating cylinders, etc., are of use.

The fibrous structure S containing the structural fibers and short fibers is then carried onwardly on the moving forming surface **20** and passes under the discharge portion **14** of another headbox associated with another stock chest (not shown). The second headbox discharge **14** discharges an aqueous slurry of relatively short fibers, similar in nature to those short fibers described previously. Again, such short fibers are preferably wood pulp fibers but other short fibers, as mentioned herein, are of use.

These short fibers being discharged from the second discharge portion **14** have deposited on and adhered to their surfaces from about 2 percent by weight to about 100 percent by weight; and preferably from about 5 percent by weight to about 35 percent by weight, of the synthetic resin binder particles described hereinbefore.

The short fibers discharged from the second discharge portion **14** are deposited in the area **16** of the forming surface **20** on top of the structural fibrous portion previously discharged from the first discharge portion **10** and before it has had sufficient time to set completely. There is a considerable amount of fibers intermingling, intermixing and interentangling in the formation of a unitary fibrous structure S'. No clear-cut interface or boundary exists between the two fibrous portions and to all intents and purposes, one unitary fibrous structure S' is present. One side of this fibrous structure S' and for a definite depth thereof is substantially 100 percent short fibers and possesses the qualities, characteristics and properties of a short fibered sheet. The structure and surface thereof is sufficiently tight and the fibers therein are sufficiently close as to form a surface well suited to receive a water-repellent or a water-proofing finishing treatment. It is a comparatively dense portion, with excellent opacity and covering power. The other side of the fibrous structure S' comprises structural fibers and short fibers and possesses the qualities, characteristics and properties of such a fibrous structure. The structural fibers lie in the plane of the nonwoven textile fabric and do not protrude therefrom. The structure is less dense than the short fibered portion.

A third discharge portion **18** is provided in the event that it is desired to deposit another aqueous slurry of dispersed fibers on the composite fibrous structure S'.

The structure S' is then forwarded to drying means **30** which preferably take the form of a series of heated rotatable drying cylinders. Other drying means such as a large drying drum, or a heated oven, or the like, are of use, if they are capable of providing an elevated drying, bonding and curing temperature in the range of from about 200° F. to about 350° F. or higher, if desired or required.

The drying at such an elevated temperature serves to activate the bonding characteristics of the resin binder particles, whereby the individual fibers become bonded to each other. This is particularly important in the case of the short fibers, such as wood pulp, which are effectively bonded and locked in position.

The dried, bonded nonwoven textile fabric is then passed through additional bonding apparatus **40** wherein there is applied to the side containing the structural fibers an additional bonding agent **42** in the form of an intermittent print pattern of spaced discrete binder areas. The particular print pattern is selected from a large group of commercially known intermittent print patterns such as, for example, illustrated in U.S. Pats. 2,705,498, 2,705,687, 2,705,688, 2,880,111 and 3,009,822.

These intermittent, print patterns are closely spaced and are intended to contact even the shortest of the structural fibers in more than one place along their length to bond the fibers and to develop the required tensile, burst, and tear strengths and stitch-tear qualities required in the finished nonwoven textile fabric.

The additional bonding agent is applied to the side of the dry nonwoven textile fabric containing the structural fibers and is applied in such a manner and at such concentrations and under such pressure that the bonding agent penetrates with an irregular, jagged leading face substantially through the structural fibrous portion but essentially does not enter the short fibered portion. Such a selective intermittent print pattern bonding greatly strengthens the structural portion of the nonwoven textile fabric, enhances its tensile, burst, and tear strengths and stitch-tear qualities, without affecting the softness, hand, or feel of the short fibered surface.

The synthetic resins which are used to additionally bond the individual structural fibers are selected from the group of synthetic resins listed hereinbefore. The amount of synthetic resin binder applied is in the range of from about 10% by weight to about 20% by weight, based on the weight of the nonwoven textile fabric being bonded.

It is to be noted that the intermittent print pattern bonding takes place on a dry fibrous substrate in order to limit or restrict the binder migration which would take place on a wet fibrous substrate. Limitation or restriction of binder migration maintains the softness, drape, and hand of the nonwoven textile fabric which otherwise could be lost if the binder migration was uncontrolled.

In the event that the application of binder takes place on a wet fibrous substrate, then resort may be had to non-migrating binders, such as viscose (see U.S. Pat. 3,009,822), or to various binder migration control systems such as described in copending, commonly assigned patent application Ser. No. 109,026, filed Jan. 22, 1971, and now Pat. No. 3,706,595.

A second dryer **46** is used to dry the nonwoven textile fabric subsequent to the intermittent print pattern bonding. This dryer **46** may comprise a series of heated drying cylinders, or a large heated drying drum, or a heated oven, or the like.

If desired, additional treatments may be applied to the nonwoven textile fabric to achieve specific purposes. An over-saturation in a padder **50** or the like with an additional binder or other additives or treating agents **52** may be resorted to, for example, in order to attain special properties, such as, for example, increased wet abrasion resistance and better launderability. The application of water-proofing or water-repellent agents, dyes and pigments, flame-proofing agents, insect or vermin-proofing materials, and the like, is also possible.

Such additional saturation bonding applies the additional specialty agent or additive treatment to the extent of from about 2% by weight to 50% by weight, based on the weight of the nonwoven textile fabric being treated.

Another dryer **56**, similar to any of the drying devices described previously may be employed to dry the nonwoven textile fabric. Subsequent to drying, the nonwoven textile is forwarded and wound on a batcher **60** or other re-wind device.

In FIG. 3, there is schematically shown in cross-section the internal construction of a typical nonwoven textile fabric **70** of the present invention. A structural fibrous portion **72** containing structural fibers and short fibers is shown, upon which is the short fibered portion **74**. As shown, there is considerable intermixing and inter-entangling of the fibers where the fibrous portions meet so that there is no clear cut interface or boundary. The nonwoven textile fabric **70** is essentially a unitary structure. Binder particles are present throughout both fibrous portions and serve to bond the individual fibers together. Additionally, an intermittent print pattern of discrete resin binder areas **76** is shown which additionally bonds and strengthens the structural fibrous portion **72** but which does not materially enter into the short fibered portion **74**. Some entry of the resin binder areas **76** into the short fibered portion **74** is tolerated provided such resin binder areas **76** do not go all the way through or affect the properties and characteristics of the short fibered portion undesirably.

The invention will be further described by reference to the following examples wherein there are disclosed preferred embodiments of the present invention. However, it is to be appreciated that such examples are illustrative and not limitative of the broader aspects of the inventive concept.

EXAMPLE I

A wet-formed, nonwoven textile fabric is prepared as follows:

The structural portion comprises: 30 percent by weight of rayon fibers having a denier of 1.5 and a length of ⅜ inch; 20 percent by weight of polyamide nylon 6,6 fiber having a denier of 6 and a length of ¾ inch; and 50 percent by weight of unbeaten and unrefined hardwood sulfite wood pulp fibers. These fibers are slurried to a consistency of about 1 percent by weight in a stock chest containing about 50 percent by weight, based on the total dry fiber weight, of Rohm & Haas Resin Emulsion E–631, a self cross-linking (methylol functionality) anionic ethyl acrylate acrylic binder, and about 1 percent by weight, based on the total dry resin solids, of Rohm & Haas Deposition Aid S–243, a moderate molecular weight cationic polyelectrolyte (hydroxy group functionality) deposition aid. When formed, the total weight of the first structural fibrous layer is 504 grains per square yard, of which 338 grains is the fiber weight and 166 is the resin particle weight. This is equivalent to a 50% add-on of resin binder particles.

The short fibered portion comprises 100% unbeaten and unrefined hardwood sulfite wood pulp fibers. These fibers are slurried separately to a 1% consistency under generally similar conditions in another stock chest containing 33% by weight, based on the dry resin solids, of Rohm & Haas Resin Emulsion E–631 and 1% by weight, based on the fiber weight, of Rohm & Haas Deposition Aid S–243.

The aqueous slurry of wood pulp fibers is deposited on top of the structural fiber portion just after that portion has been formed on a forming surface and while it is still wet. There is considerable fiber intermixing and inter-entangling and a unitary fibrous structure is formed. When formed, the total weight of the wood pulp fiber portion is 336 grains per square yard, of which 252 grains is the fiber weight and 84 grains is the resin particle weight. This is equivalent to a 33% add-on of resin particles. This unitary fibrous structure is then dried by being passed over heated drying cylinders at a temperature of about 250° F. The individual overlapping and intersecting fibers of each layer are bonded to each other. The total weight of the dried nonwoven textile fabric is 840 grains per square yard.

The dried nonwoven textile fabric is then passed through an intermittent print pattern bonding apparatus of a conventional design. The print pattern comprises a double-diagonal diamond pattern (see FIG. 3, U.S. Pat. 2,705,498) wherein there are five lines per inch, with each line 0.020 inch wide, as measured on the binder applying roll. The binder is polyethyl acrylate and it is applied to the structural fiber side of the dried nonwoven textile fabric and penetrates substantially completely through that portion but does not appreciably penetrate into the wood pulp fiber portion. Lateral migration is minimal. The total finished weight of the nonwoven textile fabric is 966 grains. This represents a print binder add-on of 126 grains per square yard, or about 15% by weight, based on the weight of the fabric being bonded.

The nonwoven textile fabric has excellent softness, drape and hand, as well as excellent tensile, burst, and tear strengths and stitch-tear qualities. It is suitable for use as a single-use, disposable surgical drape.

EXAMPLE II

The procedures of Example I are followed substantially as set forth therein with the exception that the composition of the first structural fibrous layer is 40 percent by weight of viscose rayon fibers 1½ denier and ⅜ inch and 60 percent by weight of hardwood sulfite wood pulp fibers.

The results are good and are generally comparable to those set forth in Example I. The resulting product is commercially acceptable.

EXAMPLE III

The procedures of Example I are followed substantially as set forth therein with the exception that the composition of the first structural fibrous layer is 75 percent by weight of 3/8 inch, 1½ denier viscose rayon fibers and 25 percent by weight of unbeaten and unrefined hardwood sulfite wood pulp fibers.

The results are good and are generally comparable to those set forth in Example I. The resulting product is commercially acceptable.

EXAMPLE IV

The procedures of Example I are followed substantially as set forth therein with the exception that the viscose rayon fibers used in the first structural fibrous layer have a length of ¼ inch rather than 3/8 inch.

The results are good and are generally comparable to those set forth in Example I. The resulting product is commercially acceptable.

EXAMPLE V

The procedures of Example I are followed substantially as set forth therein with the exception that the viscose rayon fibers used in the first structural fibrous layer have a length of ½ inch rather than 3/8 inch.

The results are good and are generally comparable to those set forth in Example I. The resulting product is commercially acceptable.

EXAMPLE VI

The procedures of Example I are followed substantially as set forth therein with the exception that the viscose rayon fibers used in the first structural fibrous layer have a length of 5/8 inch rather than 3/8 inch and the denier is increased from 1½ to 3.

The results are good and are generally comparable to those set forth in Example I. The resulting product is commercially acceptable.

EXAMPLE VII

The procedures of Example I are followed substantially as set forth therein with the exception that the viscose rayon fibers used in the first structural fibrous layer have a length of ¾ inch rather than 3/8 inch and the denier is increased from 1½ to 3.

The results are good and are generally comparable to those set forth in Example I. The resulting product is commercially acceptable.

EXAMPLE VIII

The procedures of Example I are followed substantially as set forth therein with the exception that the print pattern resin binder is a copolymer of ethyl acrylate and methyl methacrylate in an anionic surfactant system.

The results are good and are generally comparable to those set forth in Example I. The resulting product is commercially acceptable.

EXAMPLE IX

The procedure of Example I are followed substantially as set forth therein with the exception that the print pattern resin binder is a copolymer of ethyl acrylate and vinyl acetate in an anionic surfactant system.

The results are good and are generally comparable to those set forth in Example I. The resulting product is commercially acceptable.

EXAMPLE X

The procedure of Example I are followed substantially as set forth therein with the exception that the print pattern resin binder is a copolymer of vinyl chloride and ethyl acrylate in an anionic surfactant system.

The results are good and are generally comparable to those set forth in Example I. The resulting product is commercially acceptable.

EXAMPLE XI

The procedure of Example I are followed substantially as set forth therein with the exception that the print pattern resin binder is a copolymer of vinyl chloride and vinyl acetate in an anionic surfactant system.

The results are good and are generally comparable to those set forth in Example I. The resulting product is commercially acceptable.

EXAMPLE XII

The procedures of Example I are followed substantially as set forth therein with the exception that the print pattern resin binder is a butadiene-styrene copolymer in an anionic surfactant system.

The results are good and are generally comparable to those set forth in Example I. The resulting product is commercially acceptable.

EXAMPLE XIII

The procedures of Example I are followed substantially as set forth therein with the exception that the concentration of the synthetic resin binder in the stock chest is reduced from 50 percent by weight to 25 percent by weight, based on the total fiber weight in the stock chest.

The results are good and are generally comparable to those set forth in Example I. The resulting product is commercially acceptable.

EXAMPLE XIV

The procedures of Example I are followed substantially as set forth therein with the exception that the diamond pattern has six lines per inch, with each line 0.018 inch wide, as measured on the binder applying roll.

The results are good and are generally comparable to those set forth in Example I. The resulting product is commercially acceptable.

EXAMPLE XV

The procedures of Example I are followed substantially as set forth therein with the exception that the diamond pattern is replaced by a cross-hatch pattern such as illustrated and described in FIG. 3 of U.S. Pat. 2,705,687.

The results are good and are generally comparable to those set forth in Example I. The resulting product is commercially acceptable.

EXAMPLE XVI

The procedures of Example I are followed substantially as set forth therein with the exception that the diamond pattern is replaced by a miniature bond pattern as illustrated and described in Example I of U.S. Pat. 2,880,111. These binder areas are substantially circular and are printed in a tilted-square pattern.

The results are good and are generally comparable to those set forth in Example I. The resulting product is commercially acceptable.

EXAMPLE XVIII

The procedures of Example I are followed substantially as set forth therein with the exception that the hardwood sulfite wood pulp fibers are replaced by (a) softwood sulfite wood pulp fibers; (b) hardwood sulfate wood pulp fibers; and (c) softwood sufate wood pulp fibers.

Three products are obtained and are generally comparable to the products set forth in Example I. The three products are commercially acceptable.

Although the present invention has been described in particularity in the presented examples by reference to specific materials and constructions, it is to be appreciated that such is merely illustrative of the present invention and is not to be construed as limitative thereof, except as defined by the appended claims.

What is claimed is:

1. A nonwoven textile fabric having excellent softness, drape, and hand, as well as excellent tensile, burst, and tear strengths and stitch-tear qualities comprising:

a first relatively flat, water-laid sheet-like fibrous portion comprising overlapping and intersecting structural textile fibers having an average length of from about ¼ inch to about 1¼ inches or more;

a second relatively flat, water-laid sheet-like fibrous portion comprising overlapping and intersecting relatively short fibers having an average length of from about ⅙ inch to about 1/25 inch or less and discrete particles of heat activatable synthetic resin binder materials;

said discrete particles of heat activatable synthetic resin binder materials adhered to and bonding said short fibers of said second fibrous portion into a unitary structure; and

an intermittent print pattern of discrete synthetic resin binder areas bonding substantially only the individual fibers of said first relatively flat water-laid sheet-like fibrous portion but not the short fibers of said second relatively flat, water-laid sheet-like fibrous portion, whereby a nonwoven textile fabric is obtained having excellent softness, drape, and hand, as well as excellent tensile burst, and tear strengths and stitch-tear qualities.

2. A nonwoven textile fabric having excellent softness, drape, and hand, as well as excellent tensile, burst, and tear strengths and stitch-tear qualities comprising:

a first relatively flat, water-laid sheet-like fibrous portion comprising a substantially uniform mixture of (a) overlapping and intersecting structural textile fibers having an average length of from about ¼ inch to about 1¼ inches or more and (b) overlapping and intersecting short fibers having an average length of from about ⅙ inch to about 1/25 inch or less and (c) discrete particles of heat activatable synthetic resin binder materials;

said discrete particles of heat activatable synthetic resin binder materials being adhered to and bonding the individual fibers of said first fibrous portion to each others;

a second relatively flat, water-laid sheet-like fibrous portion comprising short fibers having an average length of from about ⅙ inch to about 1/25 inch or less and discrete particles of heat activatable synthetic resin binder materials;

said discrete particles of heat activatable synthetic resin binder materials being adhered to and bonding said short fibers of said fibrous portions into a unitary structure; and

an intermittent print pattern of discrete synthetic resin binder areas bonding substantially only the individual fibers of said first relatively flat, water-laid sheet-like fibrous portion but not the short fibers of said second relatively flat, water-laid sheet-like fibrous portion, whereby a nonwoven textile fabric is obtained having excellent softness, drape, and hand, as well as excellent tensile, burst, and tear strengths, and stitch-tear qualities.

3. A nonwoven textile fabric as defined in claim **2** wherein the first structural fibrous portion comprises from about 20% by weight to about 90% by weight of structural fibers; and from about 10% by weight to about 80% by weight of wood pulp fibers.

4. A nonwoven textile fabric as defined in claim **2** wherein the first structural fibrous portion comprises from about 20% by weight to about 90% by weight of rayon fibers; up to about 30% by weight of synthetic non-cellulosic fibers; and from about 10% to about 80% by weight of wood pulp fibers.

5. A nonwoven textile fabric as defined in claim **4** wherein the synthetic non-cellulosic fibers are polyamide nylon 6,6 fibers.

6. A nonwoven textile fabric as defined in claim **2** wherein the structural fibers have an average length of from about ⅜ inch to about ¾ inch.

7. A nonwoven textile fabric as defined in claim **2** wherein the second short fibered portion comprises unbeaten wood pulp fibers.

8. A nonwoven textile fabric as defined in claim **2** wherein the unbeaten short fibers are hardwood sulfite wood pulp fibers.

9. A nonwoven textile fabric as defined in claim **2** wherein the resin is polyethylacrylate.

10. A nonwoven textile fabric as defined in claim **2** wherein the resin is a copolymer of ethyl acrylate and methyl methacrylate.

11. A nonwoven textile fabric as defined in claim **2** wherein the resin is a copolymer of ethyl acrylate and vinyl acetate.

12. A nonwoven textile fabric as defined in claim **2** wherein the resin is a copolymer of vinyl chloride and ethyl acrylate.

13. A nonwoven textile fabric as defined in claim **2** wherein the resin is a copolymer of vinyl chloride and vinyl acetate.

14. A nonwoven textile fabric as defined in claim **2** wherein the resin is a butadiene-styrene copolymer.

15. A method of making a nonwoven textile fabric having excellent softness, drape, and hand, as well as excellent tensile, burst, and tear strengths and stitch-tear qualities comprising:

forming a first aqueous slurry of structural textile fibers having an average length of from about ¼ inch to about 1¼ inches or more;

forming a second aqueous slurry of relatively short fibers having an average length of from about ⅙ inch to about 1/25 inch or less, said second aqueous slurry of fibers having incorporated therein discrete particles of heat activatable synthetic resin binder materials;

forming a wet relatively flat, sheet-like fibrous portion of overlapping and intersecting structural textile fibers from said first aqueous slurry;

depositing on said structural fiber portion said second aqueous slurry of relatively short fibers, whereby a relatively flat, sheet-like short fiber portion is formed in intimate and interentangled fiber relationship with said structural fiber portion;

heating said fibrous portions to elevated temperatures whereby the discrete particles of heat activatable resin binder materials bond individual fibers to each other; and

bonding only the individual fibers of the dried, relatively flat, sheet-like structural fiber portion with an intermittent print pattern of discrete synthetic resin binder areas, without bonding the individual fibers of the dried, bonded relatively-flat, sheet-like short fiber portion with the intermittent print pattern of discrete synthetic resin binder areas whereby a nonwoven textile fabric is obtained having excellent softness, drape, and hand, as well as excellent tensile, burst, and tear strengths and stitch-tear qualities.

16. A method of making a nonwoven textile fabric as defined in claim **15** wherein the relatively flat, sheet-like fibrous portion is formed on a moving forming surface.

17. A method of making a nonwoven textile fabric as defined in claim **15** wherein the bonded fibrous portions are dried at elevated temperatures and additionally saturation bonded with a bonding agent.

18. A method of making a nonwoven textile fabric as defined in claim **15** wherein the concentration of the fibers in the aqueous slurries is in the range of from about 1/20 percent by weight to about 1½ percent by weight.

19. A method of making a nonwoven textile fabric as defined in claim **15** wherein a deposition aid for the discrete particles of heat activatable synthetic resin binder materials is included in the aqueous slurry of relatively short fibers.

20. A method of making a nonwoven textile fabric as defined in claim **15** wherein the concentration of the discrete particles of heat activatable synthetic resin binder materials in the aqueous slurry ranges from about 5 percent by weight to about 100 percent by weight of dry resin solids, based on the total fiber weight in the slurry.

21. A method of making a nonwoven textile fabric having excellent softness, drape, and hand, as well as excellent tensile, burst, and tear strengths and stitch-tear qualities which comprises:

forming a first aqueous slurry of structural textile fibers having an average length of from about ¼ inch to about 1¼ inches or more and relatively short fibers having an average length of from about ⅛ inch to about 1/25 inch or less, said first aqueous slurry of fibers having incorporated therewith discrete heat activatable particles of synthetic resin binder materials;

forming a second aqueous slurry of relatively short fibers having an average length of from about ⅛ inch to about 1/25 inch or less, said second aqueous slurry of fibers having incorporated therewith discrete particles of heat activatable synthetic resin binder materials;

forming a wet, relatively flat, sheet-like fibrous portion containing said structural fibers and short fibers and discrete particles of synthetic resin binder materials from said first aqueous slurry;

depositing on said structural and relatively short fiber portion said second aqueous slurry of relatively short fibers, whereby a relatively flat, sheet-like short fiber portion is formed in intimate and interentangled fiber relationship with said structural and relatively short fiber portion, said relatively short fibers also having deposited thereon discrete particles of heat activatable synthetic resin binder materials;

drying said fibrous portions at elevated temperatures whereby the discrete particles of heat activatable resin binder materials bond said fibrous portions into a unitary structure; and

additionally bonding only the individual fibers of said dried, bonded relatively flat, water-laid sheet-like structural and relatively short fiber portion with an intermittent print pattern of discrete synthetic resin binder areas without bonding the individual fibers of the dried, bonded relatively-flat, sheet-like short fiber portion with the intermittent print pattern of discrete synthetic resin binder areas, whereby a nonwoven textile fabric is obtained having excellent softness, drape, and hand, as well as excellent tensile, burst, and tear strengths and stitch-tear qualities.

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