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Kulkarni(10) **Pub. No.: US 2017/0145610 A1**(43) **Pub. Date: May 25, 2017**(54) **WONDER FABRIC****Publication Classification**(71) Applicant: **Welspun Global Brands Limited,**
Mumbai (IN)(51) **Int. Cl.****D04H 13/00** (2006.01)**D04H 18/04** (2006.01)**D04B 21/12** (2006.01)**D04H 1/498** (2006.01)(72) Inventor: **Sachin Hanmant Kulkarni,** Mumbai
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Mumbai (IN)CPC **D04H 13/00** (2013.01); **D04H 1/498**
(2013.01); **D04H 18/04** (2013.01); **D04B**
21/12 (2013.01)(21) Appl. No.: **15/372,971**

(57)

ABSTRACT(22) Filed: **Dec. 8, 2016****Related U.S. Application Data**(63) Continuation-in-part of application No. 12/569,784,
filed on Sep. 29, 2009, now abandoned.(30) **Foreign Application Priority Data**

Sep. 24, 2009 (IN) 2226/MUM/2009

A novel textile material particularly a wonder fabric comprising of a see-through construction of plurality of yarns intersecting one another at certain angles hydro-laminated thereof with pseudo yarns formed out of staple fibers and mechanical cross linking of yarns on at least one side under specific conditions thereof resulting into a durable and multi functional material suitable for home and apparel textile applications is disclosed herein. A process for production and apparatus thereof are also disclosed.

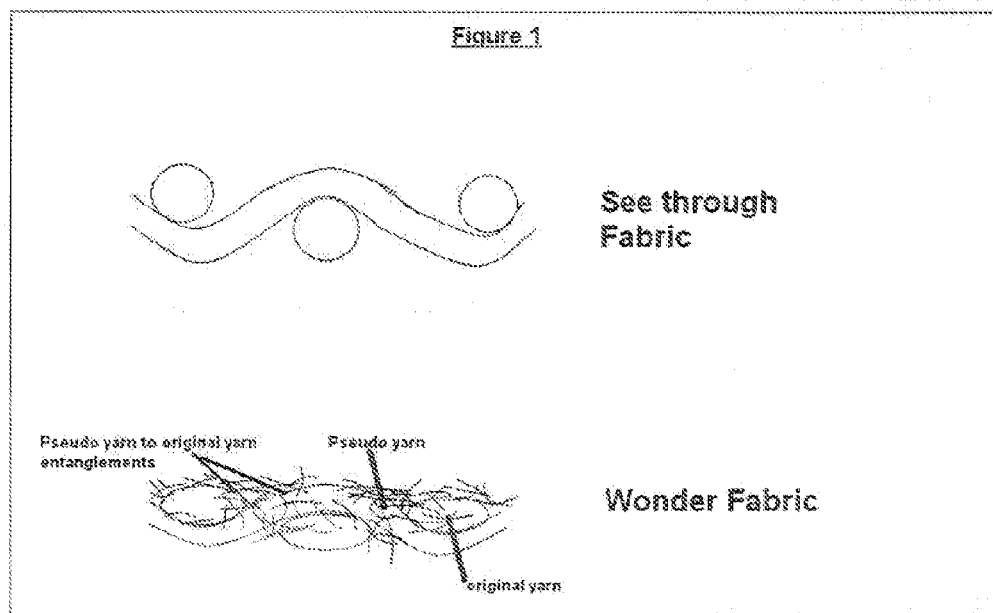


FIGURE: 1

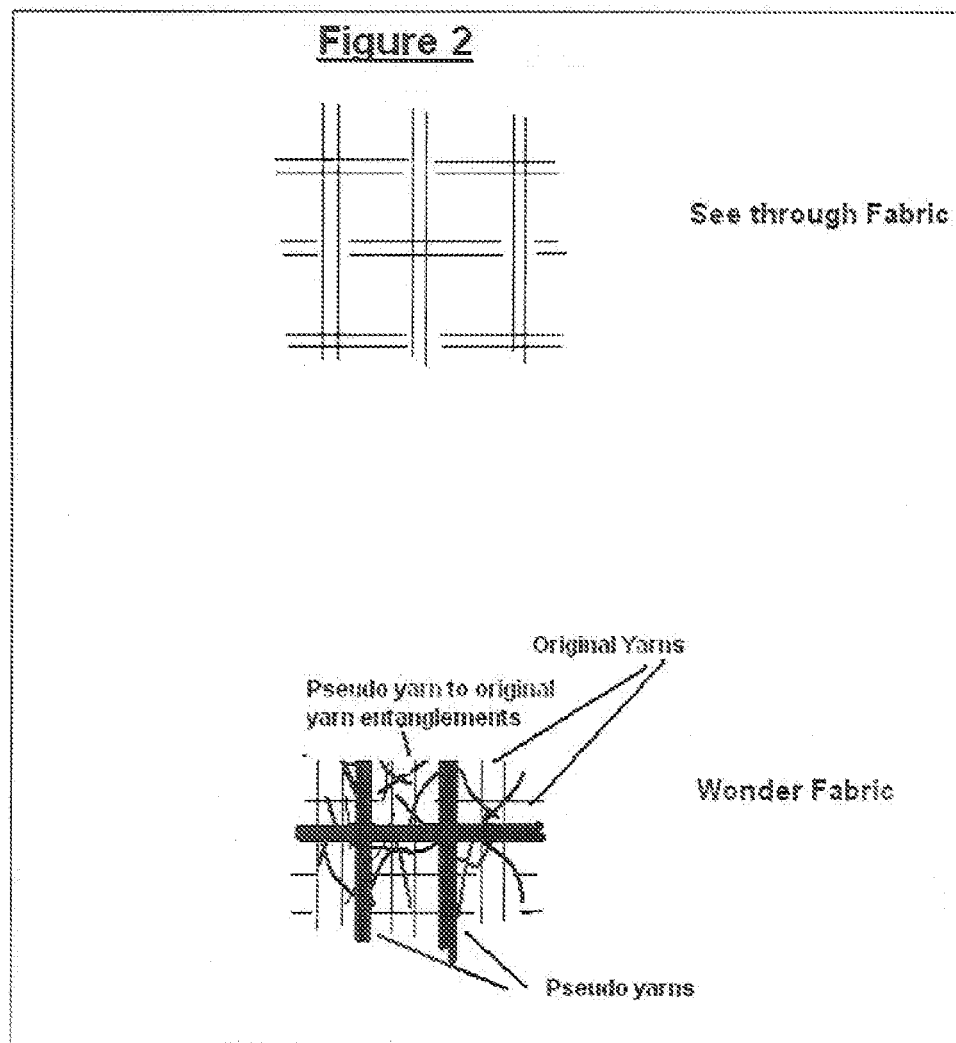


FIGURE 2

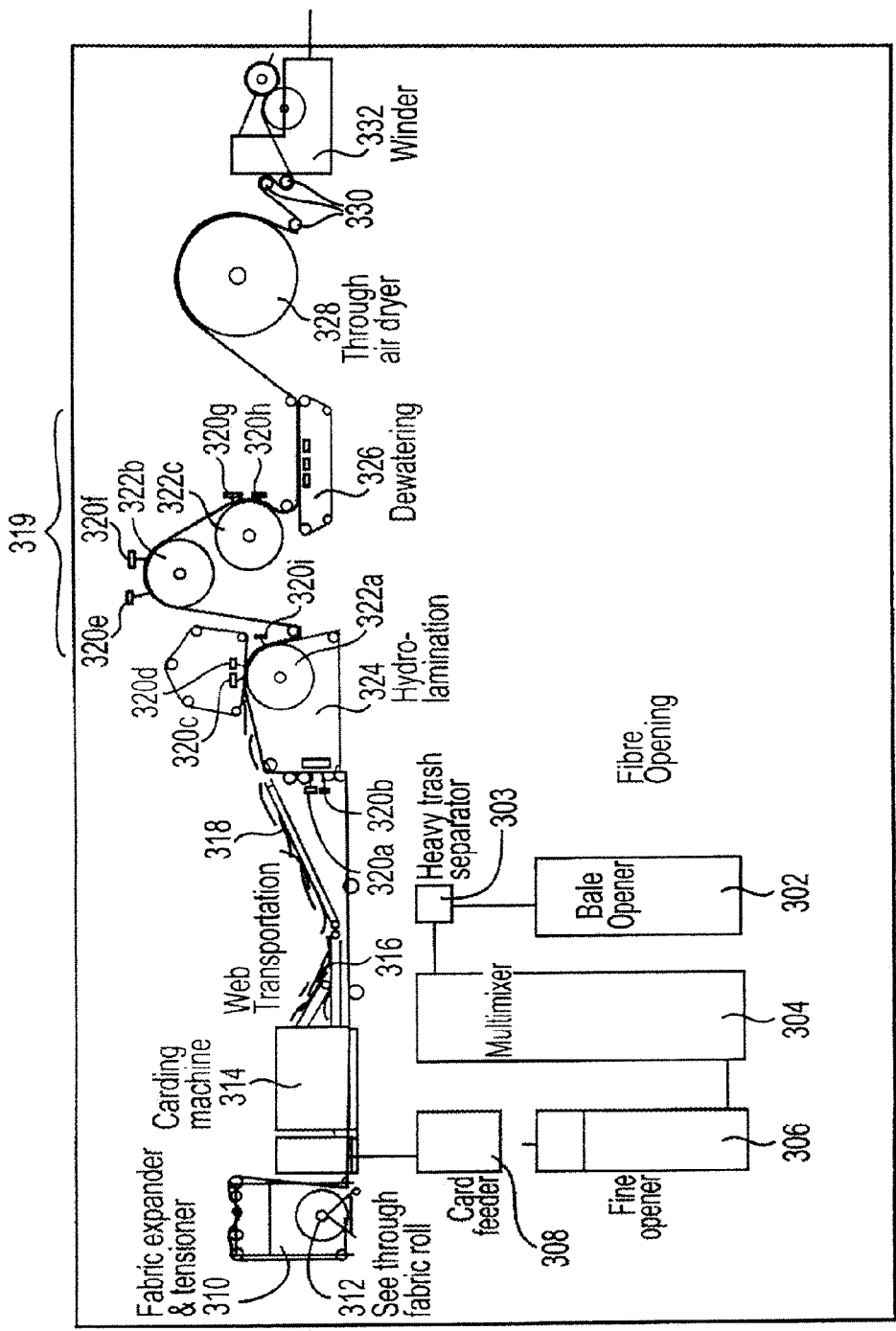


FIGURE 3A

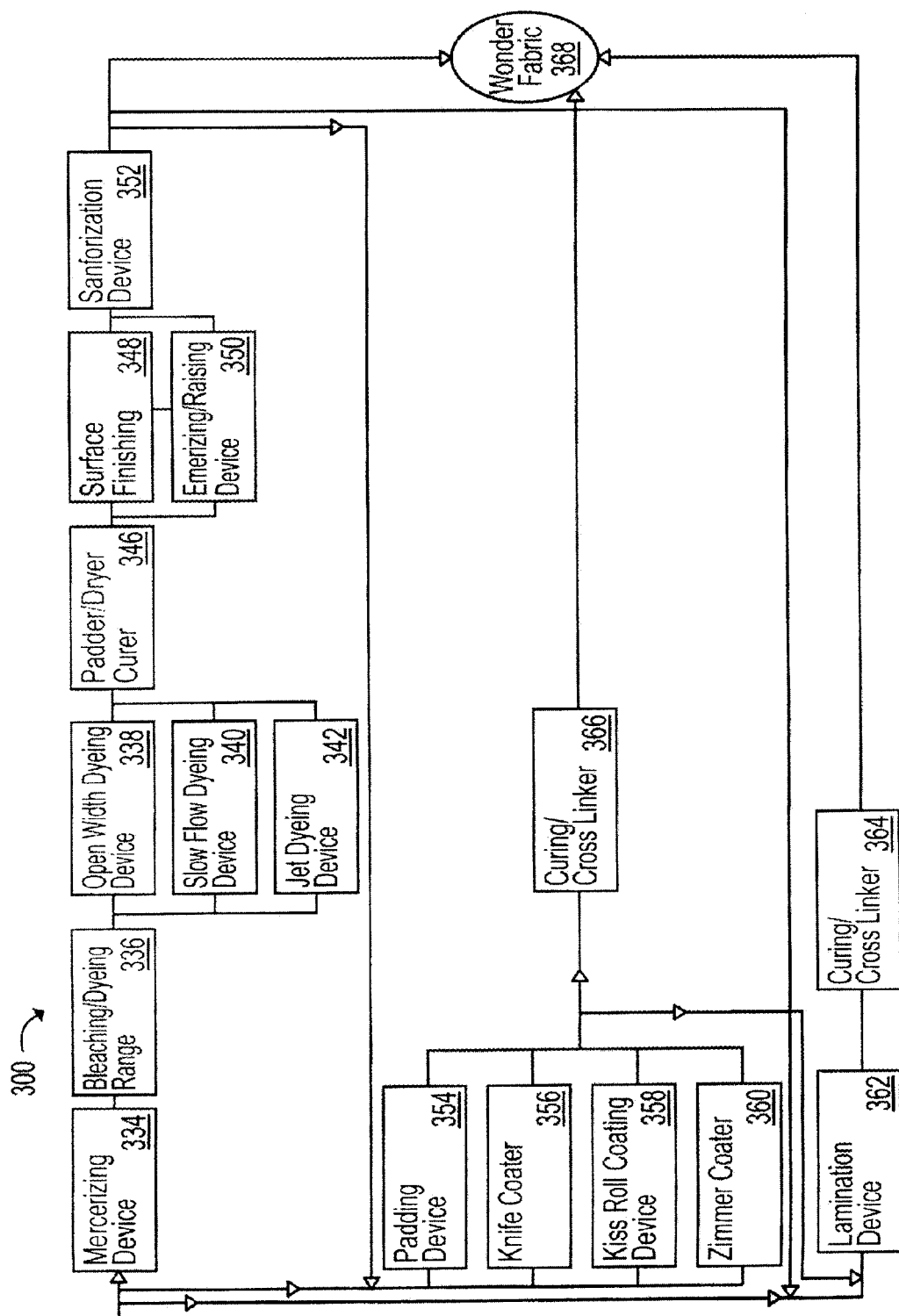


FIGURE 3B

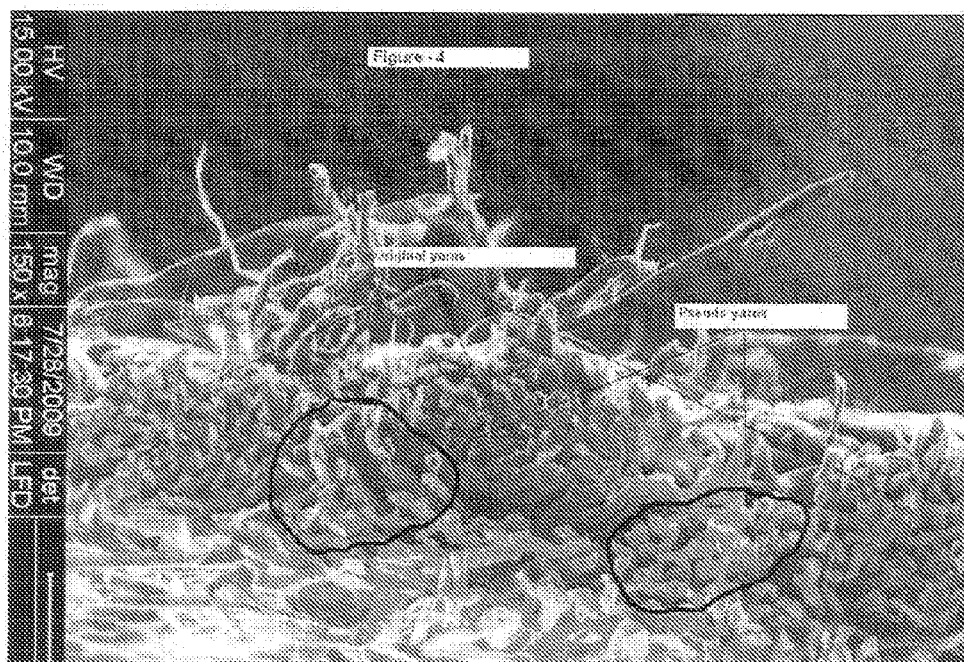


FIGURE 4

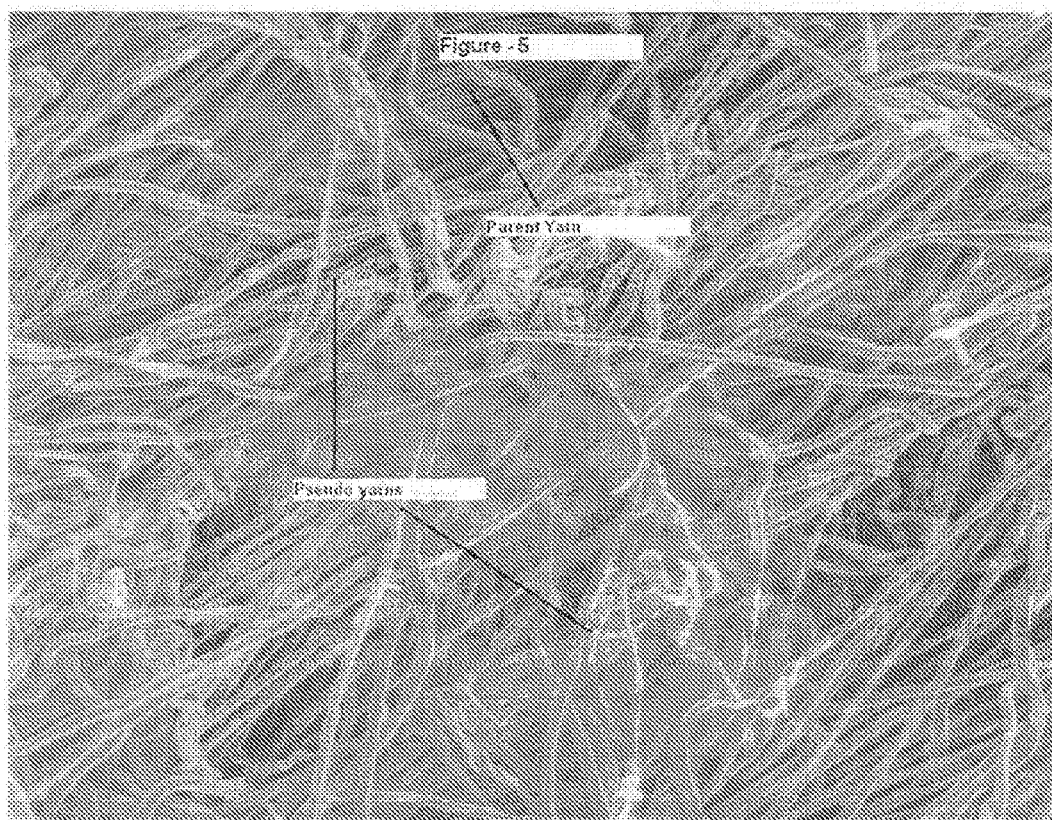


FIGURE 5

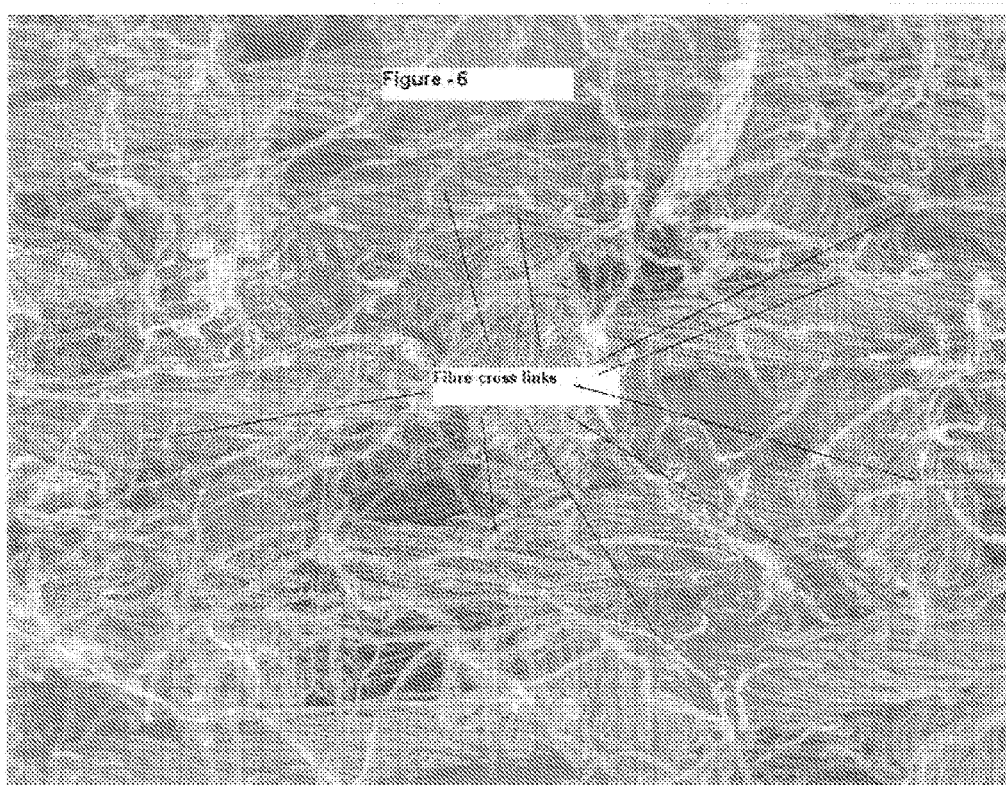


FIGURE 6

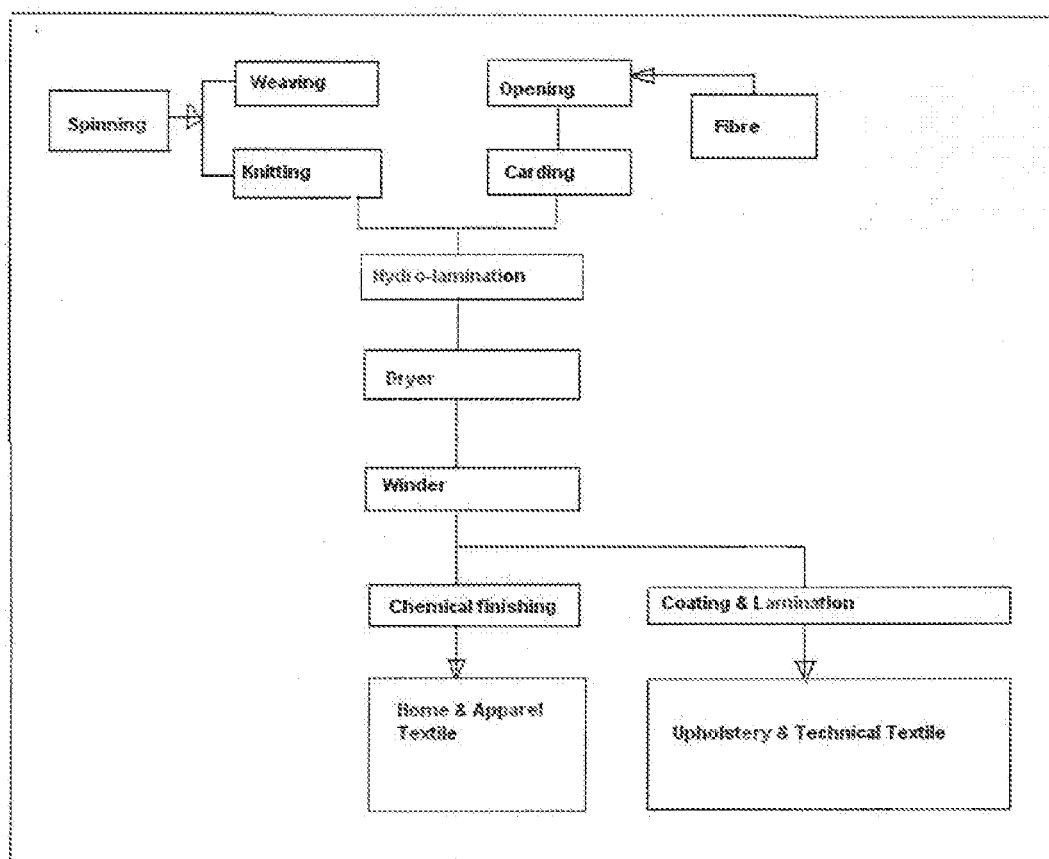


FIGURE 7



FIGURE 8

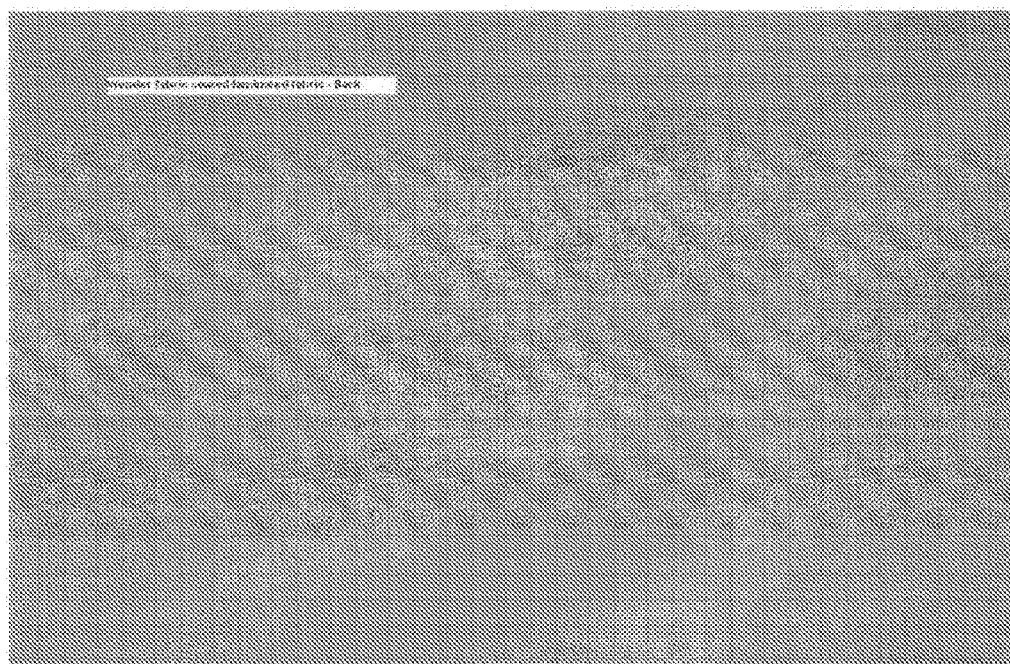


FIGURE 9

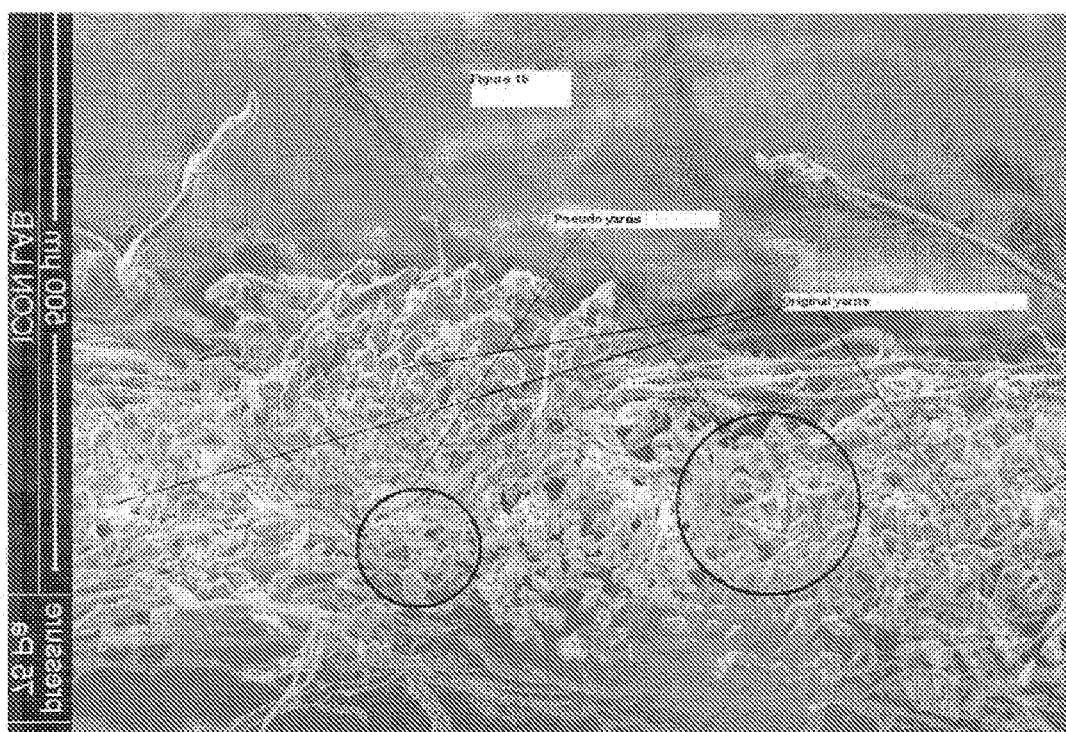


FIGURE 10

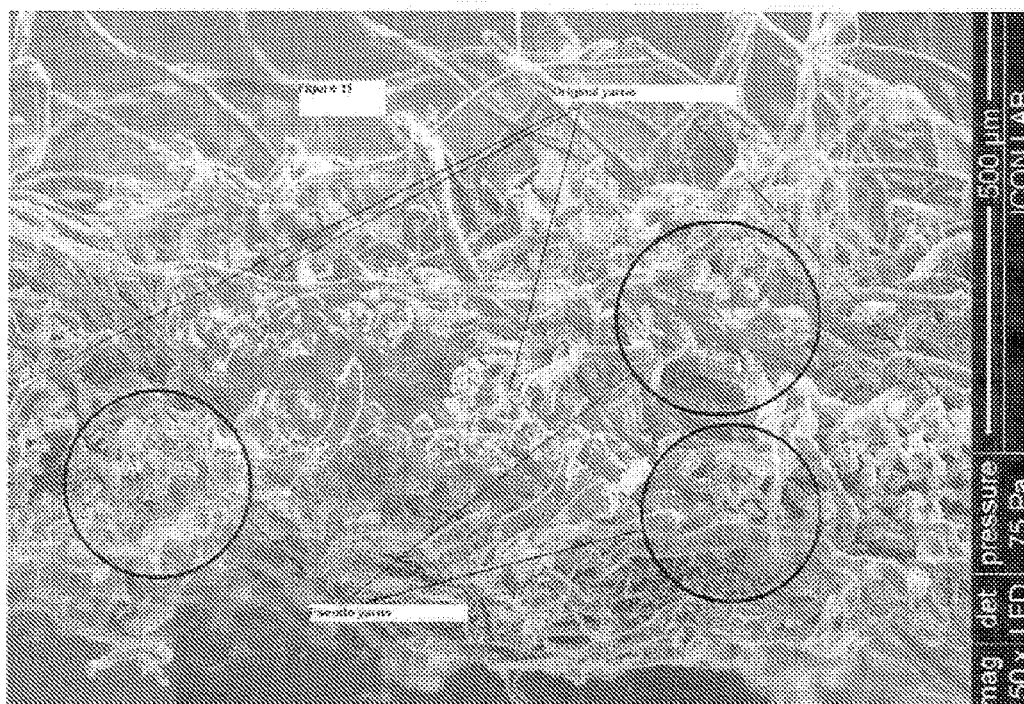


FIGURE 11

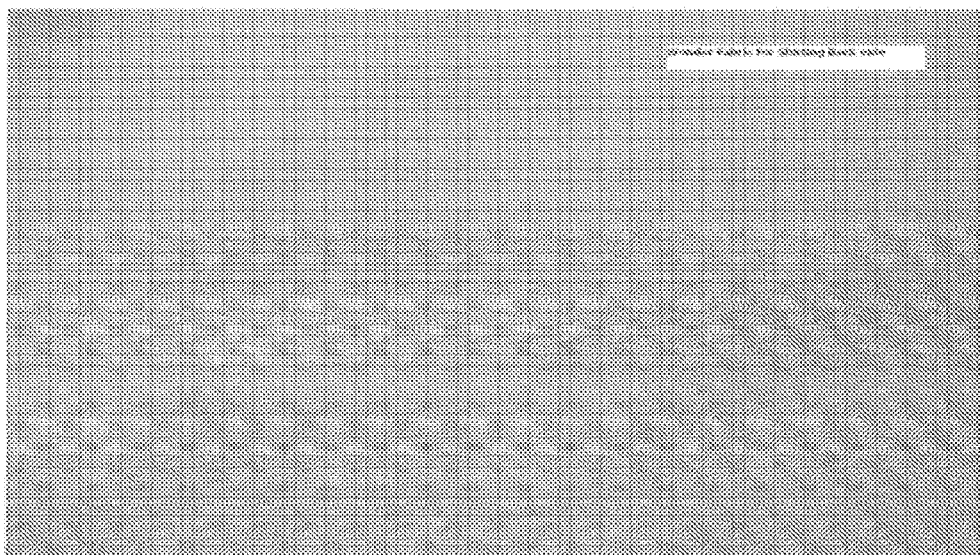


FIGURE 12(a)

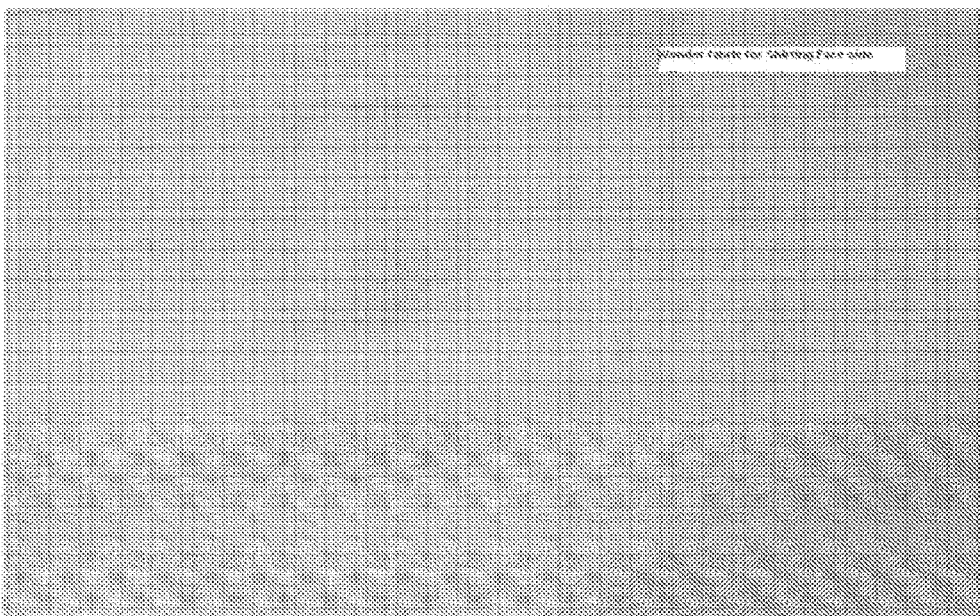


FIGURE 12(b)

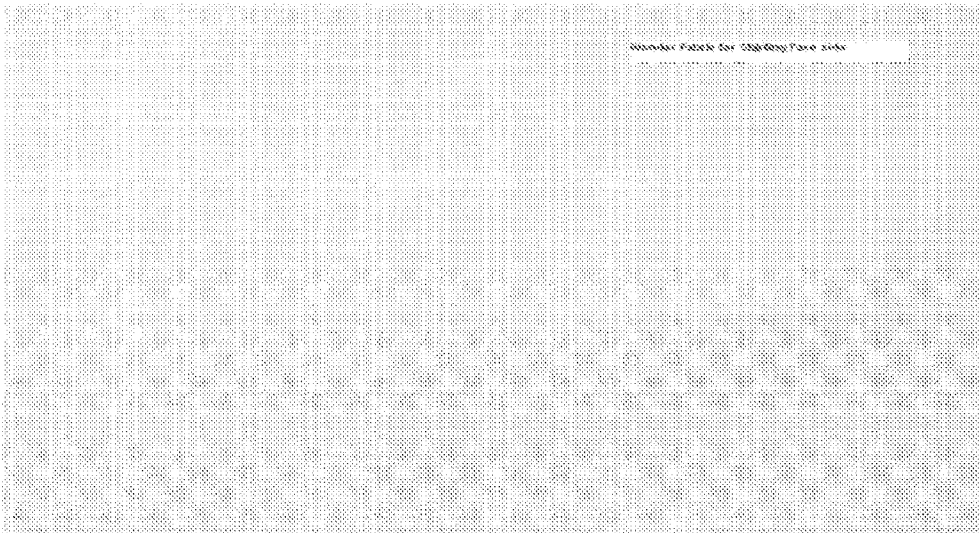


FIGURE 13(a)

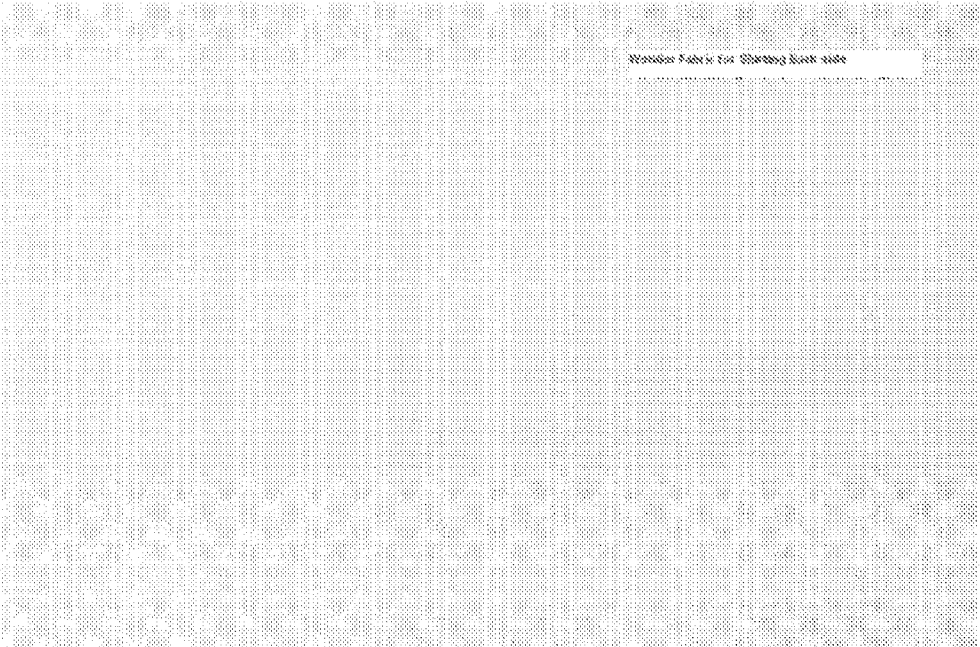


FIGURE 13(b)

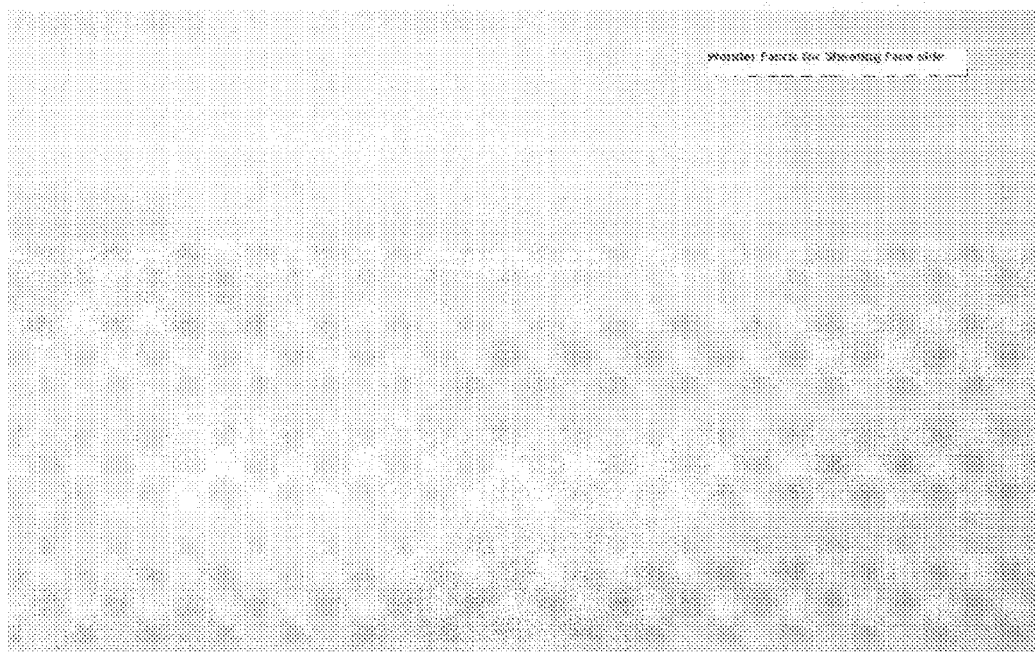


FIGURE 14(a)

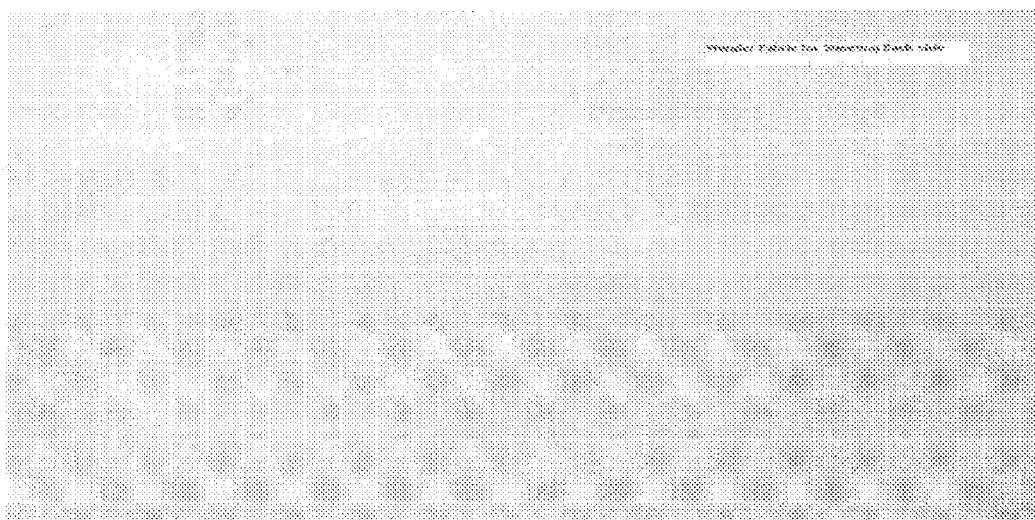


FIGURE 14(b)

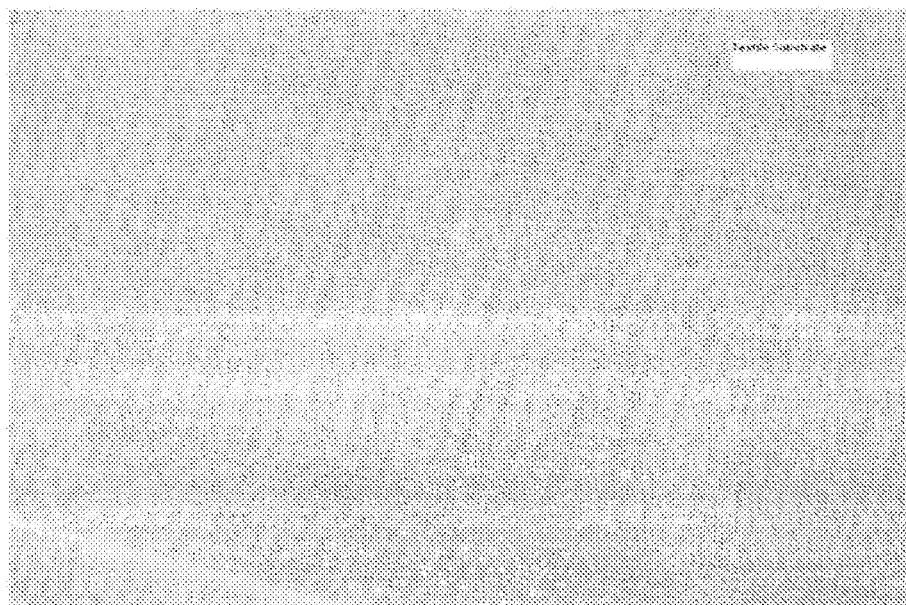


FIGURE 15(a)

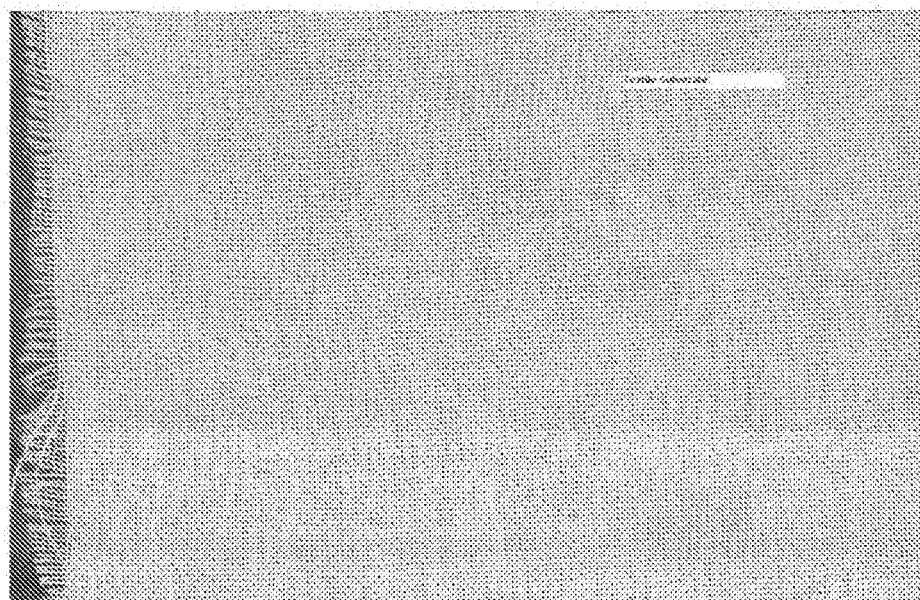


FIGURE 15(b)

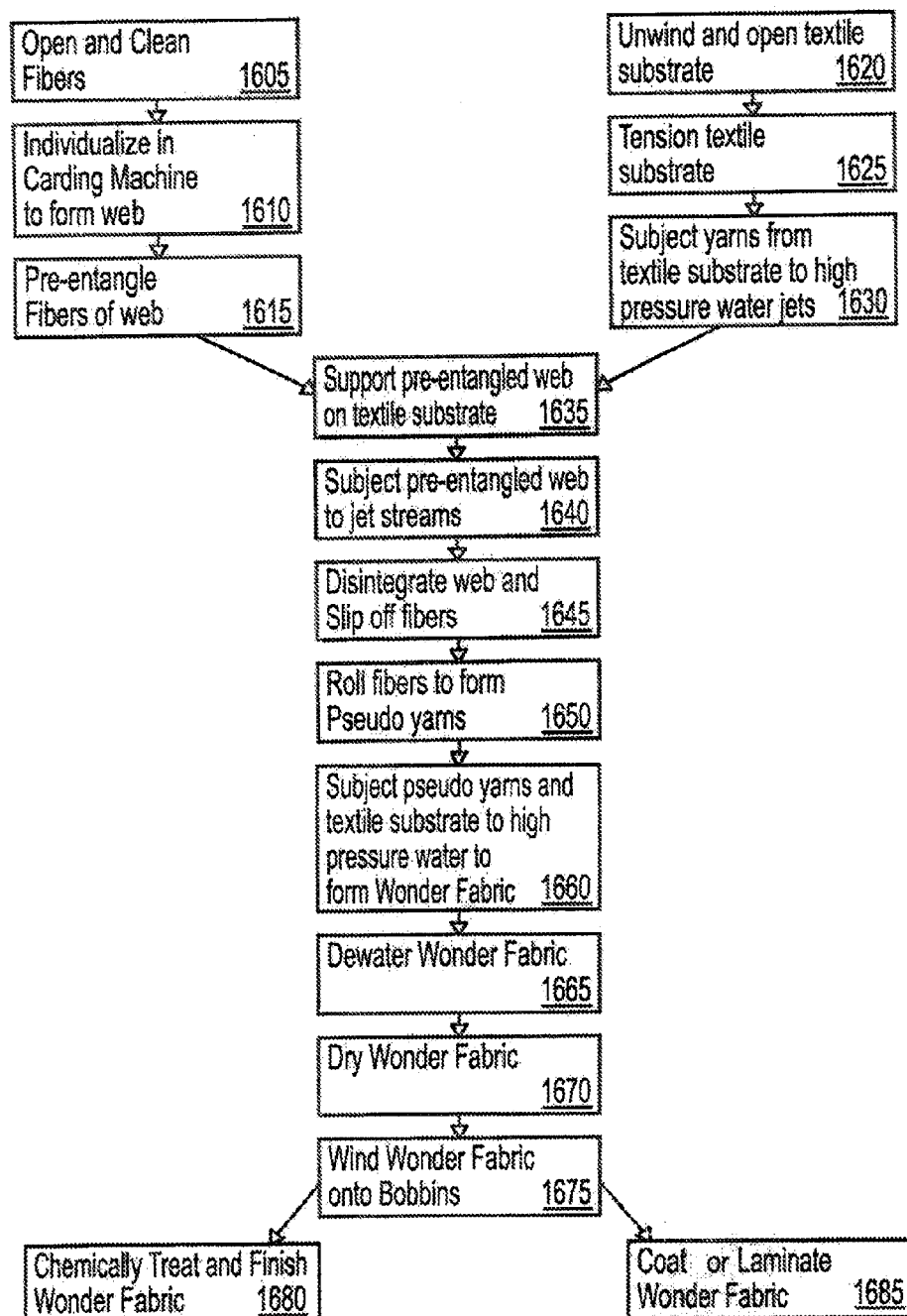


FIGURE 16

OK SAMPLE

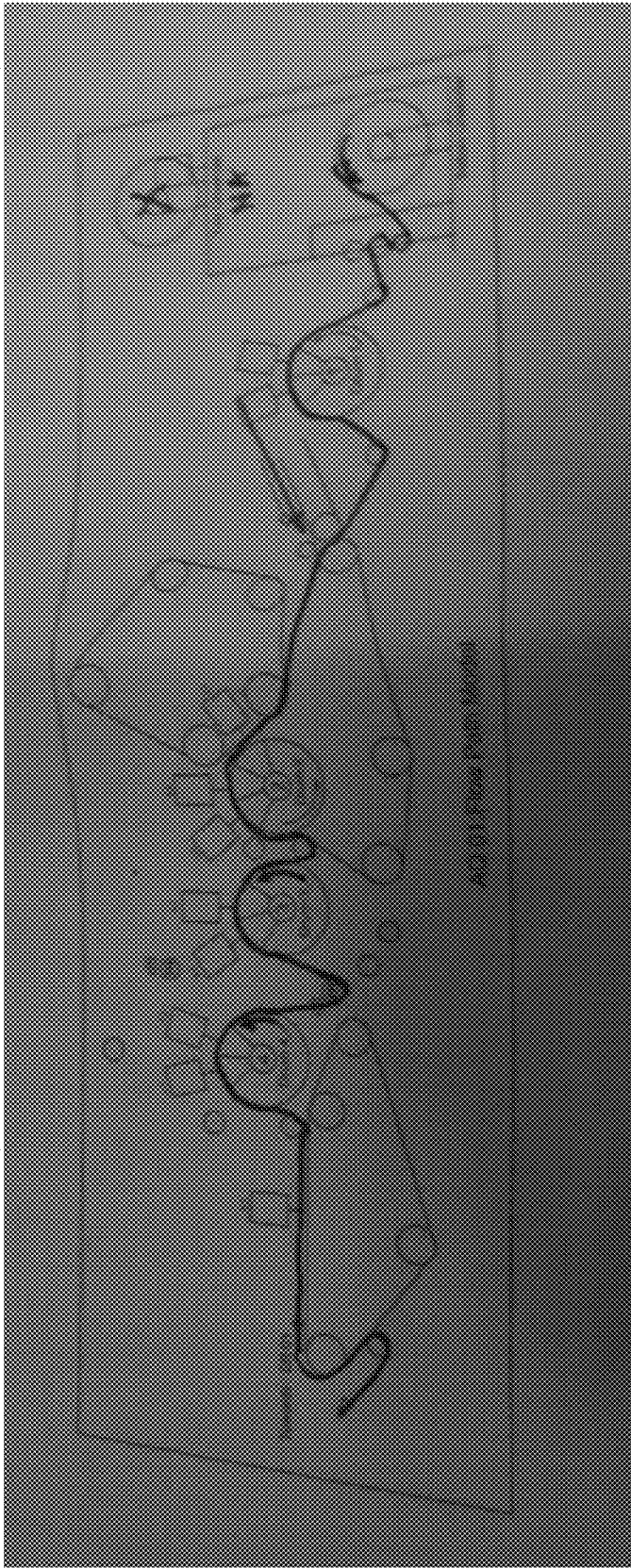
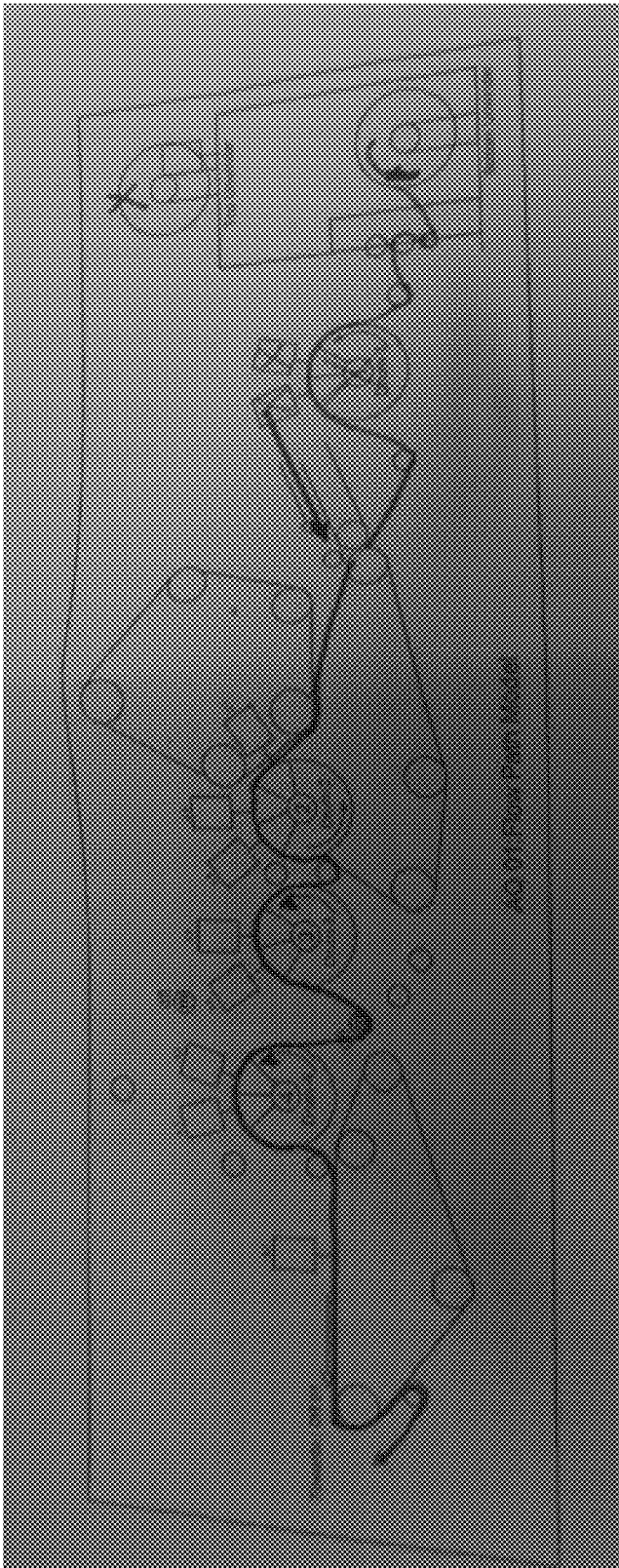


FIGURE 17A

NOT OK SAMPLE



OK SAMPLE Parameters

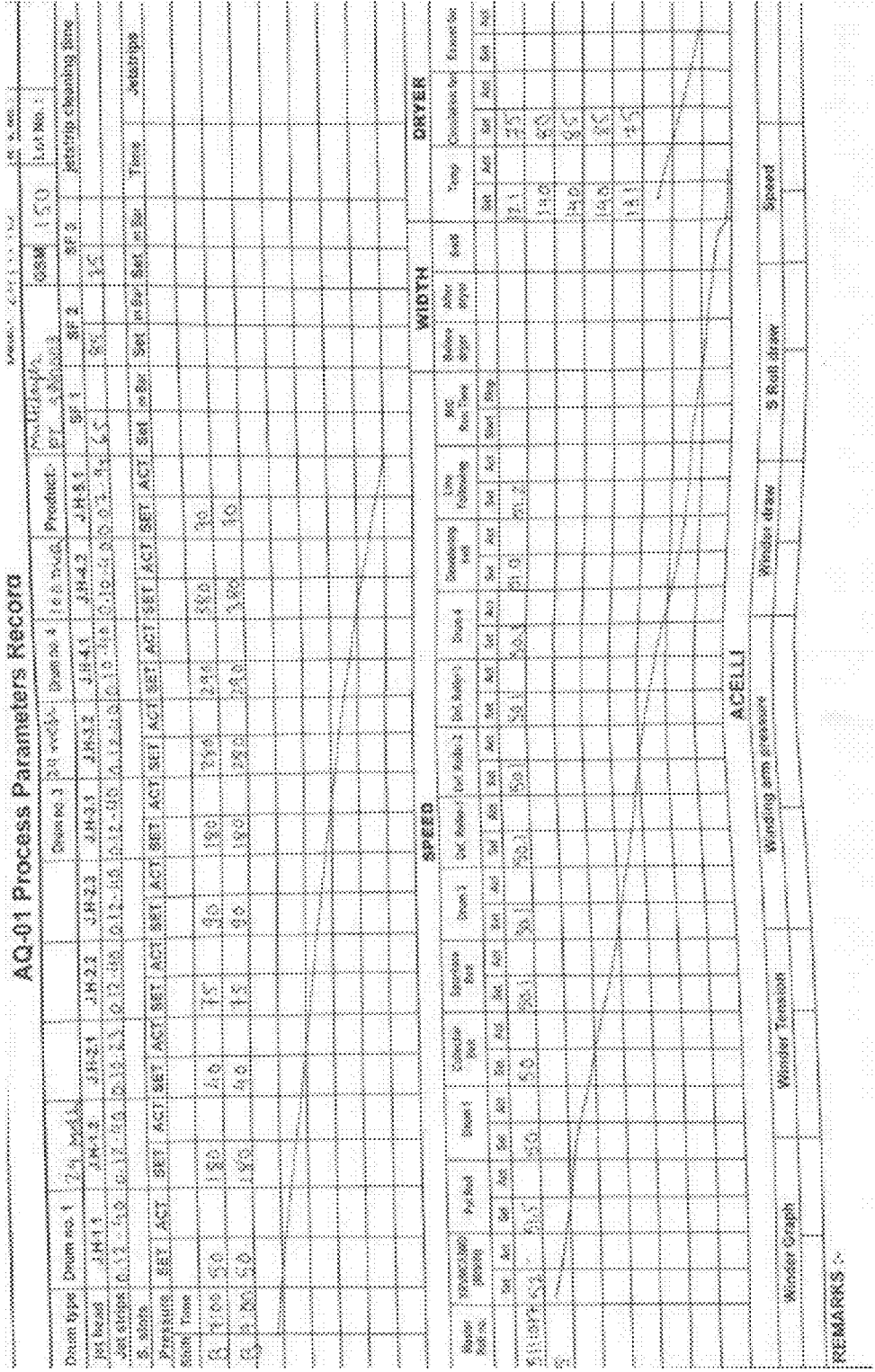


FIGURE 18A

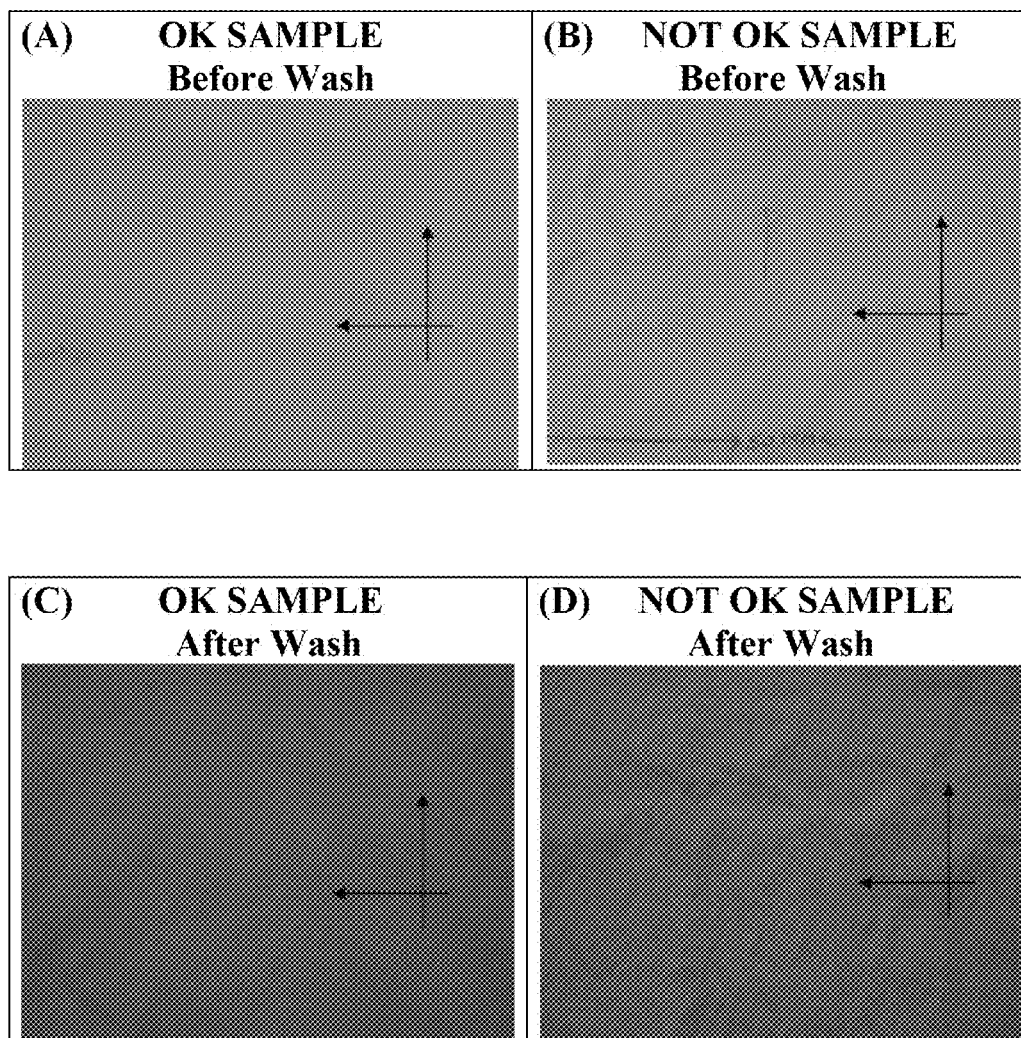


FIGURE 19

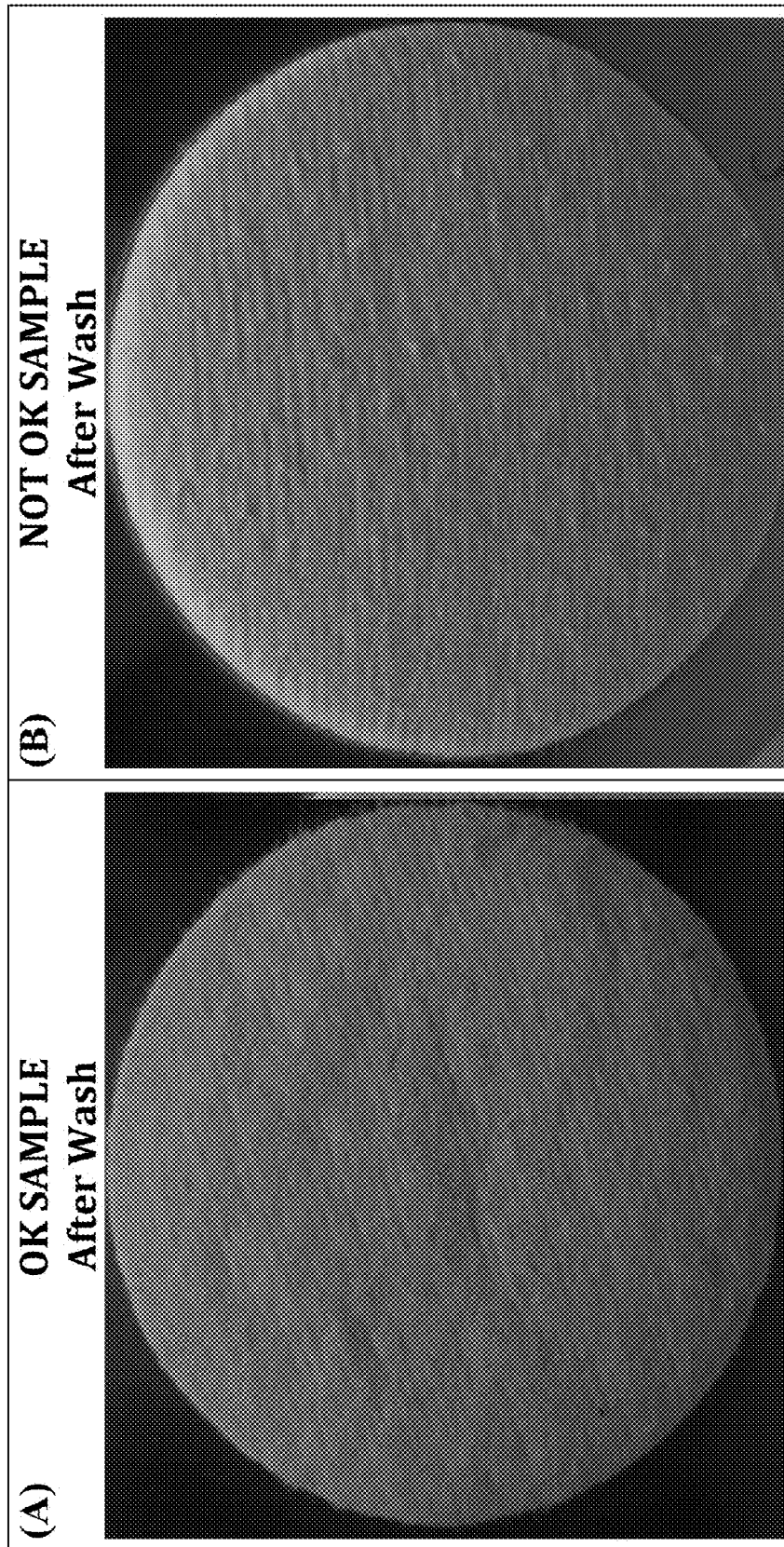
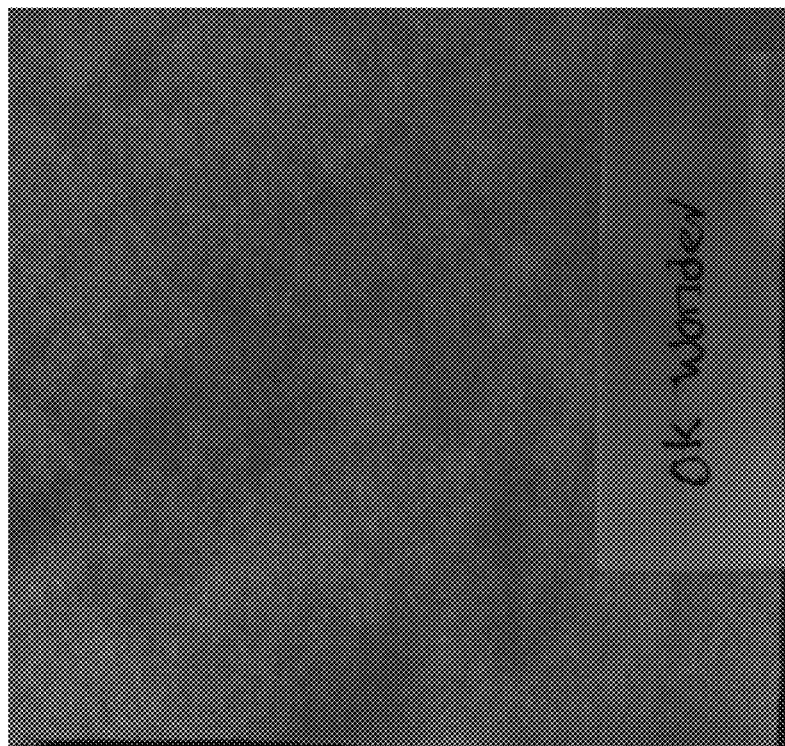


FIGURE 20

(B)



(A)

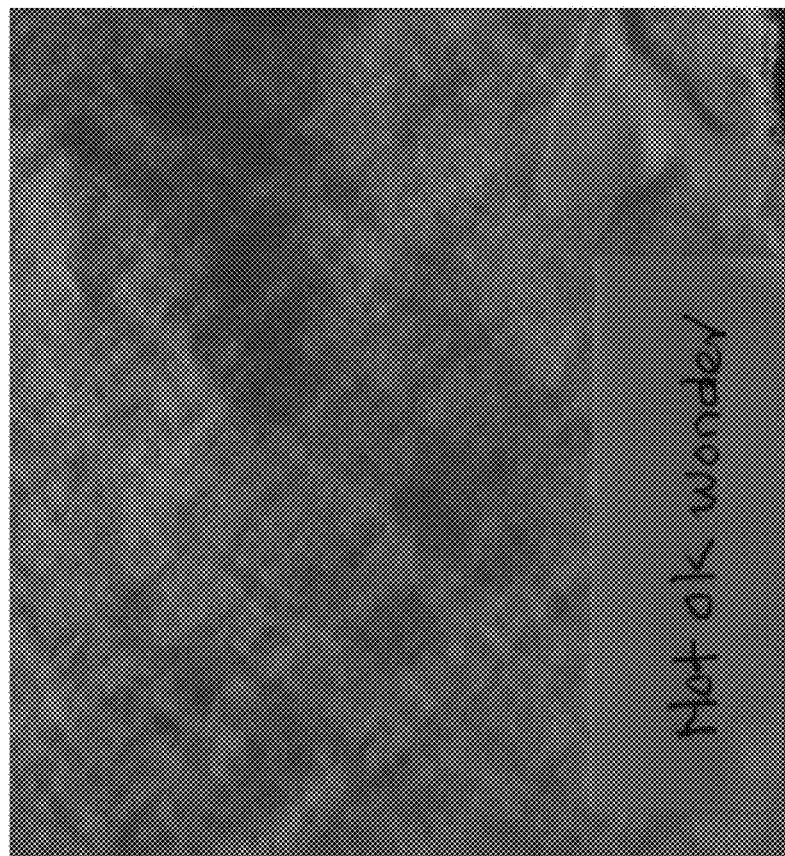


FIGURE 21

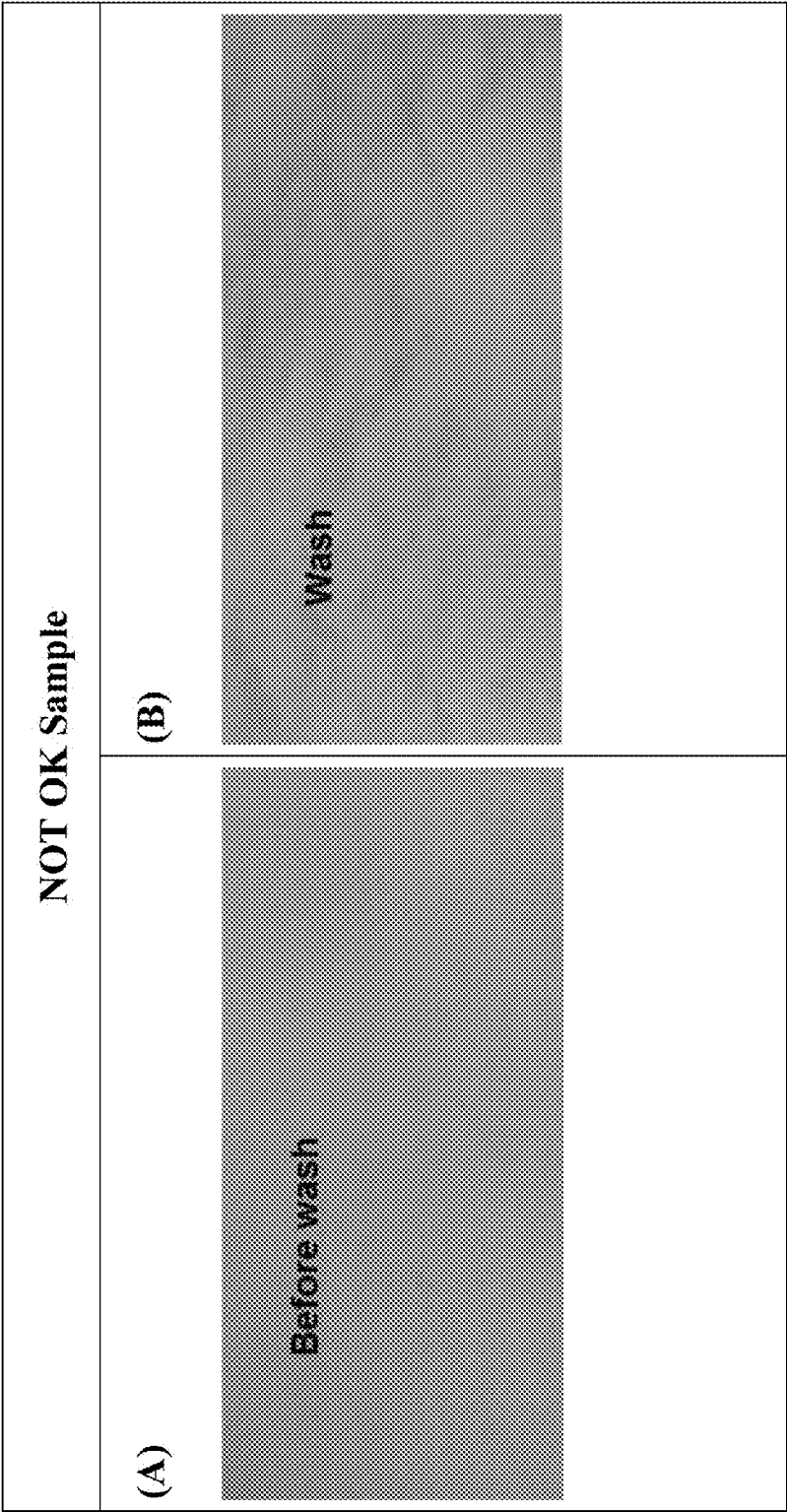


FIGURE 22

WONDER FABRIC

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part application under 35 U.S.C. §120 of U.S. patent application Ser. No. 12/569,784, filed on Sep. 29, 2009, entitled "Wonder Fabric", and which claims the benefit of Indian Patent Application No. 2226/MUM/2009, filed on Sep. 24, 2009, entitled "Wonder Fabric". The contents of the above applications are hereby all incorporated by reference in their entirety.

FIELD OF INVENTION

[0002] This invention generally relates to a novel textile material, more particularly wonder fabric, comprising of a see-through construction of plurality of yarns intersecting one another at certain angles, hydro-laminated thereof with pseudo yarns formed out of staple fibers and mechanical cross linking of yarns on at least one side under specific conditions thereof, resulting into a durable and multifunctional material suitable for home, upholstery and apparel textile applications. The process for production and apparatus thereof are also described.

BACKGROUND OF THE INVENTION

[0003] Traditionally, home and apparel textile fabric is produced through weaving or knitting technology. Weaving is the process of interlacement of plurality of yarns in vertical that is warp way direction with plurality of yarns in horizontal that is weft way direction. Knitting process requires only one yarn component. Using this yarn component, loops are formed followed by intermeshing of the same with the previously formed ones.

[0004] Each technology has its own application. Woven fabrics are strong and have advantage of drape and fall, are most commonly used for formal wear and most of home textile products. Knitted fabrics with their advantage of high extensibility/flexibility, softness and hugging tendency, are used for casual wear, undergarments and sometimes for sheeting applications in home textiles. Knitted fabrics lack in their strength and durability.

[0005] Both the traditional textile manufacturing processes are highly expensive and labor intensive. With day by day increasing competition, there is a high demand for cost reductions. On the other hand raw material cost is continuously increasing and labor cost is also increasing. This can be seen from the fact that Europe and America are almost out of traditional textile manufacturing business. Mostly, third world is having high concentration of this industry where low labor cost was the attraction. Year by year here also labor cost is steadily increasing and the solution of shifting of the traditional textile manufacturing base is not remaining cost advantageous.

[0006] Of all costs, raw material cost is the biggest contributor and it always contributes to the extent of 55% to 65%. Another important cost is operation cost which contributes to the extent of 10% to 15% of total cost.

[0007] From the human comfort point of view, in home and apparel textile, consumption of natural fiber, for example, cotton based products is high and is continuously increasing.

[0008] With fibers like cotton, impact of raw material cost on total cost is very high.

[0009] There is an intense relationship between yarn properties, fabric construction and fabric properties. Yarns should have certain minimum strength so as to withstand the stresses and strains of different types during weaving preparation and weaving and knitting.

[0010] On the similar lines, there exists an intense relationship between fiber properties and yarn properties. One needs to maintain certain minimum fiber properties to meet the required yarn properties. Most important of all the fiber properties is fiber length and strength. Longer and stronger fiber delivers stronger yarn. However, cost is directly dependent upon fiber length. This is how it puts a restriction on cost.

[0011] Also, it is very difficult to get all the fabric properties to the best level. Always it's a compromised approach followed for optimization of fabric properties. For example, wrinkle free 100% cotton fabric is on high demand. For this purpose cotton fabric is treated with wrinkle free finish. This brings down the tensile strength, tear strength, look and feel of the fabric will not be the same, fabric drape is also different. The wrinkle behavior improves with increased add-on of chemicals and with this increased chemical add-on, remaining fabric properties go bad. In this case, if one desires to have remaining properties also best, then there is a need for long and strong fiber meaning high cost.

[0012] With increasing demands for fabric functions like wrinkle free, odor free, antimicrobial, etc.; lot of chemical finishes are reacted with fibers in the fabric or are fixed with fibers using binders. Since they hamper fabric properties like strength, feel, etc., one needs to use expensive long and strong fibers. This adds further to the cost.

[0013] Various attempts for increasing throughput rates are made in fabric weaving and knitting. Dornier and also Pseudakoma, etc. are supplying weaving looms which can run at the speeds of 1000 to 1200 pick/minute. Mayer and Cie, Fukuwara are supplying circular knitting machines which can run at 80 to 100 r.p.m. Weaving looms with wider widths of 3.5 meter are also available which offer higher outputs.

[0014] On the similar lines, different high speed spinning technologies like Rotor spinning, air jet spinning and air vortex spinning are invented. However, ring spinning is still maintaining its dominance in yarn production. This is based upon its unique yarn structure most suitable for apparel and home textiles and also none of other spinning technologies are able to offer this yarn structure. However, ring spinning is the slowest among various yarn manufacturing technologies. Various attempts to improve its throughput rate are made and are still going on. With so many such efforts in entire traditional textile chain, one can expect some relief on operation cost.

[0015] With high speed textile machines and an increasing demand for high density fabrics, raw material quality demands are going high and there by the costs also are going high and advantage of lower operation cost is defeated.

[0016] Contrary to all this, consumer is looking for good products at lower costs.

[0017] Though ring spun yarn structure is the best, still there exists a limitation on fiber selection. One can not spin Ne 60/1 yarn from 20 mm fiber length. Similarly, Ne 60/1 yarn with strength of 16 Rkm can not run efficiently on high

speed/wider Air Jet loom. This way technology has put a restriction on possibility of raw material value engineering.

[0018] Looking to today's scenario above, traditional textile technology has reached to its limit. Though one wishes for value engineering and meet market needs, it is very difficult. So there is a need to look at the subject from different angle. There is a requirement to redefine the fiber/yarn/fabric properties relationships so as to arrive at techno-economical solution.

[0019] In this direction attempts are made to work upon nonwovens. Nonwoven technology is another technology and method of producing fabrics. Using this technology, staple fibers and/or continuous filaments are bonded together to form a fabric. U.S. Pat. No. 6,736,916, U.S. Pat. No. 7,455,800, U.S. Pat. No. 7,452,834, U.S. Pat. No. 7,432,219, U.S. Pat. No. 4,805,275, U.S. Pat. No. 7,331,091, U.S. Pat. No. 6,103,061, and U.S. Pat. No. 6,063,717 disclose various ways of producing nonwovens. Nonwoven manufacturing involves web preparation, bonding, drying/curing, cutting slitting/winding.

[0020] There are various ways of bonding:

[0021] 1. Mechanical bonding like malimo, needle punch and hydro entanglement;

[0022] 2. Chemical bonding;

[0023] 3. Thermal bonding; and

[0024] 4. Combination of above

[0025] However, nonwovens are not perfect like woven or knitted fabrics and so far are not suitable for direct use in home and apparel textiles. They do exist in combination with woven or knitted fabrics. The best example is interlinings inside the garment.

[0026] Nonwovens lack in important aspects like look, drape and fall, abrasion and pilling resistance required for home and apparel textile. All these properties are not possible to be attained at the same time. For example, if bonding amount is improved so as to improve pilling resistance will hamper the hand feel and drape. The fabric becomes stiff. Another example can be that of fiber free movement if preserved, will generate good drape and feel. However, this will hamper the strength and pilling resistance. Various attempts have been made to improve nonwovens and make them suitable for apparel and home textiles. Still lot of work is going on in this direction.

[0027] European Patent No. 0896645 discloses lamination of two nonwoven fabrics using chemical adhesives. This invention relates to making nonwoven fabrics which are durable for machine washing and durable for other wet and hard use or abusive applications. The inventive fabrics retain the qualities of a spun laced nonwoven fabric which include low cost, comfort, drape ability, softness, absorbency, breathability and others while having the durability comparable to traditional knitted or woven fabrics. However, commercial success of this is limited. This fabric lacks in textile fabric look and feel/touch. Also, this fabric being originally a nonwoven lacks in pilling resistance. This fabric lacks in quick recovery from elastic deformations. If used in bottom weights, this limitation of the fabric results in cup formation at knees. This problem can be resolved through chemical adhesives, but then results in to making fabric very stiff and uncomfortable to wear. This fabric can go as the work wear that is worn on top of textile apparel fabric. At least today, we do not see this product on racks anywhere in the world meant for direct apparel and home textile application.

[0028] Another U.S. Pat. No. 3,498,874 reveals the attempt made to create a nonwoven material having a textile like look. Apertured nonwoven fabric which closely resembles woven fabric is characterized by fibers locked into place by tanglelacing that extends in a zigzag pattern along parallel bands interconnected laterally by fiber bundles defining rows of apertures between the bands. Preparation of the fabric from a loose layer of fibers, such as a random web, is illustrated by processing fiber layers on screen woven of heavier wires in one direction and 3 to 5 times as many finer wires per inch in the other screen direction. The fiber layer is traversed with fine, essentially columnar liquid streams from a manifold supplied with high pressure liquid to entangle the fibers. This product lacks in strength and durability required for its use into textile applications like home and apparel textile. Application of all such products is mostly limited to disposable products.

[0029] In U.S. Pat. No. 6,315,864, improved cloth-like base web is disclosed. In particular, the base web of the present invention has a cloth-like look and feel and improved absorbency. The base web is made by first hydroneedling a web containing pulp and/or staple fibers. A bonding material is then applied to at least one side of the web and the web is creped on at least one side. By combining a hydroneedling operation with a creping operation, a base web is produced that is strong, stretchable, very soft and absorbent. This also is a disposable product, suitable for hygiene applications.

[0030] Hydro-entanglement technology is the one which many researchers have tried to develop products which have a close resemblance to textiles. After understanding the potential of this technology, many attempts were made to use this technology to enhance traditional textile fabrics.

[0031] U.S. Pat. No. RE40362, U.S. Pat. No. 5,136,761, U.S. Pat. No. 4,967,456, WO/2005/059215, WO/1992/007984 disclose the attempts made for using high pressure water jets and treat face and back side of woven or knitted fabric thereby enhancing their dimensional stability, pilling resistance and mechanical properties like tensile strength. However, this is a kind of finishing process. This improves textile fabrics but at a high cost when compared to traditional textile finishing process. Therefore, we do not see its commercial advantage and application.

[0032] Reference can be made to U.S. Pat. No. 4,695,500 which discloses the use of hydro entanglement technology for stabilization of bandage woven fabric. The stabilized fabric is formed by covering one or both sides of the loosely constructed base fabric with a light web of the staple length fibers, and subjecting the composite material to hydraulic entanglement while supported on a porous forming belt configured to direct and concentrate the staple length fibers at the intersections of the yarns comprising the base fabric.

[0033] This improves the ease of bandage fabric usage. Bandage fabric feels soft and is more absorbent. However, this is a disposable product and also adds to the cost of basic product. Application is limited to bandage cloth which is used once and never washed and used again.

[0034] U.S. Pat. No. 4,145,468 discloses use of hydro-entanglement technology for manufacturing of synthetic leather substratum material. Composite fabric useful as a substratum sheet for artificial leather is composed of a woven or knitted fabric constituent and at least one nonwoven fabric constituent. The nonwoven fabric comprises numerous fibrous bundles composed of a plurality of indi-

vidual fibers arranged parallel to each other, and varying in the number of the individual fibers from which the bundles are formed, and numerous individual fibers independent from each other and from the fibrous bundles. The individual fibers and the fibrous bundles being randomly distributed and entangled with each other to form a body of nonwoven fabric, and the nonwoven fabric constituent and woven or knitted fabric constituent being superimposed and bonded together, to form a body of composite fabric, in such a manner that portions of the individual fibers and the fibrous bundles of the non-woven fabric constituent penetrate into the inside of the woven or knitted fabric and are entangled with a portion of fibers in the woven or knitted fabric constituent. This composite in its original format is not a durable product. Once coated with the suitable chemicals for making it synthetic leather, it becomes durable. This product is not suitable for apparel or home textile application.

[0035] Reference can be made to patent WO 2008/107907 A2. This invention relates to a composite fabric and a method and apparatus for manufacturing a composite fabric. In an embodiment composite comprises a base fabric made by weaving or knitting. A plurality of gaps is disposed in between the fibers of the yarns of the base fabric. A plurality of functional fibers is entangled in the gaps followed by swelling of the fibers, with predetermined retention to the yarns of the base fabric. This is a first attempt made to develop a fabric suitable for textile application. However, this composite has a limitation of wash durability. Also, there are limitations in entanglement of individual fibers with the fibers from yarns of base fabric. This poses a risk of entanglement of fibers from web amongst themselves and thereby resulting into problem of missed out entanglement between fibers from web and fibers from yarn of base fabric thereby resulting in delamination and poor durability and life. Also, it does not reveal great commercial advantage over the present textile fabrics.

[0036] The German company Freudenberg and the US company BBA Nonwovens did try to develop and introduce a 100% nonwoven fabric called Evolon using spun jet technology and splittable bi-component synthetic filaments for apparel textile application. Compared to other nonwovens, EVOLON was a much more durable product, processable on traditional textile dyeing and finishing machines. It also has a good drape.

[0037] However, this product was 100% synthetic and had a sueded leather touch which is not appreciated always. Also it lacked the traditional textile fabric look which people are familiar with. Also, it was expensive and did not get a commercial success.

[0038] As seen from prior arts and above, sufficient successful attempts are not made so far as to create an alternate to durable traditional textiles used for home, upholstery and apparel application. There is a need to relook at traditional textiles the way they are done today from the perspective of achieving required product attributes with ease of process and at lower costs.

[0039] The wonder fabric invention offers a solution required for today's traditional textiles. Through this invention, it is possible to deliver the right product suitable for home and apparel textile applications at costs lower than today's.

[0040] Unlike nonwovens or composites referred in prior art, wonder fabric so done is launderable and durable and processable just like traditional textiles.

[0041] This invention simplifies the traditional textile process and helps curtail cost. Woven or knitted fabric is manufactured with lightest possible construction to the extent that it is having a see through effect and is completely unstable. Required properties/attributes/functions are inculcated in the later stage during hydro-lamination with pseudo yarns and cross linking fibers in a cost effective manner.

[0042] This makes traditional textile process simple and cost effective. This also makes the final product cost effective. Wonder fabric can be dyed and finished using the same equipments and process as they are used for traditional textiles.

[0043] In one final step, this invention inculcates important attributes like high comfort, easy care or wrinkle free property, good recovery from creasing, clean and sharp look, smooth and tough surface and of course good wash durability required for apparel and home textile applications.

OBJECT OF INVENTION

[0044] The main object of this invention is to provide a multifunctional wonder fabric comprising of fabric element with see through and unstable construction which is hydro-laminated with pseudo yarns and cross linking fibers.

[0045] Another object of invention is to provide a cost effective method and process of manufacturing fabric suitable for home, upholstery and apparel textile application.

[0046] Yet another object of the invention is to develop a new method of creating pseudo yarns in the plurality of gaps among the yarns and entangling them strongly with the yarns from woven or knitted fabric, thereby creating a look very close to traditional textile fabrics used for home, upholstery and apparel textile.

[0047] Further, object of this invention is to redefine traditional relationship between count and fabric construction with fabric properties.

[0048] Yet another object of the invention is to provide a new method and process of inculcating the required functions or attributes in the openly constructed and unstable fabric.

[0049] It is also the object of the invention is to provide a launderable fabric with high durability.

SUMMARY OF INVENTION

[0050] In accordance with above objectives, the present invention provides a novel multifunctional wonder fabric suitable for sheeting, mattress/pillow shell and similar applications in home textiles. This fabric is also suitable for tops and bottoms, undergarments and similar applications in apparel textiles. This fabric is also suitable for curtains, furniture covers and similar products in upholstery.

[0051] According to present invention, the wonder fabric comprises an open fabric with see through and unstable construction of intersecting plurality of yarns together with pseudo yarns hydro-laminated thereby delivering a stable product with acceptable look and functions/attributes required for home, apparel and upholstery applications.

[0052] According to present invention, a fabric with see through and unstable construction is hydro-laminated with pseudo yarns on at least one side thereby inculcating properties like dimensional stability, strength and durability.

[0053] According to present invention, fibers which do not participate in the formation of pseudo yarns are cross linked

with yarns of fabric thereby helps to inculcate properties like easy care/wrinkle free, recovery from creases and dimensional stability.

[0054] According to present invention, amount of entanglement depicts the textile feel, touch and behavior.

[0055] According to present invention, fabric is either woven or knitted and can be taken directly from loom or prior to dyeing or dyed or in finished form. The so hydro-laminated wonder fabric can be dyed and finished in the later stage in the same way like any other textile fabric.

BRIEF DESCRIPTION OF DRAWINGS

[0056] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate an implementation of the present invention, and together with the description, serve to explain the advantages and principles of the invention. The patent or application file contains at least one drawing executed in color. Copies of this patent or patent application publication with color drawings will be provided by the Office upon request and payment of the necessary fee. In the drawings:

[0057] FIG. 1 shows the schemata of cross-section of see through component fabric and of wonder fabric.

[0058] FIG. 2 shows the schemata of plan view of see through component fabric and wonder fabric.

[0059] FIGS. 3a-3b illustrate an entire equipment configuration for manufacturing wonder fabric.

[0060] FIGS. 4, 10, and 11 show the scanning electron microscope (SEM) photograph of cross-section of wonder fabric.

[0061] FIG. 5 shows the SEM photograph of plan view of wonder fabric.

[0062] FIG. 6 shows the SEM photograph of cross linking fibers and cross links.

[0063] FIG. 7 and FIG. 16 show two illustrations of process routes used for manufacture of wonder fabric.

[0064] FIG. 8 and FIG. 9 show the face and back side of coated/laminated blackout curtain made out of wonder fabric.

[0065] FIGS. 12a, 12b, 13a, 13b, 14a and 14b show photographs of the face and back side of the wonder fabric: Green (FIGS. 12 (a) and 9(b)), Orange (FIGS. 13 (a) and (b)) in color and white bleached (FIGS. 14(a) and (b)), one can clearly find out the look aspects inculcated by the invention. From these figures, one can make out how the fabric with see through construction is converted into non transparent wonder fabric suitable for home, upholstery and apparel textile.

[0066] FIGS. 15 (a) and (b) shows textile substrate.

[0067] FIG. 17A-FIG. 17B show the Flow Path Models of (A) an OK Sample which includes pre-treatment of the textile substrate, and (B) a NOT OK Sample which omits pre-treatment of the textile substrate.

[0068] FIG. 18 A-FIG. 18B show the parameters for producing (A) an OK Sample which includes pre-treatment of the textile substrate, and (B) a NOT OK Sample which omits pre-treatment of the textile substrate.

[0069] FIG. 19 shows the results of wrinkling on an OK Sample (A) Before wash and (B) After wash; and a NOT OK Sample (A) Before Wash and (B) After wash.

[0070] FIG. 20 shows the pilling results after washing an (A) OK Sample and (B) NOT OK Sample.

[0071] FIG. 21 shows the delamination of (A) a NOT OK Sample compared to (B) an OK Sample.

[0072] FIG. 22 shows a NOT OK Sample both (A) Before Wash and (B) After Wash, which was produced using a modified method with an increase in jet stream water pressures.

DETAILED DESCRIPTION OF DRAWINGS

[0073] From FIGS. 1 and 2 one can see the pseudo yarns formed in the space between two consecutive yarns of the see through fabric component. One also can understand that fibers from these pseudo yarns and also external fibers entangle and create bonding between pseudo yarns and yarns of the see through fabric component.

[0074] In the SEM photograph as shown in FIGS. 4, 10, and 11 one can see the pseudo yarns formed in the space between two successive original yarns. For better clarity, these pseudo yarns are encircled and shown. In the SEM photograph as shown in FIG. 5, one can see the pseudo yarns. External fibers bonding these pseudo yarns are also seen.

[0075] In the SEM photograph as shown in FIG. 6, there are external fibers which bond the original yarns to each other. This helps guide and control original yarn movement in the fabric. Fabric properties are depicted accordingly.

[0076] FIGS. 3a-3b show the equipment configuration 300 used for the manufacture of this wonder fabric. This line has at least one fiber opening line with various opening, mixing/blending machines 302, 304, 306 and if cotton then cleaning machines 303. Thus opened and/or cleaned fiber material is fed to carding machine 314 through the card feeder 308. Here fibers are individualized and arranged in a particular manner as depicted by speeds and settings of rotating parts. For example, with proper planning and control of speeds and settings of doffer-transfer roll-random roll (not shown) and adjustment of condenser suction rate one can control fiber orientation in the machine direction, cross direction or can create a random orientation. Fibers so individualized are delivered on to fiber transport belt 318 in the form of a fiber web which is then transported 316 to hydro-lamination device 324.

[0077] The fabric with see through construction is delivered from a fabric roll 312 arranged behind the carding machine 314. Fabric is passed through the expander 310 for proper opening followed by proper tensioning through drafting rolls in the expander 310. So opened up fabric is supported/transported by guide rolls (not shown) to hydro-lamination device 324.

[0078] In the hydro-lamination device 324, the see through fabric is hit by at least one streams of high pressure water streams delivered through injectors 320a, 320b, 320c, 320d, 320e, 320f, 320g, 320h, 320i. There may be a different number of injectors than shown. In addition, these injectors 320a, 320b, 320c, 320d, 320e, 320f, 320g, 320h, 320i are found in the hydro-lamination divide 324, and at other points in the equipment configuration. At least one of the water stream strikes the fabric at an angle. Depending upon requirement, at least one water stream strikes the fabric in a direction in which fabric is moving or an opposite.

[0079] Selection of hydro-lamination parameters is guided by the final fabric properties required.

[0080] So treated fabric with relaxed and volumized yarns is met with fiber web as shown in the FIG. 3a. Both now onwards are made to face successive steps of hydro-lamination.

[0081] Hydro-lamination is done using at least belt or perforated drums 322a, 322b, 322c with suitable shells. These drums 322a, 322b, 322c can also be found elsewhere in the equipment configuration 300. Shells depict the effective perforation area used and water rebound.

[0082] During hydro-lamination, at least one water stream will strike the fibers and fabric at preset angle and direction from injectors or jet heads 320a, 320b, 320c, 320d, 320e, 320f, 320g, 320h, 320i above. Fabric and fibers are also made to face at least one oscillating water stream. Also, fabric and fibers are made to face at least one high pressure water stream. These water streams are arranged and parameters are designed based upon properties required in the final product. Water streams are delivered by injectors 320a, 320b, 320c, 320d, 320e, 320f, 320g, 320h, 320i as shown in the FIG. 3a.

[0083] Remaining hydro-lamination parameters like jet size, jets/inch, jet length, vacuum, shell type, etc., are planned depending upon the properties required in the final product that is wonder fabric.

[0084] So formed wonder fabric is then passed on to dewatering device 326. This device removes physically held water by using vacuum.

[0085] Thus, dewatered wonder fabric is then passed through the dryer 328 for removing chemically held water. Wonder fabric so dried is finally wound on bobbins, at the winder 332. If necessary, before winding, it is slit in width wise direction to the pieces of required widths.

[0086] A fabric may be produced using a textile substrate that has either been pre-treated (OK Sample) as described here or an inferior fabric produced using a textile substrate not pre-treated (NOT OK Sample). The Flow Path Model where an OK Sample with the pre-treatment of the textile substrate at Drum 1 (FIG. 17A) and where a NOT OK Sample without the pre-treatment of the textile substrate at Drum 1 (FIG. 17B) are shown. This is demonstrated by the presence and absence of the two Drum 1 jet streams, where the Flow Path Model of the NOT OK Sample has "X" markings in the two Drum 1 jet stream rectangular boxes indicating the absence of the jet streams and hence the absence of the pre-treatment. The specific process route parameters chart further demonstrates the presence of the pre-treatment of the textile substrate for the OK Sample with the pre-treatment of the textile identified by the specific pressures for jet head (J.H.) 1.1 and jet head (J.H.) 1.2 of Drum 1 and the absence of the pre-treatment of the textile substrate for the NOT OK Sample without the pre-treatment of the textile shown by the lack of any pressures for jet heads 1.1 and 1.2. All of the other parameters in the production of the final fabrics were the same.

DETAILED DESCRIPTION OF INVENTION

[0087] The invention will now be described in detail, along with certain preferred and optional embodiments so that various aspects thereof may be more fully understood and appreciated.

[0088] The present invention provides a unique, multi-functional and durable textile material with a look acceptable for home textile, upholstery and apparel textile application having multiple advantages over prior art.

[0089] Here onwards, textile fabric with see through and unstable construction will be called as textile substrate as shown in FIGS. 15(a) and (b). As shown in FIGS. 4 and 5,

at least on one side of textile substrate, pseudo yarns are formed. These pseudo yarns are entangled with textile substrate.

[0090] Textile substrate can be manufactured using weaving technology or knitting technology. Yarns those are used for manufacturing of textile substrate can be combed and/or carded yarns. Further, these yarns can be either ring spun or open end spun yarns or air jet yarns or air vortex yarns or friction spun yarns. Also, yarns spun from any other technology other than the one mentioned before can be used for manufacturing textile substrate. Also, these yarns can be monofilament yarns or multifilament yarns spun from synthetic polymer melts.

[0091] Yarns used for the manufacturing of textile substrate can be a single yarn or plied yarn. Also, these yarns can be with hard core or soft core.

[0092] Yarns used for manufacturing of textile substrate can be spun out of grey cotton or bleached cotton or dyed cotton or undyed manmade fiber or dyed manmade fiber or blends.

[0093] As shown in FIG. 6, the yarns from textile substrate are also entangled with the fibers. These fibers here onwards will be called as cross linking fibers.

[0094] Process of layering of fiber web on top side of textile substrate followed by entanglement of fibers amongst themselves thereby forming pseudo yarns followed by entanglement of pseudo yarns with yarns of textile substrate followed by entanglement of cross linking fibers with fibers of yarns from textile substrate and pseudo yarns will be called as hydro-lamination.

[0095] Hydro-entanglement device usually consists of at least one pressurized water stream delivered by injector through jet strip on to material being supported by belt or drum with or without shell. It is common that water jets from injector point towards the drum centre.

[0096] Material so formed, is further treated with chemicals for pre treatment, dyeing and/or printing and post treatment. The final product so delivered and as shown in FIG. 8, 9 and dyed/bleached fabric as shown in FIGS. 12(a) and 12(b), 13(a) and 13(b) and 14(a) and 14(b), now onwards will be called as wonder fabric or multi-purpose fabric.

[0097] Textile substrate is taken directly from weaving machine or knitting machine. Also, it is possible that textile substrate is dyed and processed before hand.

[0098] In an embodiment, the textile substrate is subjected to at least one high pressure straight jet stream. Further, the said textile substrate is also subjected to at least one jet stream that strikes at an angle. Another embodiment is directed to the pre-treatment of a textile substrate where a straight jet nozzle is first applied to a textile substrate and followed by an angled jet nozzle. Yet a further embodiment relates to at least one high pressure jet stream. In a preferred embodiment, a textile substrate undergoes at least two jet streams where the second jet nozzle applies a high pressure jet stream to the textile substrate. The second high pressure jet stream has a pressure ranging from at or about 100 bar-at or about 400 bar, at or about 150 bar-at or about 250 bar, and at or about 180 bar. The application to a textile substrate, or to yarns of a textile substrate, of at least two jet streams, comprising at least one straight jet nozzle and at least one angled jet nozzle, results in combing and stripping actions. This may also result in partial entanglement of fibers from component yarns. The entanglement levels can be controlled

by varying the jet stream pressures, jet nozzle types, and order of the application of jet streams during entanglement. Without being bound by theory, a higher pressure results in more random entanglement and application of a jet stream through an angled nozzle results in random entanglements as well. The speed of a textile substrate and/or web fiber before or after pre-entanglement is generally the same as shown in FIG. 18A. As required, direction of fabric movement is adjusted in such a way that jets and textile substrate move in the same direction or oppose each other. In either case, yarns from textile substrate are subjected to combing/stripping action and thereby resulting in to rearrangement of fibers in the yarns and making it suitable for serving as the support material during formation of pseudo yarns. This also results in to random fiber entanglements resulting in to yarn structure which can not be untwisted or disintegrated easily. This also results in to partial entanglement of fibers from component yarns. As per requirement, the entanglement level can be controlled thereby improving fabric properties.

[0099] By selecting proper jet stream parameters like jet size of 0.079 mm to 0.14 mm, with suitable energy when strikes textile substrate, suitable hand-feel and touch are created.

[0100] In a preferred embodiment, the invention provides a multipurpose wonder fabric suitable for home textile, upholstery and apparel textile application comprising at least one textile substrate with see-through and unstable construction, hydro-laminated with pseudo yarns so formed by hydro-entangling fibers on at least one side of textile substrate. The wonder fabric will have at least one textile substrate hydro-entangled with cross linking fibers at least on one side.

[0101] The said textile substrate is manufactured using weaving technology or knitting technology. Further, textile substrate can be manufactured from natural fibers or man-made fibers or their blends. The said textile substrate is constructed with yarn counts in the range of Ne 1 to 160, preferably in the range of Ne 5 to 160. Further, said textile substrate if woven, is constructed with 42 up to 300 threads/inch in warp way direction, preferably in the range of 30 to 168 threads/inch and 15 to 500 threads/inch in weft way direction, preferably in the range of 25 to 300 threads/inch and with a plain or twill or satin or combination weave and with weight of 45 up to 1200 g/m² preferably in the range of 45 to 300 and if warp knitted or weft knitted, with weight of 60 up to 400 g/m².

[0102] The fibers used for formation of said pseudo yarns are selected from natural or manmade fibers or blends thereof.

[0103] In another embodiment, the invention provides an assembly for manufacturing of wonder fabric comprising, an opening line which comprises a bale opener 302, a heavy trash separator 303, a multimixer 304, a fine opener 306 and card feeder 308 for cleaning and opening the fiber material for feeding to carding machine 314, a carding machine 314 for individualization and arranging of fibers in a required manner, a fabric unwinding expanding and tensioning device 310 and as a part of hydro-lamination device 324, a fabric combing device 319 comprising of at least one perforated drum 322a, 322b, 322c (there may be additional drums) or at least one perforated belt or at least one perforated drum with belt and with at least one straight jet stream and/or at least one jet stream striking textile substrate at an angle via injectors 320a and 320b, and injectors 320c,

320d, 320e, 320f, 320g, 320h, and 320i striking the textile substrate and the fiber web from the fiber transport belt 318. There may be additional injectors or fewer injectors as well. Perforated drums 322a, 322b, 322c if covered can be with perforated sleeve or perforated belt. Hydro-lamination assembly 324 further comprises at least one perforated drum or plurality of drums 322a, 322b, 322c comprising of at least one straight jet stream or plurality of jet streams with pressures gradient as required for hydro-lamination and at least one high pressure straight jet stream and at least one jet stream striking drum at an angle and at least one oscillating injector. These are shown as injectors 320a and 320b for the textile substrate alone for producing a pre-treated textile substrate, and injectors 320c, 320d, 320e, 320f, 320g, 320h, and 320i for textile substrate and the fiber web from the fiber transport belt 318. Perforated drum or drums 322a, 322b, and 322c are covered with belt with suitable openness or metal or plastic sleeve with suitable perforations, a dewatering device 326 for dewatering of wonder fabric, a dryer 328 for drying of wet wonder fabric, winder 332 for winding of dried wonder fabric, a padless chainless or chain mercerizer 334 for mercerization, swelling and preparation of wonder fabric for textile dyeing and finishing process, an open width continuous bleaching/dyeing range 336 for dyeing of wonder fabric, a padder with curing device 346 for padding of chemical agents, an open width dyeing device 338, a slow flow dyeing machine 340, or a jet dyeing machine 342, as required for pretreatment and dyeing of wonder fabric, an open width machine or soft flow surface finishing machine 348 for top or surface finishing of wonder fabric, and/or an emerizing or raising machine 350 for mechanical surface finishing of wonder fabric, a sanforization machine 352 or decatizing machine (not shown) for dimensional stabilization of wonder fabric, a knife coater 356 or padder 354 or kiss roll arrangement 358 or zimmer coater machine 360 followed by curing device/cross linking device 364 or 366 for coating of wonder fabric on at least one side with chemicals like polyurethane, thermoplastic polyolephenes, thermoplastic polyurethane, polyurethane plus aluminium, etc. A lamination device 362 for lamination of wonder fabric on at least one side with membrane/films made out of PU or TPU or TPO, FR Material, etc., can be included depending upon the ultimate use of the fabric, with wonder fabric 368 being produced.

[0104] In another embodiment, the invention provides a process for manufacturing pseudo yarns or web fibers entangled among themselves in gaps of the pre-treated textile substrate comprising the following steps, as seen in FIG. 16:

- [0105] a. pre-entangling fibers 1615 of web thereby creating necessary strength in the web;
- [0106] b. supporting 1635 the web of step (a) on at least one side of a pre-treated textile substrate 1630;
- [0107] c. subjecting the web on at least one side of the pre-treated textile substrate 1630 of step (b) to at least one jet stream at required pressure or plurality of jet streams 1640 with pressure gradient resulting into web disintegration and slipping away of fibers 1645 and;
- [0108] d. rolling around of fibers formed in step (c) in the same space being supported by the pre-treated textile substrate thereby resulting in to formation of pseudo yarns or web fibers entangled among themselves in gaps of the pre-treated textile substrate 1650.

[0109] In yet another embodiment, also shown in FIG. 16, the invention provides for a process for manufacturing of wonder fabric comprising steps of:

[0110] a. opening and cleaning of fibers in opening machines **1605**;

[0111] b. individualizing the fibers of step (a) in carding machine thereby delivering web of fibers **1610**;

[0112] c. opening of textile substrate by expander roll **1620**;

[0113] d. tensioning of textile substrate of step (c) through fabric tensioner **1625** and then subjecting it to high pressure water jets **1630** striking straight and/or at an angle;

[0114] e. layering of pre-treated textile substrate of step (d) with pre-entangled fiber web of step (b) for the formation of pseudo yarns or web fibers entangled among themselves in gaps of the pre-treated textile substrate **1635**;

[0115] f. subjecting the layered pre-treated textile substrate and pseudo yarns or web fibers entangled among themselves in gaps of the pre-treated textile substrate of step (e) to at least 1 high pressure water jet **1660**, striking straight or at an angle and oscillating water jet so as to form wonder fabric;

[0116] g. dewatering wonder fabric of step (f) by passing through dewatering device **1665**;

[0117] h. drying dewatered wonder fabric of step (g) by passing through dryer wherein temperature is adjusted according to fiber type such that, dried fabric is left with residual moisture equal to natural moisture regain of the fiber **1670**;

[0118] i. winding dried wonder fabric of step (h) on to bobbins/tubes by using winder **1675**;

[0119] j. chemically treating and/or drying and/or dyeing and/or printing and top finishing the wonder fabric of step (i) **1680** so that it can be used for textile applications like home, upholstery and apparel textile, and/or;

[0120] k. coating or laminating of wonder fabric of step (h) for technical textile and upholstery application **1685**.

[0121] Textile substrate can be made out of natural or manmade fibers or their blends. It can be woven or knitted or composite material but with see through and unstable construction.

[0122] Staple fibers are opened or opened and cleaned followed by carding. One can use a classical non woven card with worker/stripper rolls or a flat card. After carding, these fibers are delivered in the web form. If required this fiber web is lightly entangled using water jets.

[0123] So pre-entangled fibers (at or about 10 gsm-at or about 300 gsm) or non-entangled fibers are delivered on top side of textile substrate. In case, fibers are non-entangled before; these fibers are lightly entangled now so that they are capable of taking higher level of energy from high pressure water jets.

[0124] In one embodiment, a multipurpose fabric comprises: a web of fibers and a pre-treated textile substrate comprising fibers, where the web fibers are entangled among themselves in gaps of a pre-treated textile substrate, where a textile substrate is hydroentangled to form a pre-treated textile substrate;

[0125] where the web fibers entangled in gaps of the pre-treated textile substrate are entangled with the pre-treated textile substrate fibers;

[0126] where the remaining web fibers, which do not become part of the entanglements in gaps of the pre-treated textile substrate, are entangled with pre-treated textile substrate fibers;

[0127] where entanglement occurs on at least one side of the pre-treated textile substrate.

[0128] A pre-treated textile substrate is produced by applying at least two jet streams to a textile substrate, where at least one jet stream is at high pressure, where high pressure is a pressure at or greater than about 100 bar, at or greater than about 110 bar, at or greater than about 120 bar, at or greater than about 130 bar, at or greater than about 140 bar, at or greater than about 150 bar, at or greater than about 160 bar, at or greater than about 170 bar, at or greater than about 180 bar, at or greater than about 190 bar, at or greater than about 200 bar, at or greater than about 210 bar, at or greater than about 220 bar, at or greater than about 230 bar, at or greater than about 240 bar, at or greater than about 250 bar, at or greater than about 260 bar, at or greater than about 270 bar, at or greater than about 280 bar, at or greater than about 290 bar, at or greater than about 300 bar, at or greater than about 310 bar, at or greater than about 320 bar, at or greater than about 330 bar, at or greater than about 340 bar, at or greater than about 350 bar, at or greater than about 360 bar, at or greater than about 370 bar, at or greater than about 380 bar, at or greater than about 390 bar, or at or greater than about 400 bar. In one embodiment, a pre-treated textile substrate is produced by applying two jet streams to a textile substrate, where at least one jet stream is of a high pressure, for example, at or greater than about 100 bar, at or greater than about 150 bar, at or greater than about 180 bar. Another embodiment is directed to pre-treating a textile substrate by applying at least 2 high pressure jet streams to the textile substrate. A further embodiment is directed to pre-treatment of a textile substrate with at least 1 high pressure jet stream and at least 1 jet stream that is not at high pressure. In yet another embodiment, a low pressure jet stream and then a high pressure jet stream are applied to a textile substrate to form a pre-treated textile substrate.

[0129] In another embodiment, a multipurpose fabric comprises: a web of fibers and a pre-treated textile substrate comprising fibers,

[0130] where the web fibers are entangled among themselves in gaps of a pre-treated textile substrate, where a textile substrate is hydroentangled by applying at least one high pressure jet stream to form a pre-treated textile substrate, where the high pressure jet stream has a pressure ranging from at or about 100 bar-at or about 400 bar, at or about 150 bar-at or about 300 bar, or at or about 180 bar;

[0131] where the web fibers entangled in gaps of the pre-treated textile substrate are entangled with the pre-treated textile substrate fibers;

[0132] where the remaining web fibers, which do not become part of the entanglements in gaps of the pre-treated textile substrate, are entangled with pre-treated textile substrate fibers;

[0133] where entanglement occurs on at least one side of the pre-treated textile substrate.

[0134] In yet another embodiment, an assembly for manufacturing a multipurpose fabric comprises:

- [0135] a. an opening line for opening and cleaning fibers;
- [0136] b. a carding machine for carding said fibers to prepare a pre-entangled fiber web;
- [0137] c. a fabric unwinding, expanding and tensioning device;
- [0138] d. a fabric combing device including at least one perforated drum having at least one jet stream to prepare a pre-treated textile substrate; and
- [0139] e. a hydro-lamination unit including at least one perforated drum including at least one jet stream for subjecting said pre-entangled fiber web layered on said pre-treated textile substrate to form a multipurpose fabric.

The assembly may further comprise the following components depending on the desired end product:

- [0140] f. a dewatering device for dewatering of said multipurpose fabric;
- [0141] g. a dryer for drying of wet fabric;
- [0142] h. a winder for winding of dried fabric;
- [0143] i. a mercerizer for mercerization, swelling and preparing the fabric for a textile dyeing and finishing process;
- [0144] j. an open width continuous bleaching/dyeing range for dyeing of fabric;
- [0145] k. a padder including a curing device for padding of chemical agents and fixation;
- [0146] l. a machine of a soft flow machine or jet dyeing machine for pretreatment and dyeing of the fabric;
- [0147] m. a machine of an open width machine or a soft flow machine for top finishing of the fabric;
- [0148] n. a machine of an emerging machine or a raising machine for mechanical surface finishing of fabric;
- [0149] o. a sanforisation machine for dimensional stabilization of fabric;
- [0150] p. a machine of a knife coater, a padder, a kiss roll arrangement, or a zimmer machine;
- [0151] q. a curing device for coating of fabric on at least one side with chemicals of thermoplastic polyolefines, thermoplastic polyurethane, or polyurethane/aluminum; and
- [0152] r. a lamination device for lamination of fabric on at least one side with a membrane made from polyurethane, thermoplastic polyurethane, thermoplastic polyolephene, a flame retardant material, or a cross linker.

[0153] A process for manufacturing a multipurpose fabric, comprising:

- [0154] a. pre-entangling fibers in a web to increase strength in the web;
- [0155] b. supporting the web on at least one side of a pre-treated textile substrate, where a textile substrate is hydroentangled by applying at least one high pressure jet stream to form a pre-treated textile substrate, where the high pressure jet stream has a pressure ranging from at or about 100 bar-at or about 400 bar, at or about 150 bar-at or about 300 bar, or at or about 180 bar;
- [0156] c. subjecting the web to at least one oscillating jet stream and at least one angled jet resulting in web disintegration and slipping away of fibers;

[0157] d. rolling the fibers formed in step (c) in gaps of the textile substrate, wherein the fibers are guided by the textile substrate.

[0158] A process of pre-entangling fibers in a web comprises:

- [0159] opening a bale of functional fibers and cleaning fibers in a fiber opening machine; and
- [0160] carding the fibers in a carding machine to prepare a pre-entangled web of fibers;

where pre-treating a textile substrate comprises:

- [0161] opening up the textile substrate in an expander roll;
- [0162] tensioning the textile substrate through a fabric tensioner;
- [0163] subjecting the textile substrate to preferably, high pressure water jets at or greater than about 100 bar or at or greater than about 150 bar, and at least two water jets, where at least one water jet strikes the textile substrate straight and at least one water jet strikes at an angle, such as for example, at least about 10 degrees, or striking at an angle of at or about 25 degrees to form a pre-treated textile substrate, where at least one water jet streams at a high pressure to form a pre-treated textile substrate, where the high pressure jet stream has a pressure ranging from at or about 100 bar-at or about 400 bar, at or about 150 bar-at or about 300 bar, or at or about 180 bar, where the jet streams are in Drum 1 which is covered with a sleeve or a belt with an openness equivalent to at or about 100 meshes;

and said process further comprising:

- [0164] layering the pre-treated textile substrate with the web fibers entangled among themselves in gaps of the pre-treated textile substrate;
- [0165] subjecting the pre-treated textile substrate and the web fibers entangled among themselves in gaps of the pre-treated textile substrate to hydro-lamination with at least one or a plurality of jet streams, preferably one or more at high pressure, where at least one jet stream is a stationary water jet or an oscillating water jet, wherein the water jet is directed at the layered pre-treated textile substrate and pre-entangled web of fibers in a direction of a straight strike, an angled strike, or a combination of a straight and angled strike, where a hydroentanglement unit comprises at least 3 drums. Drum 2 comprises at least 3 straight jet streams where gradually increasing pressures are applied to the layers, Drum 3 comprises at least one high pressure straight jet stream and at least one jet stream striking at an angle of at least 10 degrees. Drum 4 comprising at least one oscillating injector and at least one high pressure straight jet stream. Drum 2 may be covered with a MPS sleeve with micropores arranged in diagonal lines. to form a multipurpose fabric. The pre-treated textile substrate and so-formed pseudo yarns or web fibers entangled among themselves in gaps of the pre-treated textile substrate may be subjected to at least 2 high pressure water jets with pressures above 180 bar, at least 1 water jet striking at an angle up to at or about 25 degrees with a pressure of at or above about 350 bar, and at least 1 oscillating water jet with a stroke length up to at or about 25 mm and a pressure of greater than or at or about 40 bar.

In contrast to other methods of fabric manufacture where fibers and textiles are compacted and sandwiched into 2

layers easily resulting in delamination, since production of the inventive multi-purpose fabric undergoes a step-by-step process involving separately pre-entangling fibers and a textile substrate, and then entangling the pre-entangled web of fibers and the pre-entangled textile substrate results in a better bond that does not delaminate or separate easily.

[0166] Pseudo yarns or web fibers entangled among themselves in gaps of the pre-treated textile substrate assist in producing a stable final fabric. Pre-entanglement of fibers of a web create the necessary strength in the web. This web is layered on at least one side of a pre-treated textile substrate and subjected to a series of jet streams with essentially successively increasing jet pressure. However, one embodiment relates to a final jet stream as applied to the web of fibers layered on a pre-treated textile substrate may have a jet pressure that is less than at least one or a plurality of prior jet streams. The successively increasing jet pressures assist in web disintegration and slipping away of fibers in the spaces between yarns, followed by rolling around of fibers in the same space being guided by yarns of the pre-treated textile substrate, thereby resulting in the formation of pseudo yarns or pre-entangled web fibers entangled among themselves in gaps of a pre-treated textile substrate.

[0167] Another embodiment further comprises post-production modifications. After hydroentanglement of the pre-treated textile substrate and the pre-entangled web of fibers, the so produced multi-purpose fabric may undergo any one of, or a combination of the following post-production steps, including:

[0168] dewatering the multi-purpose fabric by passing it through a dewatering device;

[0169] drying the dewatered multi-purpose fabric by passing it through a dryer;

[0170] winding the dried multi-purpose fabric on to bobbins on a winder;

[0171] chemically pre-treating the multi-purpose fabric with a process of dyeing, printing, top finishing, or a combination thereof; and

[0172] treating the multi-purpose fabric with a process of coating or laminating, such that the fabric has a smooth surface in accordance with the desired end product.

[0173] The process, where drying is performed at a temperature such that the dried fabric has a residual moisture content equal to natural moisture content of the fibers.

ASPECTS OF THE INVENTION

[0174] Aspect 1. A multipurpose fabric comprising:

[0175] a pre-entangled web of fibers and a pre-treated textile substrate comprising fibers,

[0176] wherein the web of fibers are entangled among themselves in gaps of a pre-treated textile substrate, wherein the pre-treated textile substrate is a result of hydroentanglement of a textile substrate under conditions of at least two jet streams, wherein at least one jet stream strikes the textile substrate at a high pressure ranging from at or about 100 bar-at or about 400 bar to form a pre-treated textile substrate;

[0177] wherein said web of fibers entangled in gaps of the pre-treated textile substrate are entangled with the pre-treated textile substrate fibers;

[0178] wherein the remaining web of fibers, which do not become part of the entanglements in gaps of the pre-treated textile substrate, are entangled with pre-treated textile substrate fibers; wherein entanglements occur on at least one side of the pre-treated textile substrate.

[0179] Aspect 2. The multipurpose fabric of claim 1, wherein the at least two jet streams comprises at least one straight jet head and at least one angled jet head, wherein said angled jet head is at or about 10 degrees-at or about 25 degrees.

[0180] Aspect 3. The multipurpose fabric according to Aspect 1, wherein the textile substrate is a woven textile substrate.

[0181] Aspect 4. The multipurpose fabric according to Aspect 1, wherein the textile substrate is a knitted textile substrate.

[0182] Aspect 5. The multipurpose fabric according to Aspect 1, wherein the textile substrate is made of fibers selected from the group consisting of natural fibers, man-made fibers, and blends of natural and manmade fibers.

[0183] Aspect 6. The multipurpose fabric according to Aspect 1, wherein the web fibers entangled among themselves in gaps of the pre-treated textile substrate are made of fibers selected from the group consisting of natural fibers, manmade fibers, and blends of natural and manmade fibers.

[0184] Aspect 7. The multipurpose fabric according to Aspect 1, wherein the textile substrate is constructed with yarn counts in the range of at or about Ne 1 up to at or about Ne 160, wherein the yarns are selected from the group consisting of single yarns and plied yarns.

[0185] Aspect 8. The multipurpose fabric according to Aspect 1, wherein the textile substrate is constructed with 30 threads/inch up to 300 threads/inch in warp way direction and 12 threads/inch up to 500 threads/inch in weft-way direction, having a weight of 45 g/m² to 1,200 g/m², wherein the weave is selected from the group consisting of a plain weave, a twill weave, a satin weave, and a combination weave.

[0186] Aspect 9. The multipurpose fabric according to Aspect 1, wherein the textile substrate has a weight of 60 g/m² to 400 g/m² with knitted structure selected from the group consisting of a warp knitted structure and a weft knitted structure.

[0187] Aspect 10. The multipurpose fabric according to Aspect 1, wherein the fabric has a tensile strength minimum of about 65 pounds (warp) and about 31 pounds (weft).

[0188] Aspect 11. The multipurpose fabric according to Aspect 1, wherein the fabric has a residual shrinkage after 5 washes of about 3% (warp) and about 0.5% (weft).

[0189] Aspect 12. The multipurpose fabric according to claim 26, wherein the fabric has a minimum seam slippage of about 16 (warp) and about 35 (weft).

[0190] Aspect 13. An assembly for manufacturing the multipurpose fabric of Aspect 1 comprising:

[0191] an opening line for opening and cleaning fibers;

[0192] a carding machine for carding said fibers to prepare a pre-entangled fiber web;

[0193] a fabric unwinding, expanding and tensioning device;

[0194] a fabric combing device including at least one perforated drum having at least one jet stream to prepare a pre-treated textile substrate, wherein the pre-treated textile substrate is a result of hydroentanglement of a textile substrate under conditions of at least two jet streams, wherein at least one jet stream strikes the textile substrate at a high pressure ranging from about 100 bar-about 400 bar to form a pre-treated textile substrate;

[0195] a hydro-lamination unit including at least one perforated drum including at least one jet stream for subjecting said pre-entangled fiber web layered on said pre-treated textile substrate to at least one high pressure jet stream ranging from about 100 bar-about 400 bar to form a multipurpose fabric.

[0196] Aspect 14. The assembly of Aspect 13, further comprising:

[0197] a dewatering device for dewatering of said multipurpose fabric;

[0198] a dryer for drying of wet fabric;

[0199] a winder for winding of dried fabric;

[0200] a mercerizer for mercerization, swelling and preparing the fabric for a textile dyeing and finishing process;

[0201] an open width continuous bleaching/dyeing range for dyeing of fabric;

[0202] a padder including a curing device for padding of chemical agents and fixation;

[0203] a machine of a soft flow machine or jet dyeing machine for pretreatment and dyeing of the fabric;

[0204] a machine of an open width machine or a soft flow machine for top finishing of the fabric;

[0205] a machine of an emerising machine or a raising machine for mechanical surface finishing of fabric;

[0206] a sanforisation machine for dimensional stabilization of fabric;

[0207] a machine of a knife coater, a padder, a kiss roll arrangement, or a zimmer machine;

[0208] a curing device for coating of fabric on at least one side with chemicals of thermoplastic polyolefenes, thermoplastic polyurethane, or polyurethane/aluminum; and

[0209] a lamination device for lamination of fabric on at least one side with a membrane made from polyurethane, thermoplastic polyurethane, thermoplastic polyolephene, a flame retardant material, or a cross linker.

[0210] Aspect 15. A process for manufacturing a multipurpose fabric of Aspect 1, comprising:

[0211] pre-entangling a web of fibers to increase strength in the web;

[0212] supporting the pre-entangled web of fibers on at least one side of a pre-treated textile substrate, wherein the pre-treated textile substrate is a result of hydroentangling a textile substrate under conditions of at least two jet streams, wherein at least one jet stream strikes the textile substrate at a high pressure ranging from about 100 bar-about 400 bar to form a pre-treated textile substrate;

[0213] subjecting the web of fibers to at least one oscillating jet stream and at least one angled jet resulting in web disintegration and slipping away of fibers;

[0214] rolling the slipped fibers in gaps of the pre-treated textile substrate, wherein the fibers are guided by the textile substrate.

[0215] Aspect 16. The process according to Aspect 15, wherein pre-entangling a web of fibers comprises:

[0216] opening and cleaning fibers in a fiber opening machine; and

[0217] carding the fibers in a carding machine to prepare a web of fibers;

wherein pre-treating the textile substrate comprises:

[0218] opening up the textile substrate in an expander roll;

[0219] tensioning the textile substrate through a fabric tensioner;

[0220] subjecting the textile substrate to at least two water jets, wherein at least one water jet comprises a high pressure jet stream ranging from about 100 bar-about 400 bar, and at least one water jet strikes the textile substrate at an angle, thereby forming a pre-treated textile substrate;

and said process further comprising:

[0221] layering the pre-treated textile substrate with the pre-entangled web of fibers entangled among themselves in gaps of the pre-treated textile substrate;

[0222] subjecting the pre-treated textile substrate and the web fibers entangled among themselves in gaps of the pre-treated textile substrate to hydro-lamination with a at least one stationary water jet or at least one oscillating water jet, wherein the water jet is directed at the pre-treated textile substrate in a direction of a straight strike, an angled strike, or a combination of a straight and angled strike, and at least one water stream is of high pressure ranging from about 100 bar-about 400 bar, thereby forming a multipurpose fabric.

[0223] Aspect 17. The process according to Aspect 16, further comprising:

[0224] dewatering the multipurpose fabric by passing through a dewatering device;

[0225] drying the dewatered multipurpose fabric by passing through a dryer;

[0226] winding the multipurpose fabric on to bobbins on a winder;

[0227] chemically pre-treating the multipurpose fabric with a process of dyeing, printing, top finishing, or a combination thereof; and

[0228] treating the multipurpose fabric with a process of coating or laminating, such that the multipurpose fabric has a smooth surface.

[0229] Aspect 18. The process according to Aspect 16, wherein the at least one water jet strikes at an angle ranging from at or about 10 degrees-at or about 25 degrees.

[0230] Aspect 19. The process according to Aspect 17, wherein the drying is performed at a temperature such that the dried multipurpose fabric has a residual moisture content equal to a natural moisture content of the fibers.

[0231] While the invention has been explained with reference to the specific examples of the invention, the explanation is illustrative, and the invention is limited only by the appended claims (after explaining the invention).

Examples

Example 1

[0232] 0.1 mm jet with 23 jets/inch arranged in single row strikes the web at pressure of 50 bar there by creating fiber entanglement level resulting in to tensile breaking load of 4.5 Newton/meter of width of web in machine direction and 1.7 Newton/meter of width of web in cross direction.

[0233] This fiber web then is subjected to a plurality of water jets designed with parameters suitable for forming pseudo yarns on the surface of the textile substrate. In this case, textile substrate works as support for fiber web. Textile substrate guides and facilitates rolling around of fibers from web there by making these fibers to entangle among themselves and form pseudo yarns.

Example 2

[0234] Textile substrate with fabric cover factor of 14 is layered with cotton fiber web and whole structure is subjected to high pressure water jet streams with jet description of 0.1 mm/23 jets/inch, 0.1 mm/40 jets/inch and 0.1 mm/40 jets/inch results into maximum fiber rolling and pseudo yarn formation as shown in FIG. 4, with very few traces of fibers on the bottom side of textile substrate.

[0235] Above phenomena is also influenced by fiber properties like polymer, fiber length, stiffness, diameter and surface friction. Web properties like fiber orientation, fiber individualization also influence the above phenomena.

[0236] Above structure is then subjected to at least one high pressure water jet stream. Fibers from pseudo yarns entangle with fibers of yarns from textile substrate. Water jet parameters are selected according to the balance between strength and product stiffness.

Example 3

[0237] Textile substrate with 80 g/m² and pseudo yarn structure with 35 g/m² when subjected to high pressure water stream with 0.1 mm jet size, arranged in single row results into pilling resistance of 5.0 and fabric stiffness acceptable for sheeting application.

[0238] Out of various attributes of textile fabric meant for home and apparel textile, first and foremost attribute important for any consumer is look of the fabric, and then comes feel. This is followed by the strength and durability. With time and increasing awareness of safety and hygiene, attributes like antimicrobial, odor kill, fire retardancy, etc., are becoming more and more important.

[0239] On the other hand, cost is also important aspect. Those products which deliver required look and attributes at nominal cost will have a surety of sale. This is known as value for money.

[0240] As described above in the background of invention, raw material cost is the biggest of all the components of cost. On account of technological limitations of spinning and weaving or knitting, technically and commercially important raw material properties like fiber length, strength, etc., can not be dropped below a particular limit. Therefore using this approach of value engineering by use of inferior raw material, costs can not be reduced drastically, for example; to the tune of 15 to 50%. Also, there is a risk of overall drop in operation efficiency. This for sure will deliver inferior product.

[0241] In this invention, a different and unique approach is followed. Textile substrate is designed and constructed with very open and see through construction there by reducing weight of the textile substrate to the tune of 15 to 50%. This brings down the cost drastically to the level of up to 50%. However, this textile substrate in its as it is form is not stable and also is not having a look and other attributes acceptable for home, upholstery and apparel application.

[0242] This invention uses this textile substrate as a support for the entanglement and formation of pseudo yarns. The fibers from web once subjected to high pressure water jets, prefer to slide down into the gaps. These fibers prefer to entangle among themselves first till they achieve a certain packing density. This gives rise to formation of pseudo yarns. So formed pseudo yarns along with textile substrate,

when subjected further to high pressure water jets, entangle through their fibers with the fibers from yarns of textile substrate.

[0243] The remaining fibers which do not roll down and become part of pseudo yarns entangle with the fibers from yarns of textile substrate. This way they cross-link among the yarns of textile substrate. This also depicts the fabric properties. By using the process defined in this invention, one can achieve durable press rating of at least 3.0 meaning wonder fabric so done is easy care, by default.

[0244] Phenomena described above also results in to introducing dimensional stability in the unstable textile substrate.

Example 4

[0245] Textile substrate with Ne 40/1×Ne 40/1 and 100×68 threads/inch in warp and weft respectively and web of 26 mm cotton fibers, when operated through this invention results into residual shrinkage of less than 4.0% in warp and less than 2% in weft way direction. This is in contrast to the original shrinkage potential of 12% in warp and 6% in weft way direction as tested in textile substrate.

[0246] Apart from look, pseudo yarns so formed and entangled with yarns from textile substrate depict the tensile strength, tear strength. One can find the improvement in tensile strength by at least 25%. Tear strength also improves by at least 8%.

Example 5

[0247] Textile substrate with Ne 40/1×Ne 40/1 and 107×38 threads/inch in warp and weft way direction when run along with cotton fiber web made out of 24 mm and 22 g/tex strength through findings of the invention gives breaking load 90 lb (+50%) and 34 (+20%) lb when tested for tensile strength. This also delivers tear strength of 4.5 lb (+35%) and 3.5 lb (+15%) in weft way direction.

[0248] Both pseudo yarn formation and entanglement with yarns from textile substrate along with cross-linking fibers entanglement with yarns from textile substrate result in to 15 to 35% improvement in resistance for seam slippage.

[0249] This invention not only blooms out yarns from textile substrate but also introduces high number of pores and continuous capillaries there by the wonder fabric delivered is highly absorbent and is capable of quick transportation of moisture through capillaries.

Example 6

[0250] Textile substrate with Ne 20/1×Ne 20/1 and 45×25 threads/inch along with cotton fiber pseudo yarns when treated using findings of the invention, wonder fabric so delivered possesses the absorption rate of less than 1 second.

[0251] Vertical wicking test shows the attainment of 13 cm in 30 minutes. This implies that wonder fabric so done is highly comfortable to wear.

[0252] During hydro-lamination, wonder fabric is subjected to at least one oscillating high pressure jet stream there by inculcating look features.

[0253] Wonder fabric so formed is also subjected to at least one high pressure jet stream which strikes the hydro-laminated surface at an angle there by inculcating durability features.

[0254] The invention provides the line configuration for the manufacture of multi-purpose wonder fabric comprising of opening line for opening of fibers in bale or similar form

into small fiber tufts, carding machine for individualization of fibers and form the web with suitable fiber orientation, transport arrangement for web up to hydro-lamination device, fabric unwinder for proper unwinding of fabric, expander and pre-tensioning roll for expanding and controlling fabric width and do not allow formation of creases, hydro-lamination device for formation of pseudo yarns, their entanglement with yarns of textile substrate, cross linking of fibers with yarns of textile substrate, combing through and stabilization of yarns from textile substrate, dewatering device for removing physically held water, dryer for removing chemically held water and winder for winding of so formed wonder fabric. For apparel, home textile and upholstery application, it is processed through traditional textile processing machines. For technical textile and upholstery application, it is processed through coating and/or lamination machines.

[0255] The invention provides the following process for manufacturing wonder fabric. The process comprises following steps:

[0256] a. Opening 1620, adjusting width and pre tensioning 1625 of the textile substrate there by preventing formation of wrinkles or creases.

[0257] b. Cleaning and combing through yarns of the textile substrate with high pressure water jet stream 1630 there by cleaning the surface, inculcating required shape and dimensions and entanglement among fibers and/or yarns as desired and to a level as desired so that textile substrate becomes suitable support for pseudo yarn formation.

[0258] c. Opening 1605 and carding 1610 of fibers and form the web 1615 with desired web properties.

[0259] d. Overlapping 1635 so formed web on the top of one of the sides of the textile substrate 1630, supporting web on textile substrate 1635 and subject both to at least one or plurality of high pressure jet streams 1640, slipping off fibers 1645, and rolling the fibers 1650, thereby forming pseudo yarns, entangle them with yarns from textile substrate and also cross link the remaining fibers with the yarns from textile substrate 1655, thereby delivering wonder fabric with desired properties, and subjecting the pseudo yarns and textile substrate to high pressure water jets 1660.

[0260] e. So formed wonder fabric is dewatered 1665 using dewatering device followed by drying 1670 using dryer.

[0261] f. Dried wonder fabric is then wound 1675 on to bobbins or rolls by winder.

[0262] g. This wonder fabric is then processed through chemical processing like dyeing and surface finish 1680 for home, upholstery and apparel textile application.

[0263] h. This wonder fabric is processed through coating/lamination machines 1685 so as to manufacture upholstery and technical textile products like black-out curtains, barrier fabrics, shoe uppers, soft covers for automobiles, etc.

[0264] The invention is more specifically explained by following examples. However, it should be understood that the scope of the present invention is not limited by the examples in any manner. It will be appreciated by any person skilled in this art that the present invention includes following examples and further can be modified and altered within the technical scope of the present invention.

Example 7

[0265] The following table shows how the invention inculcates high absorption rate in the so created wonder fabrics. Textile substrates with different counts and constructions along with cotton fiber pseudo yarns are processed using method as defined by this invention there by they exhibit the high absorption rate.

[0266] Water Absorption Test

[0267] Test Method used: AATCC 79

[0268] Test Conducted by: SGS, Mumbai

TABLE 1

Test Results:							
Sr. No.	ITS ID	Fabric ID	EPI	PPI	WrpCt	Weft Ct	Absorption Time (sec)
1.	13999	4031D	107	38	40 cw	40 cw	1
2.	14000	6031D	96	45	60 cw	60 cw	1
3.	14009	6031W	96	45	60 cw	60 cw	1
4.	14003	6031P	96	45	60 cw	60 cw	1
5.	14010	4032W	107	38	40 cw	40 cw	1
6.	14007	3031W	49	34	30 cw	30 cw	1
7.	14008	4031W	107	38	40 cw	40 cw	1

Example 8

[0269] The following table shows that different textile substrates along with pseudo yarns made out of cotton fibers when processed using findings of the invention result into having a high water wicking rate. This high wicking rate combined with high absorption rate provides a high level of comfort to the user.

[0270] Vertical Wicking Test

[0271] Test Method: SGS in house

[0272] Test Conducted by: SGS

TABLE 2

Test Results:							
Sr. No.	Fabric ID	EPI	PPI	WrpCt	Weft Ct	After 5 Min in Cms	After 30 Min in Cms
1	C212-1	45	25	20 kd	20 kd	8.1	13.3
2	C252	68	45	40 kd	40 kd	7.7	13
3	C222	56	25	20 kd	20 kd	7.2	12.6
4	C212-2	45	25	20 kd	20 kd	7.3	12.8
5	C232	45	25	30 kd	30 kd	7.6	13.3
6	C241	56	25	30 kd	30 kd	7.5	12.5

Example 9

[0273] One can see from the table that this invention delivers wonder fabric which is highly durable.

[0274] Different textile substrates as shown in the table along with pseudo yarns made out of polyester/cotton fiber blend are processed using findings of invention result in to a very good resistance for pilling. The test is conducted on the hydro-laminated side so as to establish the high durability.

[0275] Pilling Test

[0276] Test Method used: ASTM 4970

[0277] Test Conducted by: ITS, Mumbai

TABLE 3

Test Results:								
Sr.	Fabric				Weft		Pilling After 100 Cycle	
No.	ID	EPI	PPI	WrpCt	Ct	ITS	Protocol	
1	13999	4031D	107	38	40 cw	40 cw	5	3
2	14000	6031D	96	45	60 cw	60 cw	5	3
3	14001	4031P	107	38	40 cw	40 cw	5	3
4	14003	6031P	96	45	60 cw	60 cw	5	3
5	14004	3031P	49	34	30 cw	30 cw	5	3
6	14007	3031W	49	34	30 cw	30 cw	5	3
7	14008	4031W	107	38	40 cw	40 cw	5	3
8	14009	6031W	96	45	60 cw	60 cw	5	3
9	14010	4032W	107	38	40 cw	40 cw	5	3

Example 10

[0278] From the following table, one can depict that wonder fabric manufactured using findings of invention exhibits a very good dimensional stability. It is interesting to note that fabric is stabilized using fiber rearrangement in the yarns of textile substrate followed by further higher level of entanglement among fibers in these yarns. The traditional process of crimp interchange and rearrangement in thread

density for fabric stabilization is not used here in this invention. Cross-linking fibers also entangle with fibers from yarns of textile substrate and there by help stabilize the structure of wonder fabric. The level of entanglement is controlled to a level there by attaining acceptable stiffness and feel of wonder fabric so manufactured.

[0279] Dimensional Stability Test

[0280] Test Method used: AATCC 135-2003

[0281] Test Conducted by: WIL, Anjar

TABLE 4

Test Results:											
Sr.	ITS	Fabric				Wft		Residual Shrinkage % Warp 5 wash		Residual Shrinkage % Weft 5 wash	
No.	ID	ID	EPI	PPI	WpCt	Ct		WIL - Anjar	Protocol	WIL - Anjar	Protocol
1.	14009	6031W	96	45	60 cw	60 Cw	3	3		0.5	3
2.	14010	4032W	107	38	40 cw	40 Cw	2.5	3		1	3
3.	Grey	6030W	102	50	60 cw	60 cw	-10			5.6	
4.	Grey	4030W	110	40	40 cw	40 cw	-9			4.5	

Example 11

[0282] Following table shows that different textile substrates along with cotton pseudo yarns with 25 to 40 g/m² are manufactured using findings of invention result in to DP rating of at least 2.5 which is well above protocol requirement for sheeting fabric.

[0283] Amount of entanglements between cross-linking fibers and yarns of textile substrate and the orientation of the same depict this wrinkle behavior.

[0284] Durable Press Rating

[0285] Test Method used: AATCC124-2001

[0286] Test Conducted by: ITS

TABLE 5

Test Results:									
Sr.	Fabric				Wrp	Weft	DP Rating 5 Wash		
No.	ID	EPI	PPI	Ct	Ct	ITS	Protocol		
1	13999	4031D	107	38	40 cw	40 cw	3	2.2	
2	14000	6031D	96	45	60 cw	60 cw	2.75	2.2	
3	14001	4031P	107	38	40 cw	40 cw	3.25	2.2	
4	14003	6031P	96	45	60 cw	60 cw	3.25	2.2	
5	14004	3031P	49	34	30 cw	30 cw	3	2.2	
6	14007	3031W	49	34	30 cw	30 cw	2.5	2.2	
7	14008	4031W	107	38	40 cw	40 cw	3	2.2	
8	14009	6031W	96	45	60 cw	60 cw	3	2.2	
9	14010	4032W	107	38	40 cw	40 cw	2.75	2.2	

Example 12

[0287] Depending upon amount of entanglement between pseudo yarns and yarns from substrate, level of entanglement among fibers in the yarns of textile substrate, orientation and amount of entanglement between cross-linking fibers and yarns from textile substrate depict the resistance for seam slippage.

[0288] Following table shows that different textile substrates with cotton fiber web when subjected to the process as depicted by this invention result in to high resistance to seam slippage.

[0289] It is important to remember the fact that textile substrate in it's original form is with very open construction and also is unstable. In this form, textile substrate is not at all suitable for applications in home and apparel textile.

[0290] Seam Slippage

[0291] Test Method used: ASTM D 434 1995; ASTM D 5034 FIXED SEAM OPENING

[0292] Test Conducted by: ITS

TABLE 6

Test Results:										
SEAM SLIPPAGE										
Sr. No.	Fabric ID	EPI	PPI	Wrp Ct	Weft Ct	WARP WIL-Anjar	Warp Protocol	WEFT WIL-Anjar	Weft Protocol	
1	13999	4031D	107	38	40 cw	40 cw	16	15.00	39.00	15.00
2	14000	6031D	96	45	60 cw	60 cw	16	15.00	39.00	15.00
3	14001	4031P	107	38	40 cw	40 cw	22	15.00	43.00	15.00
4	14003	6031P	96	45	60 cw	60 cw	23	15.00	42.00	15.00
5	14004	3031P	49	34	30 cw	30 cw	32	15.00	39.00	15.00
6	14007	3031W	49	34	30 cw	30 cw	26	15.00	44	15.00
7	14008	4031W	107	38	40 cw	40 cw	21	15.00	34.0	15.00
8	14009	6031W	96	45	60 cw	60 cw	20	15.00	35.0	15.00
9	14010	4032W	107	38	40 cw	40 cw	25	15.00	44.0	15.00

Example 13

[0293] The following table shows that wonder fabric comprising of different textile substrates with open and unstable construction along with cotton fiber web with more fibers oriented in warp way direction when treated through the process depicted by invention results in to acceptable tensile strength in both warp and weft direction.

[0294] Since more fibers are oriented in warp way direction result in to higher tensile strength in that direction.

[0295] Tensile Testing Test

[0296] Test Method: ASTM D 5034

[0297] Test Conducted by: ITS

TABLE 7

Test Results:										
Tensile Testing Test										
Sr. No.	Fabric ID	EPI	PPI	Wrp Ct	Weft Ct	Warp Force in Lbs		Weft Force In lbs		
						ITS	Protocol	ITS	Protocol	
1.	14007	3031W	49	34	30 cw	30 cw	79.2	30	31.89	30
2.	14008	4031W	107	38	40 cw	40 cw	71.3	30	34.92	30
3.	14009	6031W	96	45	60 cw	60 cw	63.5	30	35.65	30
4.	14010	4032W	107	38	40 cw	40 cw	113.8	30	32.08	30

Example 14

[0298] Following table shows that wonder fabric so manufactured delivers required tear strength.

[0299] Tear Strength Test

[0300] Test Method: ASTM D 1424-2007A (Elmendorf Tester)

[0301] Test Conducted by: ITS

TABLE 8

Test Results:										
Sr. No.	Fabric ID	EPI	PPI	Wrp Ct	Weft Ct	Warp ITS	Protocol	Weft ITS	Protocol	
1.	14007	3031W	49	34	30 cw	30 cw	3.9	1.5	1.6	1.5
2.	14008	4031W	107	38	40 cw	40 cw	2.7	1.5	1.8	1.5
3.	14009	6031W	96	45	60 cw	60 cw	2.6	1.5	1.9	1.5
4.	14010	4032W	107	38	40 cw	40 cw	3.8	1.5	1.5	1.5

Example 15: Quality Testing of Washability

[0302] Test Method: AATCC-135

[0303] A fabric sample produced with a pre-treated textile substrate (OK Sample) and without a pre-treated textile substrate (NOT OK Sample) underwent various quality testing, including washability. After 3 washes as performed per guidelines of AATCC-135 with a machine wash at 105° F., normal cycle followed by tumble dry at medium mode of both the OK sample and the NOT OK sample resulted in a dimensional change percentage of 6% in the warp direction and 6.4% in the weft direction of the NOT OK sample compared to the OK sample which had a dimensional change percentage of 3.8% in the warp direction and 2% in the weft direction. High residual shrinkage found in the NOT OK sample compared to that of the OK sample was concluded to be due to the absence of the two jet heads used in the pre-treatment of the textile substrate.

[0304] The unwashed and washed fabric pictures in FIG. 19 show the wrinkling behaviors between the two fabrics. As can be easily seen, the NOT OK sample has more wrinkles for both the Before Wash (B) and After Wash (D) samples as compared to that of the OK sample, where Before Wash (A) and (After Wash (C) samples have fewer visually noticeable wrinkles.

Example 16: Quality Testing of Pilling

[0305] Test Method: ASTM D 4970

[0306] Pilling, which is caused by a fiber migration from the fabric surface as the fabric rubs against itself or another fabric or even the skin, was also tested on the final samples (i.e., OK Sample and NOT OK Sample). The severity of a pilling problem is related to fabric construction and/or fiber type. For closed weave fabrics with high bonded fibers, pilling will be less. Weaves with loose bonded fibers have fewer binding points, so pilling will be greater.

[0307] Each of the OK Sample and NOT OK Sample were tested at 100 cycles. A pilling grade 4 means superior (i.e., less pilling) and 1 means worst (i.e., more pilling and fuzziness). Though a pilling numerical grade difference of 0.5 may be thought to be insignificant to laypeople, comparatively high pilling formation indicates that a fabric is inferior which is clearly visible after washing the sample.

[0308] On a Pilling Grade scale of 1 (worst) to 4 (superior), the Pilling Grade of the NOT OK Sample was 2 (i.e., deteriorated as compared to before washing. After washing, the binding of fibers started to loosen further). While, the Pilling Grade of the OK Sample was 3.5 (i.e., no deterioration of the fabric structure and fiber bonding). From FIG. 20, it is clear that the NOT OK Sample (B) has several pills compared to that of the OK sample (A).

[0309] Samples that were not manufactured as claimed easily delaminated. The comparative study disclosed in the Examples demonstrated that the NOT OK Sample was found to easily delaminate as shown by the separation of the layers in the bottom right corner of the NOT OK Sample of FIG. 21(A). Whereas, the OK Sample had the appearance of a single fabric with sharp edges that did not delaminate as shown in FIG. 21(B). The NOT OK Sample is more wrinkled and thus easier to delaminate, while the appearance of the OK Sample is satisfactory and without any delamination issue.

[0310] As is understood by those in the textile art, increasing jet stream pressure increases the entanglements thereby resulting in stronger materials. The multipurpose fabric was produced using a variety of water jet streams with several high pressure jet streams. FIG. 22 shows a NOT OK Sample both (A) Before Wash and (B) After Wash, which was produced using a modified method with an increase in jet stream water pressures. They were greater than the corresponding jet streams of an OK Sample manufacturing method by about 5 pressure bars for at least 3 jet heads, i.e., for example, J.H.-3.1, J.H.-3.2, and J.H.-4.1. However, even with the increased water pressures that were applied to both the final product comprising a textile substrate (without pre-treatment) and the web of fibers, the NOT OK Sample still resulted in an inferior final fabric as shown in the Before Wash (FIG. 22A) and After Wash (FIG. 22B) compared with the OK Sample Before Wash (FIG. 19A) and After Wash (FIG. 19C).

[0311] The foregoing descriptions of the invention are intended to be illustrative and not limiting. Those skilled in the art will appreciate that the invention can be practiced with various combinations of the functionalities and capabilities described above, and can include fewer or additional components than described above. Certain additional aspects and features of the invention are further set forth below, and can be obtained using the functionalities and components described in more detail above, as will be appreciated by those skilled in the art after being taught by the present disclosure.

[0312] Although the present invention has been described with reference to specific exemplary embodiments, one of ordinary skill in the art would know that various modifications and changes may be made to these embodiments without departing from the broader spirit and scope of the

invention. Accordingly, the specification and drawings are illustrative, rather than restrictive. All patents, patent applications and publications cited herein are fully incorporated by reference in their entirety.

What is claimed is:

- 1) A multipurpose fabric comprising:
 - a pre-entangled web of fibers and a pre-treated textile substrate comprising fibers,
 - wherein the web of fibers are entangled among themselves in gaps of a pre-treated textile substrate, wherein the pre-treated textile substrate is a result of hydroentangling a textile substrate under conditions of at least two jet streams, wherein at least one jet stream strikes the textile substrate at a high pressure ranging from at or about 100 bar-at or about 400 bar to form a pre-treated textile substrate;
 - wherein said web of fibers entangled in gaps of the pre-treated textile substrate are entangled with the pre-treated textile substrate fibers;
 - wherein the remaining web of fibers, which do not become part of the entanglements in gaps of the pre-treated textile substrate, are entangled with pre-treated textile substrate fibers; wherein entanglements occur on at least one side of the pre-treated textile substrate.
2. The multipurpose fabric of claim 1, wherein the at least two jet streams comprises at least one straight jet head and at least one angled jet head, wherein said angled jet head is at or about 10 degrees-at or about 25 degrees.
3. The multipurpose fabric according to claim 1, wherein the textile substrate is a woven textile substrate.
4. The multipurpose fabric according to claim 1, wherein the textile substrate is a knitted textile substrate.
5. The multipurpose fabric according to claim 1, wherein the textile substrate is made of fibers selected from the group consisting of natural fibers, manmade fibers, and blends of natural and manmade fibers.
6. The multipurpose fabric according to claim 1, wherein the web fibers entangled among themselves in gaps of the pre-treated textile substrate are made of fibers selected from the group consisting of natural fibers, manmade fibers, and blends of natural and manmade fibers.
7. The multipurpose fabric according to claim 1, wherein the textile substrate is constructed with yarn counts in the range of at or about Ne 1 up to at or about Ne 160, wherein the yarns are selected from the group consisting of single yarns and plied yarns.
8. The multipurpose fabric according to claim 1, wherein the textile substrate is constructed with 30 threads/inch up to 300 threads/inch in warp way direction and 12 threads/inch up to 500 threads/inch in weft-way direction, having a weight of 45 g/m² to 1,200 g/m², wherein the weave is selected from the group consisting of a plain weave, a twill weave, a satin weave, and a combination weave.
9. The multipurpose fabric according to claim 1, wherein the textile substrate has a weight of 60 g/m² to 400 g/m² with knitted structure selected from the group consisting of a warp knitted structure and a weft knitted structure.
10. The multipurpose fabric according to claim 1, wherein the fabric has a tensile strength minimum of about 65 pounds (warp) and about 31 pounds (weft).
11. The multipurpose fabric according to claim 1, wherein the fabric has a residual shrinkage after 5 washes of about 3% (warp) and about 0.5% (weft).

12. The multipurpose fabric according to claim 1, wherein the fabric has a minimum seam slippage of about 16 (warp) and about 35 (weft).

13. An assembly for manufacturing the multipurpose fabric of claim 1 comprising:

- an opening line for opening and cleaning fibers;
 - a carding machine for carding said fibers to prepare a pre-entangled fiber web;
 - a fabric unwinding, expanding and tensioning device;
 - a fabric combing device including at least one perforated drum having at least one jet stream to prepare a pre-treated textile substrate, wherein the pre-treated textile substrate is a result of hydroentangling a textile substrate under conditions of at least two jet streams, wherein at least one jet stream strikes the textile substrate at a high pressure ranging from about 100 bar-about 400 bar to form a pre-treated textile substrate;
 - a hydro-lamination unit including at least one perforated drum including at least one jet stream for subjecting said pre-entangled fiber web layered on said pre-treated textile substrate to at least one high pressure jet stream ranging from about 100 bar-about 400 bar to form a multipurpose fabric.
14. The assembly of claim 13, further comprising:
- a dewatering device for dewatering of said multipurpose fabric;
 - a dryer for drying of wet fabric;
 - a winder for winding of dried fabric;
 - a mercerizer for mercerization, swelling and preparing the fabric for a textile dyeing and finishing process;
 - an open width continuous bleaching/dyeing range for dyeing of fabric;
 - a padder including a curing device for padding of chemical agents and fixation;
 - a machine of a soft flow machine or jet dyeing machine for pretreatment and dyeing of the fabric;
 - a machine of an open width machine or a soft flow machine for top finishing of the fabric;
 - a machine of an emerging machine or a raising machine for mechanical surface finishing of fabric;
 - a sanforisation machine for dimensional stabilization of fabric;
 - a machine of a knife coater, a padder, a kiss roll arrangement, or a zimmer machine;
 - a curing device for coating of fabric on at least one side with chemicals of thermoplastic polyolephenes, thermoplastic polyurethane, or polyurethane/aluminum; and
 - a lamination device for lamination of fabric on at least one side with a membrane made from polyurethane, thermoplastic polyurethane, thermoplastic polyolephene, a flame retardant material, or a cross linker.
15. A process for manufacturing a multipurpose fabric of claim 1, comprising:
- pre-entangling a web of fibers to increase strength in the web;
 - supporting the pre-entangled web of fibers on at least one side of a pre-treated textile substrate, wherein the pre-treated textile substrate is a result of hydroentangling a textile substrate under conditions of at least two jet streams, wherein at least one jet stream strikes the

textile substrate at a high pressure ranging from about 100 bar-about 400 bar to form a pre-treated textile substrate;

subjecting the web of fibers to at least one oscillating jet stream and at least one angled jet resulting in web disintegration and slipping away of fibers;

rolling the slipped fibers in gaps of the pre-treated textile substrate, wherein the fibers are guided by the textile substrate.

16. The process according to claim **15**, wherein pre-entangling a web of fibers comprises:

opening and cleaning fibers in a fiber opening machine; and

carding the fibers in a carding machine to prepare a web of fibers;

wherein pre-treating the textile substrate comprises:

opening up the textile substrate in an expander roll;

tensioning the textile substrate through a fabric tensioner;

subjecting the textile substrate to at least two water jets, wherein at least one water jet comprises a high pressure jet stream ranging from about 100 bar-about 400 bar, and at least one water jet strikes the textile substrate at an angle, thereby forming a pre-treated textile substrate;

and said process further comprising:

layering the pre-treated textile substrate with the pre-entangled web of fibers entangled among themselves in gaps of the pre-treated textile substrate;

subjecting the pre-treated textile substrate and the web fibers entangled among themselves in gaps of the

pre-treated textile substrate to hydro-lamination with a at least one stationary water jet or at least one oscillating water jet, wherein the water jet is directed at the pre-treated textile substrate in a direction of a straight strike, an angled strike, or a combination of a straight and angled strike, and at least one water stream is of high pressure ranging from about 100 bar-about 400 bar, thereby forming a multipurpose fabric.

17. The process according to claim **16**, further comprising:

dewatering the multipurpose fabric by passing through a dewatering device;

drying the dewatered multipurpose fabric by passing through a dryer;

winding the multipurpose fabric on to bobbins on a winder;

chemically pre-treating the multipurpose fabric with a process of dyeing, printing, top finishing, or a combination thereof; and

treating the multipurpose fabric with a process of coating or laminating, such that the multipurpose fabric has a smooth surface.

18. The process according to claim **16**, wherein the at least one water jet strikes at an angle ranging from at or about 10 degrees-at or about 25 degrees.

19. The process according to claim **17**, wherein the drying is performed at a temperature such that the dried multipurpose fabric has a residual moisture content equal to a natural moisture content of the fibers.

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