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(54) METHOD OF MANUFACTURING INDUSTRIAL TEXTILES BY MINIMIZING WARP CHANGES AND FABRICS MADE ACCORDING TO THE METHOD

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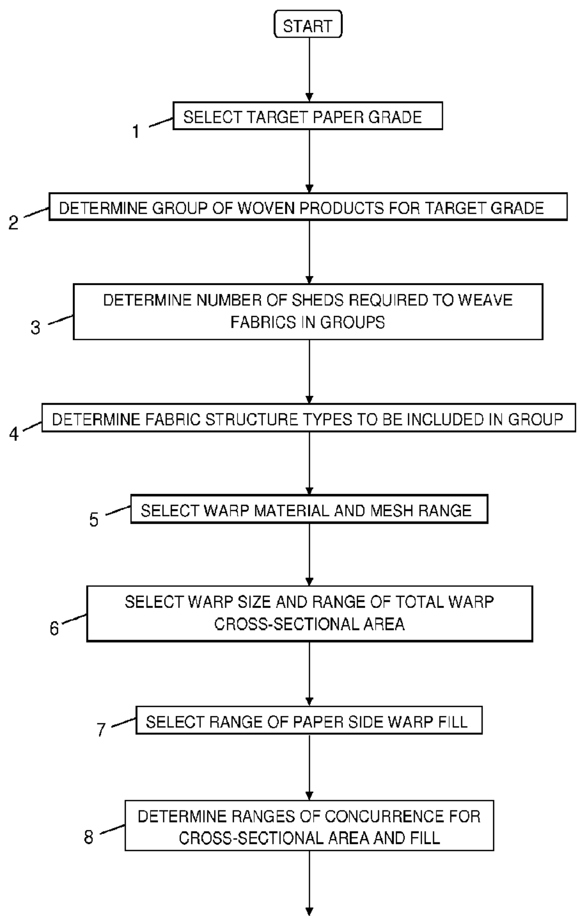
(57) **ABSTRACT**

A method of weaving industrial textiles to a single warp platform, and textiles made thereby. The method comprises identifying optimal fabric characteristics for selected uses to determine groups of suitable fabrics; selecting a first group, identifying fabric properties for optimal characteristics, and identifying optimal properties for warp yarns to be used for all fabrics in the group; selecting a structure type and weave design for each fabric of the group; providing a loom with selected shedding options and installing warp yarns having the identified optimal properties. Thereafter, each fabric in the group can be woven without changing the warp yarns, simply by identifying properties for weft yarns to correspond with the weave design of the respective fabric, setting the loom accordingly and weaving the fabrics as required, adjusting only the weft parameters between successive fabrics, resulting in increased efficiency of manufacturing and avoiding time consuming warp changes between fabrics.



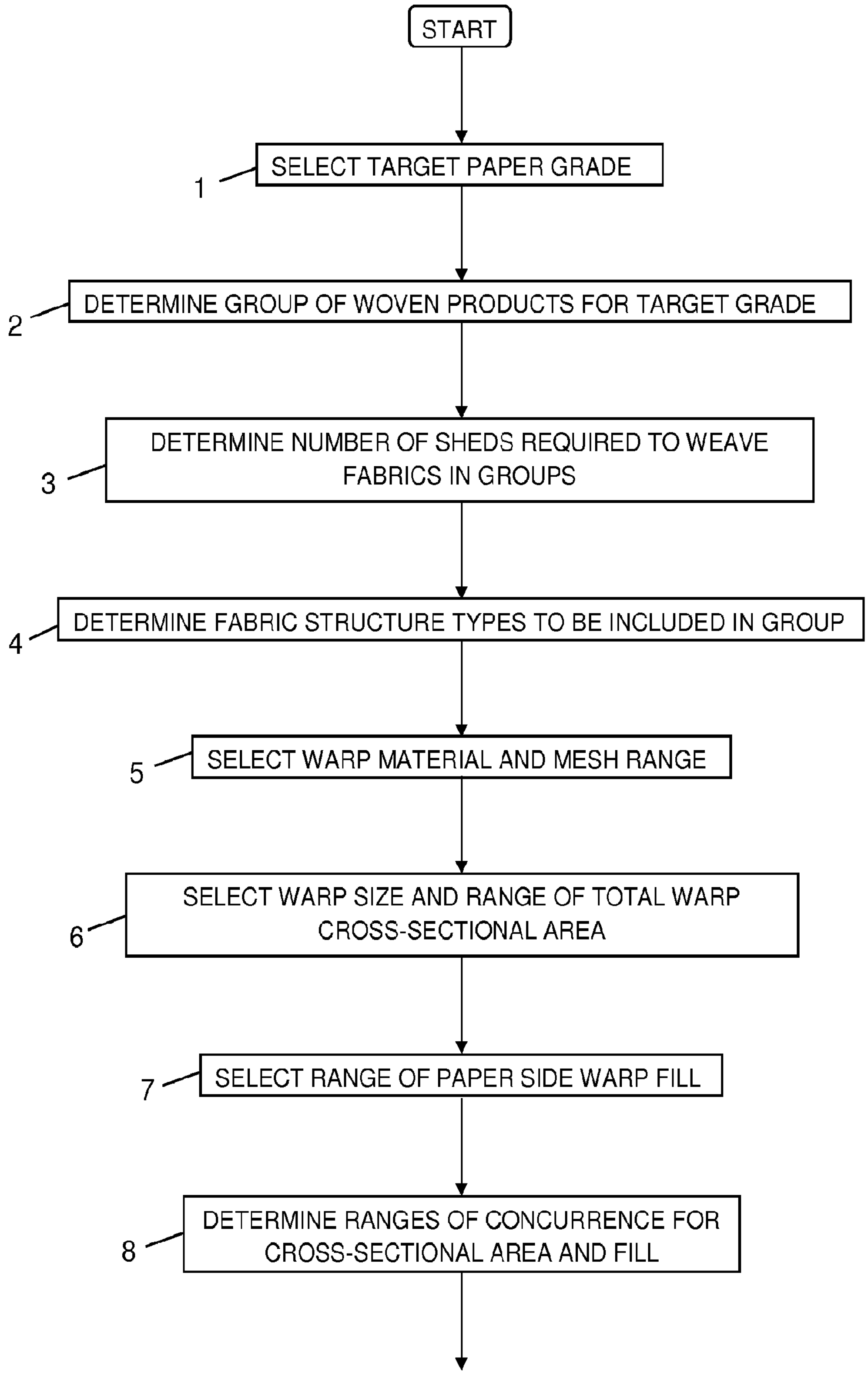

START
SELECT TARGET PAPER GRADE
1
DETERMINE GROUP OF WOVEN PRODUCTS FOR TARGET GRADE
2
DETERMINE NUMBER OF SHEDS REQUIRED TO WEAVE FABRICS IN GROUPS
3
DETERMINE FABRIC STRUCTURE TYPES TO BE INCLUDED IN GROUP
4
SELECT WARP MATERIAL AND MESH RANGE
5
SELECT WARP SIZE AND RANGE OF TOTAL WARP CROSS-SECTIONAL AREA
6
SELECT RANGE OF PAPER SIDE WARP FILL
7
DETERMINE RANGES OF CONCURRENCE FOR CROSS-SECTIONAL AREA AND FILL
8

FIGURE 1A

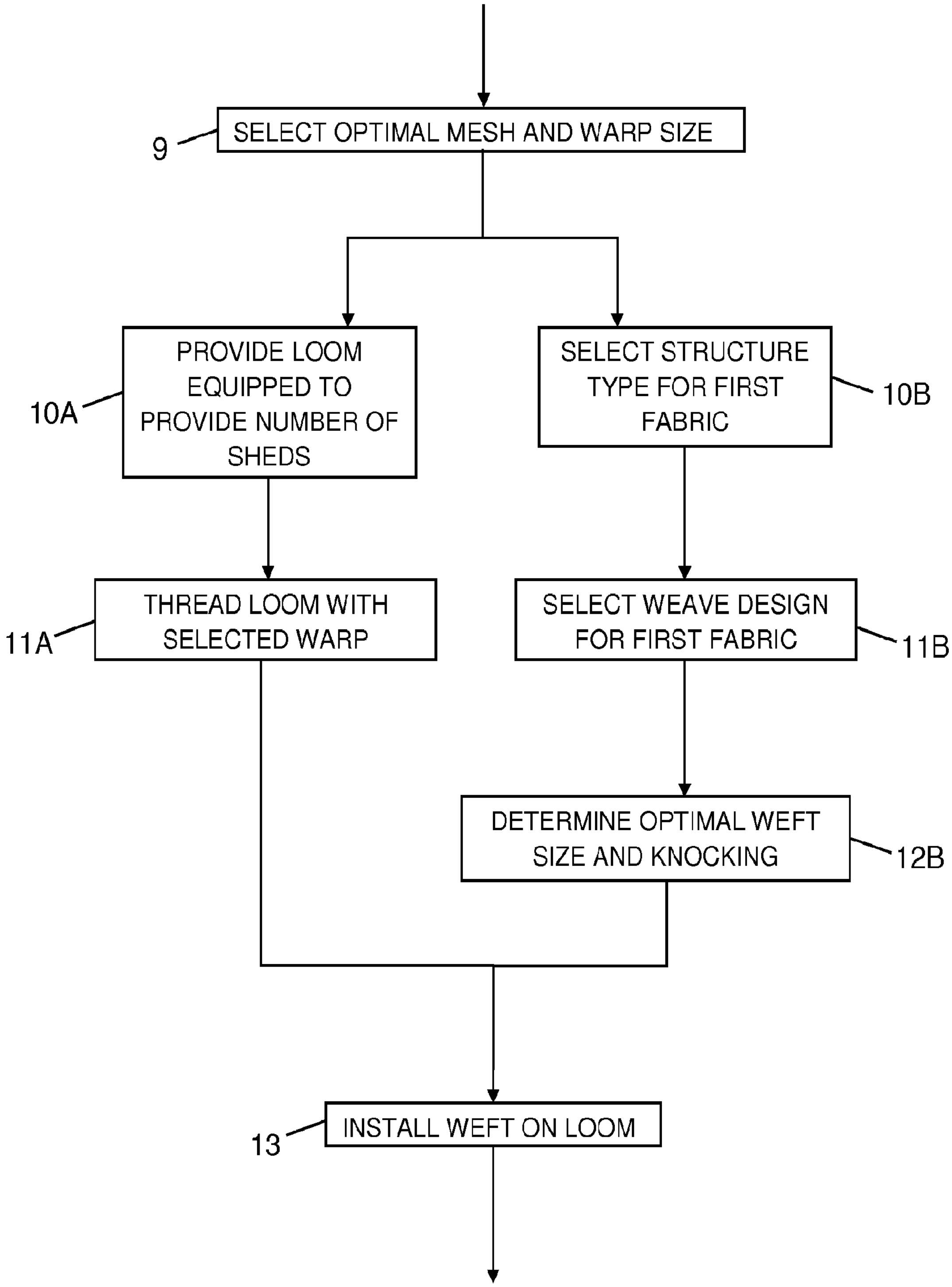

SELECT OPTIMAL MESH AND WARP SIZE
9
PROVIDE LOOM EQUIPPED TO PROVIDE NUMBER OF SHEDS
10A
SELECT STRUCTURE TYPE FOR FIRST FABRIC
10B
THREAD LOOM WITH SELECTED WARP
11A
SELECT WEAVE DESIGN FOR FIRST FABRIC
11B
DETERMINE OPTIMAL WEFT SIZE AND KNOCKING
12B
INSTALL WEFT ON LOOM
13

FIGURE 1B

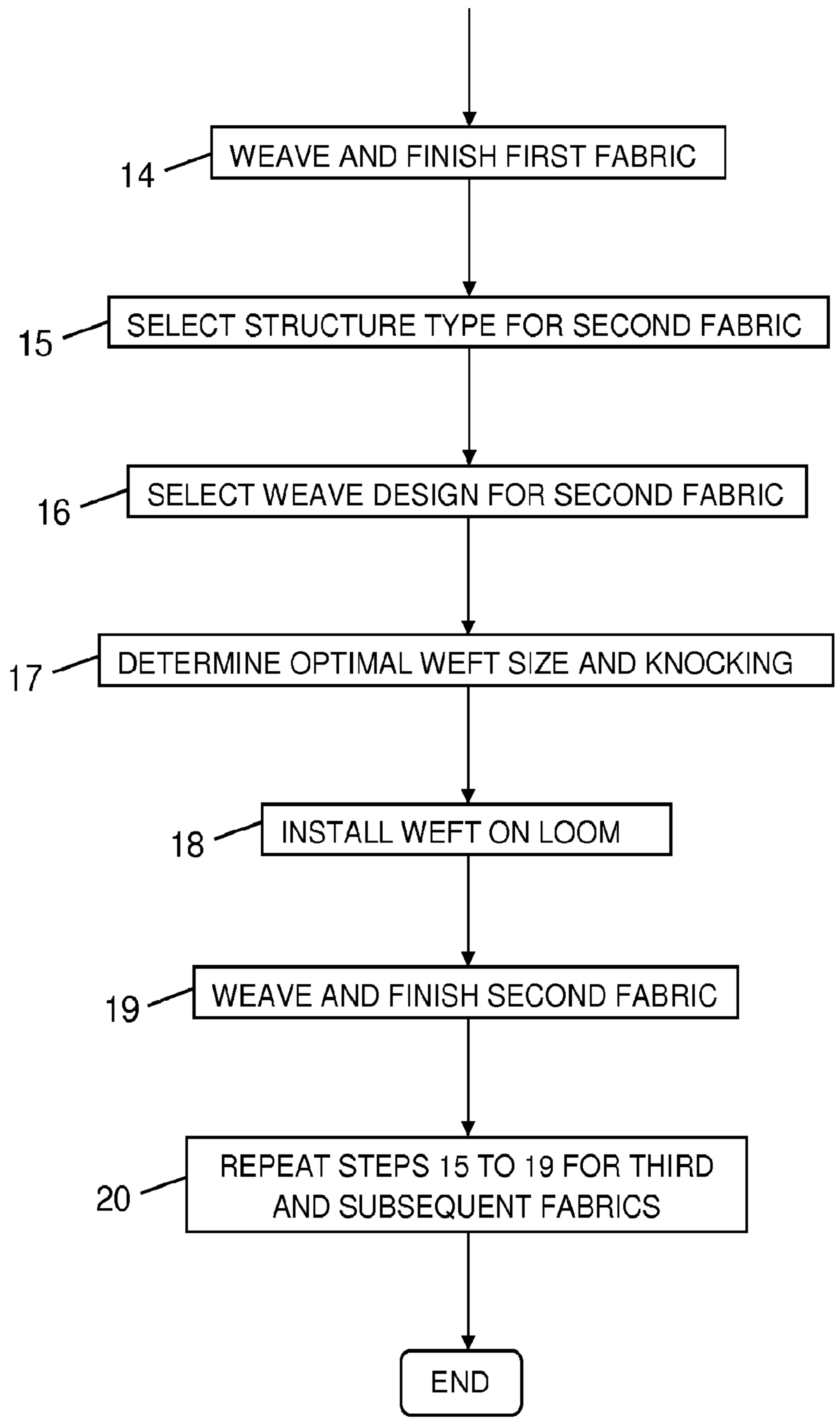

WEAVE AND FINISH FIRST FABRIC
14
SELECT STRUCTURE TYPE FOR SECOND FABRIC
15
SELECT WEAVE DESIGN FOR SECOND FABRIC
16
DETERMINE OPTIMAL WEFT SIZE AND KNOCKING
17
INSTALL WEFT ON LOOM
18
WEAVE AND FINISH SECOND FABRIC
19
REPEAT STEPS 15 TO 19 FOR THIRD AND SUBSEQUENT FABRICS
20
END

FIGURE 1C

METHOD OF MANUFACTURING INDUSTRIAL TEXTILES BY MINIMIZING WARP CHANGES AND FABRICS MADE ACCORDING TO THE METHOD

FIELD OF THE INVENTION

[0001] This invention relates to the manufacture of industrial textiles, and in particular to a method of operating looms in such manufacture and to fabrics produced according to the method. More particularly, the invention relates to a method of improved manufacturing of such textiles by reducing the number of different meshes (number of warp yarns per unit width of fabric across the loom, e.g. yarns/in. or yarns/cm) and warp yarn sizes required, and thus the number of warp yarn changes required for such looms to produce in sequence a number of different fabrics each having similar properties to those of fabrics previously woven at differing meshes and using differing warp yarn sizes, so as to thereby minimize the idle time, or down time, of looms.

BACKGROUND OF THE INVENTION

[0002] Industrial fabrics such as are used in papermaking, filtration and like applications are generally woven structures made using very wide industrial looms which can be 30 ft. (10 m) in width or wider. Certain of these fabrics, particularly those used in papermaking to initially form and drain the sheet (referred to as forming fabrics), are frequently woven at very high mesh counts, meaning that the number of warp yarns per unit of fabric width is relatively high in comparison to other papermaking fabrics, and can be in the range of up to 200 yarns per inch (78.7 yarns/cm) or more. These yarns can be very small in size, with diameters ranging from as low as about 0.08 mm or less up to about 0.30 mm or more; other fabrics, such as those used in the press or dryer sections of papermaking machines, or in similar industrial filtration applications, may have warp yarn sizes in the range from about 0.3 mm up to about 0.7 mm or higher. These larger yarns are frequently woven to provide a mesh of from 20 yarns/inch (7.87 yarns/cm) up to about 70 yarns/inch (27.6 yarns/cm). Selection of appropriate weave designs for these industrial fabrics, and selection of warp and weft yarn diameters and cross-sectional shapes for use in these industrial fabrics is generally based on the type of product to be made, the environment in which the fabric is to be used, and characteristics of the machine for which the fabric is intended.

[0003] The features of the present invention are particularly applicable to papermakers fabrics, and most particularly to papermakers forming fabrics, but are also applicable to many other types of industrial fabrics used for various filtration purposes. In the following discussion, references to papermakers fabrics, or to papermakers forming fabrics, can generally be understood as including such other types of industrial filtration fabrics.

[0004] Industrial fabrics such as papermakers forming fabrics are currently woven to provide one of the following well-known textile structures:

[0005] a. Single layer fabrics, woven using one warp yarn system and one weft yarn system;

[0006] b. Semi duplex fabrics, woven with one warp yarn system and two layers of weft yarns, which yarns are not stacked directly over each other;

[0007] c. Double layer fabrics, woven with one warp yarn system and two layers of weft yarns which are arranged so that each weft yarn in the top surface is vertically stacked so as to be directly above a corresponding weft yarn in the lower surface;

[0008] d. Extra support double layer fabrics, similar to double layer fabrics but with additional weft yarns woven into the top surface;

[0009] e. Triple weft fabrics, woven using one warp yarn system and three weft yarn systems arranged so that the weft yarns are vertically stacked over each other;

[0010] f. Standard triple layer fabrics, woven using two warp yarn systems and two weft yarn systems to provide two independent fabric structures which are frequently tied together during weaving by means of an additional weft yarn system;

[0011] g. Triple layer sheet support binder (SSB) fabrics, woven using two systems of warps and two systems of weft yarns; a selected number of the weft are woven into the fabric as exchanging, interchanging yarn pairs so that as one yarn of the pair is being woven into e.g. the top surface the other is woven into the bottom;

[0012] h. Triple layer “warp tie” fabrics, woven using two weft (CD) yarn systems and two warp (MD) yarn systems; at least a portion of the warp yarns are woven as interchanging pairs so that as one yarn of the pair is being woven into e.g. the top surface the other is woven into the bottom; in certain designs, some of the warp yarns of each of the two systems will be interwoven exclusively with weft yarns of one of the top or bottom systems of weft yarns;

[0013] i. Triple layer warp integrated sheet support binders (WISS), woven using two weft (CD) yarn systems and two warp (MD) yarn systems in which all (100%) of the warp yarns are woven as interchanging pairs so that as one yarn of the pair is being woven into e.g. the top surface the other is woven into the bottom.

[0014] Papermakers forming fabrics are currently manufactured using carefully selected yarn sizes and materials which, when woven to provide one of the above textile structures, with a chosen mesh and knock (number of weft yarns per unit length of fabric, e.g. yarns/in. or yarns/cm), are intended to best suit the grade or type of product that is to be manufactured on a specific papermaking machine having unique performance characteristics. Each papermaking machine and each type of stock (that is, the highly aqueous mixture of water, papermaking fibers and chemicals) have, in combination, a unique set of operating parameters which the papermaking fabric manufacturer will strive to accommodate so as to optimize the quality of the paper product to be made. In addition, the fabric itself must be extremely rugged and provide a stable structure which will withstand, without distorting or catastrophically failing, the speeds and environmental conditions in which it is expected to operate.

[0015] The fabric surface upon which the papermaking fibers are deposited, referred to as the paper side or PS, must be constructed so as to uniformly support the fibers and form the sheet, while providing adequate drainage of fluid from the papermaking stock deposited thereon. The opposite fabric surface, referred to as the machine side or MS, must be rugged and dimensionally stable so as to provide a secure and robust base below the fine papermaking surface. While in operation, the fabric will be running in an endless loop through the papermaking machine at speeds as high as 1,500 m/min or more and will be in moving contact with various stationary dewatering devices (such as blades, foils and suction box covers) in the machine.

[0016] Given these differing requirements, either for the two surfaces of a single layer fabric or the different layers of other fabric types, the fabric manufacturer must strike a balance between the papermaking properties (e.g.: fiber support and drainage capabilities of the PS layer), and the mechanical properties of the fabric (e.g.: elastic modulus, shear stability, caliper and seam strength) while providing a textile product which is suitable for the manufacture of a particular grade of paper on the machine for which it is intended. In the past, this was frequently done by changing one or more of the fabric mesh, knock, yarn size and structure.

[0017] Woven industrial textiles are typically manufactured from polymeric monofilament or multifilament yarns as each of the warp and weft materials. During weaving, the warp is paid off from a yarn supply at the back of the loom (from what is referred to as a back beam), passed through reed openings mounted in the loom heddles, and then around a take-up roll at the front of the loom. As the heddles are moved up and down, the individual warp yarns are thus moved to create so-called shed openings. The weft yarns are shot, or carried, across the shed openings from one side of the fabric to the other by means of a shuttle, rapier or similar mechanism, depending on the loom type. These weft yarns are paid off from a storage canister or bobbin located at each side of the fabric. The weave pattern of the fabric is created by controlling the movement of the heddles and thus the individual warp yarns so that selected ones are positioned either above or below a specific weft yarn, thereby creating interlacing locations across the width of the fabric.

[0018] Changes to the weft yarn size and knocking are easily made by canister changes and frequently such changes are an integral part of the fabric manufacturing process. However, warp yarn changes are much more difficult and time consuming to make, particularly on wide industrial looms such as those used for the manufacture of papermaking fabrics, as they require changing one or both of the back beam and the heddles, and re-threading of each of the thousands of individual warp yarns through both the heddles and reeds.

[0019] Industrial fabric manufacturers typically wind thousands of feet or meters of warp yarn onto large individual spools (referred to as "cans") which are about 3 ft (1 m) in diameter and range from about 4 to 12 inches (10 cm to 30.5 cm) in width. These cans are usually made of steel or a similar rugged material and, when full of yarn (which has been carefully wound onto the can at predetermined tension) they are then mounted in succession along the back beam of the loom to provide the supply of warp material for the fabrics that are to be woven. For example, a 10 m wide loom equipped with 4 inch (10.2 cm) wide cans might have more than 100 of such cans mounted in succession along its back beam. If the loom is a double beam loom, meaning it is equipped with two such back beams, then the number of cans would be double that of a single beam loom, or 200 such cans or more.

[0020] Warp changes on a loom, other than for replenishment, are typically made to accommodate fabrics having either different textile structures or meshes, or both, than those made previously on the same loom. The warp change will usually be made to allow the manufacturer to weave other fabrics having differing mechanical properties and constructions from those previously produced. For example, a warp change would be made to allow the production of a fabric with a different mesh, or larger or smaller warp yarn sizes than previously used, or yarns having a different cross-sectional shape, or made from a different material, than was previously made on the same loom. Alternatively, a warp change will be made when the manufacturer wishes to weave a different textile structure on the same loom previously used to weave another structure (e.g. a triple layer fabric where previously a semi-duplex fabric was woven). Such changes are usually made to produce a fabric which is optimized for its intended end use, whether for papermaking properties or mechanical properties. Because of the difficulties associated with changing the warp material or the fabric mesh, fabric manufacturers will frequently devote one or more looms to a particular warp size and fabric type or structure, and will then carefully schedule fabric production so that the same loom is devoted to making as many of that style using that same warp as are required before a further and very time consuming warp change is necessary.

[0021] A simple warp change (that is, a material replenishment that does not require a mesh change) is effected as follows when there is no fabric structure change. The original warp yarns are cut before (i.e. on the can side of) the heddles so as to leave trailing ends, and the cans containing the old warp material are removed from the back beam; cans containing the new warp material are then mounted onto a new or the existing back beam at the back of the loom. The old beam or cans are removed from the loom and the new beam or cans are then suitably positioned. The trailing ends of the existing warp yarns are then joined onto those from the new beam and the loom is advanced (i.e. the take-up roll is advanced so that the existing warp is wound onto it) and the yarns from the new beam are passed through the heddles following the previous ones. Weaving can then re-commence once all of the new yarns are in position and placed under suitable tension. This relatively simple change can be executed quickly compared to a complete warp and mesh change.

[0022] However, when the warp change is required due to a fabric mesh change, or warp material change, or the number of sheds required to weave the new fabric is different from that needed to weave the previous fabric, or if the new fabric has a different structure (i.e. single layer, double layer, triple layer, etc.) from that previously woven, then the loom must be completely re-drawn or re-threaded, meaning that the old warp must be removed and the new warp must be individually and manually threaded through the eyelets of each of the heddles. It will be appreciated that when 100 or more warp yarns/inch (39/cm) must be threaded through the heddles of a loom used to produce a 10 m wide fabric, this threading can be a very time consuming process. Other loom components may also need to be changed. Following the warp change, the loom must then be re-set so as to establish appropriate weaving tensions and other parameters, which will allow the manufacturer to produce a fabric according to the required specifications. Depending on the width of the loom and the warp yarn size, this entire process can remove the loom from production for several weeks and require the assistance of numerous skilled employees; while re-threading is occurring, the loom is unable to produce any fabric. It will thus be appreciated that a warp change can be a very expensive and time consuming process.

[0023] The as-woven fabric mesh, warp diameter, material and cross-sectional shape, together with the number of sheds on the loom required to weave the fabric, are collectively referred to as a "warp platform"; a warp platform specifies all of the requirements needed to specifically define the warp of the fabric to be woven.

[0024] Efforts have been made by various loom and textile manufacturers to reduce the time taken for performing the conventional warp changing process, by improving the efficiency of steps within the process. Examples of attempts to address the mechanical aspects of the steps in warp changing include U.S. Pat. No. 6,314,628 to Crook; U.S. Pat. No. 7,178,558 and U.S. Pat. No. 7,318,456 both to Nayfeh et al.; U.S. Pat. No. 5,775,380 to Roelstraete et al.; U.S. Pat. No. 5,394,596 and EP 592807 both to Lindenmuller et al.; and U.S. Pat. No. 4,910,837 to Fujimoto et al.

[0025] However, none of these disclosures address the distinct and fundamental issue of the disadvantages of the frequency at which complete warp changes are required. It would therefore be highly desirable to avoid or significantly reduce the need to make such changes, thereby reducing production costs while increasing efficiency, while continuing to allow for the manufacture of a wide range of industrial textile products, and accommodate a variety of fabric meshes, structures and designs.

[0026] It has now been found that this desired reduction in the frequency of warp changes, in comparison with present practice, can be achieved by establishing a warp platform which is compatible with the parameters for a variety of fabric products, and making adjustments to the parameters for the weft yarns, resulting in the ability to weave a variety of different fabrics in succession, each having properties and designs equivalent to those of selected fabrics of different types, without any need for the warp changes which would previously have been required for weaving those various fabric types in succession.

SUMMARY OF THE INVENTION

[0027] Conventionally, industrial textile manufacturers have diversified the number of warp sizes, meshes, materials and cross-sectional shapes used to make fabrics for their customers in the belief that, in this manner, the fabrics could be optimized for the grade of product to be manufactured and the machine for which the fabric was intended.

[0028] It has now been found that fabric manufacturers have unnecessarily over-diversified their production in the past, and have been producing fabrics within the same design "family" (e.g. double layer, triple layer) which may utilize a warp yarn size difference of as little as 0.02 mm, using differing meshes, for different applications or customers, i.e. two fabrics within the same design would conventionally be manufactured on different looms employing differing meshes and warp yarns whose diameter differed by as little as 0.02 mm so as to meet customer-specific or basis weight requirements. The invention is thus predicated on the understanding that there are more warp sizes in use than are justified by the difference in basis weight and other paper properties between the products being manufactured using the fabrics.

[0029] It has now been found from recent experience and experimentation that it is possible to accommodate almost all papermaking (and similar fabric) requirements by reducing the number of warp meshes, yarn sizes, and cross-sectional shapes (warp platforms) to as few as one, but no more than four types, thus minimizing the number of different warp platforms used to weave the fabrics and thus the number of warp changes required to produce fabrics adequate to meet almost all of those needs.

[0030] Whereas in the past it was necessary to have, for example, as many as ten looms (and warp size and mesh combinations) or more, each devoted to the production of a single product having a specific design and mesh so as to minimize warp changes on the individual looms, it is now possible by means of the present invention to reduce the number of warp changes significantly, generally to no more than four, and possibly as few as one, depending on the papermaking and mechanical requirements of the textile products to be made. This rationalization process is described herein as a "single warp platform" (SWP) approach, meaning that the weaving parameters for all fabrics previously made, and new fabrics compatible therewith, and previously using a variety of warp sizes and meshes, can now be modified so that the warps can be selected from no more than four configurations, and preferably as few as three. Adjustments to fabric properties are then made by selection of any or all of the weft yarn parameters of size, shape, material and density (knocking) prior to and during weaving as well as the subsequent fabric processing parameters, such as heatsetting and tensioning.

[0031] Pursuant to the invention, a single loom can be provided for each of one or more chosen warp platforms, each including yarns having a specified composition, cross-sectional shape and size, threaded to a chosen mesh. Each one can then be used to weave a group of fabrics, the different groups having differing structures, each of which is intended for use in the production of paper products of differing grades or having differing basis weights. In order to do this, one or more of the weft yarn size, cross-sectional shape, polymer composition and knocking is adjusted in the design of the fabric (in comparison to a corresponding substantially equivalent known fabric), or provided in new designs for fabrics in the specific group, so as to provide a textile product with both comparable papermaking properties including drainage area, fiber support, frame length and air permeability, and mechanical properties including elastic modulus, shear stability and stiffness sufficient to accommodate the production of paper products having differing basis weights. The fabrics woven using the warps on that one loom will, of necessity, all have the same mesh in each of the PS and MS layers and will be woven using the same number of sheds in the loom. In the case of a single layer fabric, the set of warp yarns can be divided into two groups, to weave upper and lower fabrics, each of which would have one-half the mesh of the previous single layer fabric. Adjustments to physical properties are then made by changing the weft yarn material and subsequent heatsetting/processing parameters.

[0032] The invention seeks to provide a method for optimizing industrial fabric production, and fabrics produced by the method, comprising reducing or minimizing the number of times the warp yarn material on a loom must be changed, by providing a manufacturing method whereby a number of different textile products, having some equivalent or closely related characteristics, can be made in sequence using the same loom and warp platform, thus minimizing the number of warp changes necessary between production of the different fabrics, in comparison to the present practice. At the same time, the physical characteristics of the fabrics can be selected to closely match the requirements necessary for the end consumer to manufacture a range of cellulosic products whose basis weights range from at least 15 to 80 gsm (grams per square meter) or more.

[0033] The fabrics of the invention comprise groups of at least two industrial fabric structures, each of which is woven using the same warp platform including polymeric warp yarns of the same composition, size, cross-sectional area and shape, and each of which is woven to the same mesh. A group of industrial fabrics produced in accordance with the method of optimizing industrial fabric production can include any two or more of the following textile structures: single layer fabrics, semi duplex fabrics, double layer fabrics, extra support double layer fabrics, triple weft fabrics, standard triple layer fabrics, triple layer sheet support binder (SSB) fabrics, triple layer warp tie fabrics, and triple layer warp integrated sheet support binders (WISS). Each fabric in a group of fabrics of the invention will include warp yarns having the same polymeric composition, cross-sectional shape and area, and number of yarns per unit of CD fabric width as the other fabrics in the group. In textile structures which include in their constructions two layers of warp yarns, in particular double layer fabrics, extra support double layer, standard triple layer, triple layer sheet support binder (SSB), triple layer warp tie fabrics, and triple layer warp integrated sheet support binders (WISS), the warp yarn cross-sectional shape, size, material composition and mesh used in each layer will be substantially the same.

[0034] The invention therefore seeks to provide a method of manufacturing woven fabrics from warp yarns and weft yarns for industrial uses, the method comprising the steps of:
(a) identifying optimal fabric characteristics to correspond with at least one selected industrial use to determine at least one group of fabrics suitable for each selected industrial use;
(b) selecting a set of shedding options for a loom and providing the loom with a shedding arrangement to provide the selected options;
(c) selecting a first group of fabrics and identifying selected fabric properties to produce the optimal fabric characteristics for the first group of fabrics;
(d) identifying optimal properties for warp yarns for the first group of fabrics;
(e) selecting a fabric structure type and a weave design for each fabric of the first group;
(f) installing warp yarns on the loom to correspond with the optimal properties identified in step (d);
(g) selecting a first fabric of the first group, identifying properties for weft yarns to correspond with a first weave design for the first fabric, setting the loom to correspond with the first weave design, and weaving the first fabric according to the first weave design; and
(h) selectively repeating step (g) for selected other ones of the fabrics in the first group.

[0035] Two or more fabrics made according to the manufacturing method herein disclosed will have the same mesh as woven, and will include warp yarns of the same composition, size and warp yarn cross-sectional configuration regardless of the chosen fabric structure. Further, in fabrics having two layers of warp yarns in their structure, the warp yarn size and mesh used in each layer will be substantially the same.

[0036] In such fabrics having two warp layers, when considered in relation to comparable fabrics of the prior art, the PS warp diameter will be larger, while the MS warp diameter will be smaller than was typically used. This usage seems to be counterintuitive to traditional forming fabric design which taught that smaller PS warp yarns were required to provide the necessary PS open area for drainage and fiber support, while relatively larger MS warp yarns were required to provide the necessary elastic modulus to the fabric. While it is still necessary to provide adequate drainage area and elastic modulus in the fabric, it has now been found that it is possible, by judicious and reasoned selection of the warp size used in each of these layers, to employ warp yarns of the same diameter or cross sectional area in both the PS and MS layers, and to adjust other parameters in the weave design to address the problems previously encountered in attempting to use warp yarns of the same size in the two layers. By doing so, the PS warp yarns will be increased in diameter in comparison to previous practice, while the MS warp size will be decreased in size. The relatively larger PS warp will tend to close up the drainage openings in the PS surface, while smaller MS warp will open up the MS fabric structure. It has now been found that doing so does not appreciably affect drainage of fluid through the fabric, as the upsizing of the PS warp is balanced or offset by the downsizing of the MS warp. Further, while making the PS and MS warp the same size, it has been found that by appropriate selection of that size in relation to various other properties, elastic modulus of the fabric can be either maintained or only slightly diminished.

[0037] In the method of the invention, preferably the identifying optimal properties in step (d) comprises the steps of

[0038] (d.1) identifying optimal warp yarn sizes for the intended end use;

[0039] (d.2) determining fabric mesh;

[0040] (d.3) determining cross-sectional shape and size of the warp yarns;

[0041] (d.4) determining total warp cross sectional area per unit width of the fabrics; and

[0042] (d.5) determining paper side warp fill.

[0043] Preferably, identifying the properties for weft yarns in step (g) comprises determining weft yarn size and knocking measured as number of weft yarns per unit length of the fabric.

[0044] Preferably, step (b) comprises providing a loom equipped with a number of back beams selected from one, two and three; and generally the loom will be equipped with two back beams.

[0045] Preferably, the warp yarns are constructed of a material selected from polyethylene terephthalate (PET), polyethylene naphthalate (PEN), polyetheretherketone (PEEK), polyphenylene sulphide (PPS) and blends and copolymers thereof.

[0046] Preferably, the weft yarns are constructed of a material selected from PET, polybutylene terephthalate (PBT), a polyamide selected from polyamide 6, 6/6, 6/10, and 6/12, and blends of thermoplastic polyurethane and PET.

[0047] Generally, step (a) comprises determining a maximum of four groups of fabrics.

[0048] Preferably, the identifying properties in step (g) comprises selection of adjustable properties selected from at least one of weft yarn material, cross-section shape, size and knocking; more preferably, the selection of adjustable properties is performed to correspond with product criteria for a paper product to be manufactured using the first fabric, wherein the product criteria comprise at least one of the basis weight and the paper grade of the paper product.

[0049] Preferably, the identified optimal properties for warp yarns comprises warp sizes in ranges between 0.08 mm and 0.50 mm, and more preferably between 0.1 mm and 0.35 mm.

[0050] The step of selecting a weave design in step (e) can comprises modifying an existing design, or preparing a new design.

[0051] Preferably, the shedding options in step (b) comprise using an integer multiple of 2, 3, 4, 6, 8, 12 or 24 sheds on the loom, and more preferably the shedding arrangement requires 24 sheds.

[0052] Preferably, the selecting fabric structure type of step (e) comprises selecting a type from single layer fabrics, semi-duplex fabrics, double layer fabrics, extra support double layer fabrics, triple weft fabrics, standard triple layer fabrics, triple layer sheet support binder fabrics, triple layer warp tie fabrics, and triple layer warp integrated sheet support binder fabrics, and more preferably from extra support double layer fabrics, triple layer sheet support binder fabrics, triple layer warp tie fabrics, and triple layer warp integrated sheet support binder fabrics.

[0053] Optionally, the selecting a weave design of step (e) comprises selecting a design requiring two systems of warp yarns, wherein the warp yarn material, size, cross-sectional shape and mesh in each system is substantially the same.

[0054] Preferably, the warp yarns are polymeric monofilaments; alternatively they can be polymeric multifilaments, and optionally in either case they can be plied or cabled. However, in general, single monofilaments are preferred for use in the papermaking fabrics made in accordance with the teachings of this invention.

[0055] Preferably, the paper product is selected from a member of one of three groups of paper products, wherein a first group has a basis weight in a range between 15 and 35 gsm, a second group has a basis weight in a range between 35 and 80 gsm, and a third group has a basis weight greater than 80 gsm. Alternatively, the paper product is selected from a member of one of three groups of paper product grades, wherein a first group comprises towel and tissue, a second group comprises printing and writing, and a third group comprises packaging and linerboard.

[0056] Preferably, the size of the PS weft yarns is in a range of between 0.08 mm and 0.50 mm, and more preferably between 0.1 mm and 0.35 mm.

[0057] Preferably, the PS weft yarns are polymeric monofilaments; alternatively they can be polymeric multifilaments, and optionally in either case they can be plied or cabled. However, the PS weft yarns should be compatible with the warp yarns, and in general, as for the warp yarns, single monofilaments are preferred for use in the papermaking fabrics made in accordance with the teachings of this invention.

[0058] Preferably, the warp yarns have a diameter which exceeds a diameter of the PS weft yarns by less than 0.10 mm, and more preferably by less than 0.05 mm.

[0059] Optionally, the method further comprises after step (g) the step of (g.1) heatsetting the first fabric.

[0060] The invention further seeks to provide a group of at least two industrial textiles, wherein each industrial textile comprises a woven structure of polymeric warp and weft yarns, wherein

(i) the warp yarns have warp yarn properties comprising size, shape, polymeric composition, and together have a mesh value; and

(ii) the warp yarn properties and mesh value of each industrial textile are substantially identical to the warp yarn properties and mesh value of each other industrial textile in the group.

[0061] Preferably, the woven structure of each industrial textile is selected from one of a single layer, semi duplex, double layer, extra support double layer, triple weft, standard triple layer, triple layer sheet support binder, triple layer warp tie, and triple layer integrated sheet support binder fabric construction.

[0062] Preferably, the composition of the warp yarns comprises polyethylene terephthalate (PET), polyethylene naphthalate (PEN), polyetheretherketone (PEEK), polyphenylene sulphide (PPS) and blends and copolymers thereof.

[0063] Preferably, each industrial textile is woven according to a pattern having a loom requirement for a number of sheds selected from an integer multiple of 2, 3, 4, 6, 8, 12 and 24. However, the industrial textiles can be woven according to patterns having a loom requirement for the less usual numbers of sheds, such as selected from an integer multiple of 5, 7, 9, 11, 13, 17, 19 and 23.

[0064] Fabrics made in accordance with the teachings of this invention can be made on a loom equipped with one, two or more warp beams. In instances where the weave design of the MS of the fabric differs substantially from that of the PS, it may be necessary to weave the fabric using a two or three beam warp configuration due to the differing path lengths of the warp yarns in each of the PS and MS layers.

[0065] By means of the present invention, a process is now provided whereby it is possible to manufacture in succession, using one loom provided with the same warp platform, any of the known fabric constructions including single layer fabrics, double layer fabrics, extra support double layer, standard triple layer, triple layer sheet support binder (SSB), triple layer warp tie fabrics, and triple layer warp integrated sheet support binders (WISS), without having to make a warp change. By means of the process, it is now possible for each of these constructions to be optimized, by adjusting one or more of the weft yarn size, knocking, or other process parameters, in particular the heatsetting process, so as to provide the desired mechanical and papermaking qualities in the final product allowing it to replace an equivalent product which is not created according to the inventive method.

BRIEF DESCRIPTION OF THE DRAWING

[0066] The invention will now be described in relation to the drawing, in which

[0067] FIGS. **1**A to **1**C together comprise a flow chart of the steps in an embodiment of the method of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0068] The invention provides the important advantage that all, or substantially all, fabrics presently manufactured from a multiplicity of differing warp types, each having differing warp yarn materials, cross-sectional shape or areas, or mesh from the other, and targeted for a generic paper grade (e.g. tissue and towel, printing and writing, packaging and linerboard) can now be made using a minimal number, possibly only one, warp platform, whose yarn size (i.e. diameter, for substantially circular yarns) is selected from the range of from 0.08 mm to about 0.50 mm such as would be optimal for a range of these textile products. Selection of a specific warp yarn size and mesh is determined primarily by the basis weight of the products to be manufactured, and characteristics of the papermaking machine for which the fabric is intended. It has also been found that fabric production can be further diversified by warp yarn size and intended use as determined by the basis weight of the product to be manufactured as shown in Table 1 below. In this table, and Tables 2 to 4 below, yarn sizes are stated for monofilaments having generally circular cross-sections; but other cross-sectional shapes can also be used. Fabrics intended for one of the grade designations below would each be woven using the distinct warp platform appropriate for the particular grade designation. Table 1 indicates three warp platforms for the three groups respectively, and the corresponding optimized warp yarn sizes.

TABLE 1

General Grade Designation	Basis Weight (gsm*) Range of Product	Warp Yarn Size Range (mm)	Optimized Warp Yarn Size (mm)
Packaging/Linerboard	80+	0.15-0.35	0.22
Printing/Writing	35-80	0.10-0.17	0.15
Towel/Tissue	15-35	0.08-0.13	0.11

*= grams per square meter

[0069] In Table 1, a wide range of paper products have been grouped by basis weight into three general grade designations: packaging and linerboard which are generally heavier products and require a high basis weight of about 80 gsm or more; printing and writing grades such as newsprint, magazine and similar papers intended for the application of ink and which have a lower basis weight range of between about 35 and 80 gsm; and towel and tissue which are relatively light basis weight products ranging from about 15 to 35 gsm. Each of these products will require a fabric the papermaking and mechanical properties of which are optimized for the manufacturing requirements and machine conditions to which they will be exposed. As noted above, fabric manufacturers would conventionally produce differing fabrics for a much smaller range of basis weights, so that within each of the above general grade designations, multiple fabric designs would be used, each having a different warp platform, to satisfy a narrower basis weight range. It has now been found that fabric products can be grouped within e.g. the categories identified in Table 1, so that a single warp platform can be used for each fabric within a specific group, i.e. utilizing one set of warp yarns in each of the PS and MS woven structures for the fabrics of the particular group, to satisfy the requirements of each grade.

[0070] If this is done, then the weft yarn size and knocking (number of weft yarns per unit length of fabric) used in combination with the warp will be selected to correspond with the warp yarn sizes. For the sizes stated in Table 1 above, appropriate PS weft yarn sizes would generally range from about 0.08 mm to about 0.50 mm, with the actual size and knocking being selected in combination with the warp yarn mesh, size and cross-sectional shape available. For example, a round cross-section warp yarn having a diameter of about 0.11 mm intended for a fabric for the manufacture of low basis weight products such as tissue would generally utilize a weft yarn size of from about 0.08 mm to 0.20 mm at a PS knocking of from about 50 to 100 yarns/inch (19.7-39.4 yarns/cm). Selection of an appropriate weft yarn size, shape, material and knocking will provide a fabric having the necessary physical and mechanical properties within the range appropriate for the product to be made. The MS weft yarns can be selected to provide the required properties for the intended end use, and can be as large as required. The warp yarn size range in Table 1 would be appropriate for any of these fabric structures and designs, and such fabrics could be woven on a loom provided with one, two or three beams as required.

[0071] The invention is based on the understanding that selection of a warp platform, i.e. preferred mesh, warp size and cross-sectional shape appropriate for a range of fabrics, is made by evaluating the mechanical properties requirements of the resulting fabrics in combination with the papermaking properties of the fabric. The fabric must provide adequate physical properties appropriate for the environment for which it is intended, which are primarily dictated by the elastic modulus of the warp materials and the resulting stability (as dictated by the shear values of the fabric). Selection of appropriate weft yarn cross-sectional shape and size, material composition and knocking thus become much more important variables that which will allow for adjustment of fabric properties to suit the intended end use of the product. Additional important mechanical properties include lateral contraction (the narrowing of a fabric as it is tensioned) and fabric caliper. These mechanical requirements are then considered in combination with the desired papermaking properties of the fabric. Once a warp platform has been selected, the section of appropriate weft yarn shape, size, composition and knocking then becomes a process which will be readily apparent to those skilled in the art.

[0072] Conventionally, a major constraint when changing from one product at one warp size and mesh to another at a different warp size and mesh was the necessity to match the new warp cross-sectional area to the old. Mechanical properties of a fabric are primarily determined by the cross-sectional area of the warp used in the fabric (e.g. for warp yarns having a circular cross-section, the total warp cross-sectional area in the fabric will be $\pi r^2 \times$mesh). When changing production from a fabric employing a relatively larger warp size (e.g. 0.25 mm) to smaller (e.g. 0.21 mm), the manufacturer would have to increase the mesh to ensure the same amount of warp cross-sectional area was available to meet the target elastic modulus of the fabric.

[0073] It has been found that the use of high modulus warp yarn materials, particularly polyethylene naphthalate (PEN) and blends thereof such as are described for example in PCT/US2009/034850, or high modulus polyethylene terephthalate (PET) yarns allows the use of smaller diameter warp at lower mesh while still maintaining adequate elastic modulus in the resulting fabric, so these materials are thus particularly suitable for use in fabrics made according to the invention. However, depending on the environment in which the fabric will be used, and the intended end use requirements, other materials may also be suitable. If warp yarns having a smaller cross-sectional area can provide adequate elastic modulus for the intended product, then greater freedom is available for the selection of an appropriate weft yarn size and knocking which will, in turn, allow for a wider variety of paper grades to be manufactured using fabrics produced from the same warp. Monofilaments formed from PEN may be more suited for use in fabrics where the chosen warp yarn size is relatively small or which may be subjected to higher than normally expected linear tensions. Yarns made from polymers such as polyetheretherketone (PEEK), polyphenylene sulphide (PPS), various polyamides or similar materials may also be used.

[0074] The chosen weft yarn can be any of the thermoplastic polymeric monofilaments or multifilaments currently employed in the manufacture of industrial textiles. While polymers such as PET and polybutylene terephthalate (PBT), polyamides such as polyamide 6, 6/6, 6/10, 6/12, and blends of thermoplastic polyurethane and PET such as are described in U.S. Pat. No. 5,169,711 or U.S. Pat. No. 5,502,120 may be suitable; others may be effective as well and the invention is not limited in this way. Similarly, the weft yarns used in fabrics made according to this invention will generally have a substantially circular cross-sectional shape, but they could also be generally rectangular, square, ovate or otherwise depending on the desired fabric properties and its intended operating environment.

[0075] Drainage area as well as other papermaking properties of the PS including air permeability, frame length, fiber support index (FSI) can be adjusted by appropriate selection of weft yarn knocking, size and materials. Weft yarn used in the fabrics of this invention can be of any size, shape or composition appropriate for the application. To meet or match fabric specifications (e.g. fiber support or drainage area) when moving from one warp size to another, it is necessary to adjust, i.e. increase or decrease, the knocking or the weft size. For example, a larger warp will reduce the drainage area; therefore, this must be accommodated by decreasing the weft size to provide both adequate support for the papermaking fibers and drainage area. The weft yarn material may also be changed to provide a monofilament which is either stiffer or more malleable, depending on the property change necessary to match specifications. Such adjustments to the weft yarn parameters would be readily apparent to the person skilled in the art of manufacture of these industrial textiles.

[0076] Preferably, the warp yarn diameter should not be larger than about 0.5 mm, but preferably will generally be in the range of 0.08 to 0.35 mm, as indicated in Table 1 above, and more preferably will be in the range of 0.1 mm to 0.25 mm, so as to provide adequate PS surface properties and the PS weft should not be smaller than the warp by a difference of greater than 0.1 mm to 0.05 mm, to ensure that on heatsetting the weft provides sufficient crimp to the warp, to avoid the warp being unduly straight, which could lead to insufficient stability of the resulting fabric. Subject to this constraint, the weft can be as large as necessary or practical to provide the required properties.

[0077] The following steps describe the method of this invention whereby a plurality of existing industrial fabric structures, in particular woven papermakers forming fabrics and similar textiles intended for industrial filtration and conveying applications, each previously including warp yarns of differing size, shape or composition, and which conventionally have been woven using differing meshes and loom shedding arrangements (and thus previously woven using differing looms, or loom settings), can now be woven using a single loom and warp platform to provide a textile having mechanical and papermaking properties very similar to those previously supplied using multiple looms, settings and components. Industrial fabric structures that can be woven using a single loom and warp platform include: single layer, semi duplex, double layer, extra support double layer, triple weft, standard triple layer, triple layer sheet support binder, triple layer warp tie, and triple layer integrated sheet support binder fabrics. Fabric properties are subsequently adjusted to meet operational requirements by appropriate selection of weft yarn materials and knocking.

[0078] In the following discussion, the term "warp platform" is used to refer to the set of warp yarn parameters including: a) diameter (or cross-sectional area in the case of non-round cross-section yarns), b) material composition (e.g. the polymer from which the yarn is formed by thermoplastic extrusion process), c) warp yarn mesh as woven (i.e. the number of warp yarns per unit width in the textile as woven and prior to any subsequent treatment such as by heatsetting) and d) the number of sheds in a single loom required to weave the chosen fabric structure.

[0079] Similarly, the term "single warp platform" is used to refer to the combination of warp-related parameters for a group of different industrial textile structures, which using conventional methods would have been woven using different warp platforms for each of the different textiles. The related terms "single warp platform product" and "single warp platform loom" refer respectively to industrial textiles woven using a single warp platform, and the loom on which they are or can be woven.

[0080] Referring now to FIGS. **1**A to **1**C, the steps taken in an exemplary embodiment of the invention, described here in relation to establishing a single warp platform for textiles for papermaking, are as follows.

Step 1: Select the intended target paper grade or basis weight for the product for which the textiles will be used (e.g. Tissue: 15-35 gsm; Printing: 35-80 gsm; Packaging/Linerboard: >80 gsm). The term "basis weight" in Table 1 above, and throughout the following discussion, has the meaning commonly assigned to it in the papermaking arts and refers to the mass per unit area of the finished paper product that is to be made using the industrial textile.

Step 2: Review the mechanical and papermaking properties of existing industrial textile structures that are currently used or expected to be used in the manufacture of a cellulosic product for the target paper grade or basis weight, and which are intended to be consolidated into a SWP Platform, using the criteria of Table 1, so as to establish an appropriate group of fabrics. In Table 1, the warp yarns have a substantially circular cross-section, which will generally be the shape selected for a new SWP Product; however, the same process would be used for other cross-sectional yarn shapes by determining their projected width on the PS. Through experimentation and experience, it has been found that the warp yarn diameters indicated below can be employed successfully in industrial textile structures intended for use in the production of paper products having the indicated basis weights:

Basis weight range >80 gsm: use 0.22 mm diameter warp yarns

Basis weight range 35-80 gsm: use 0.15 mm diameter warp yarns

Basis weight range 15-35 gsm: use 0.11 mm diameter warp yarns

Step 3: Determine the number of sheds used by looms to weave fabrics currently intended for use for the target paper grades and basis weights listed in Step 1, and the number of sheds which would be required for any new fabrics which would advantageously be included in the group under consideration, as identified in Step 2. Select an appropriate number of sheds to be provided. It has been found that previously existing industrial textile structures woven according to 2, 3, 4, 6, 8, 12, and 24 shed weave designs are most suitable for conversion to an SWP Platform; however others are possible. A 24 shed loom is particularly advantageous as it can accommodate a wider range of existing industrial textile structures than looms provided with differing shedding arrangements, such as 20.

Step 4: Select the different fabric structure types to be included in the group, e.g. single layer, double layer, triple layer, and others as listed above. From these fabric structure types, select those structures for which the weave designs will require a number of sheds which is equal to, or is an integer multiple of, the number of sheds selected in Step 3. For example, a 24 shed SWP loom can produce 2, 3, 4, 6, 8, 12 and 24 shed weave designs, but cannot produce 5 or 7 shed designs.

Step 5: From the fabrics identified in Step 4, select those with meshes within 20% (i.e. ±10%) of each other which, in addition, utilize warp yarn materials whose diameters (or projected widths on the PS of the fabric) are within ±25% of each other. It has been found that fabrics within such range of each other will be particularly amenable to the SWP process, primarily because the mesh will determine, to a great extent, both the mechanical and papermaking properties of the resulting SWP fabric. The SWP Product must have sufficient modulus (i.e. MD strength), as well as air permeability, drainage and fiber support to enable the manufacture of the target paper grade. By selecting related fabrics for the particular group (i.e. intended for the same general grade designation, such as is shown in Table 1) it is much easier to consolidate the characteristics of several differing fabrics into one or a few having acceptable mechanical and papermaking properties for the intended end use.

Step 6: From the set of target fabrics identified in Step 5, select those having total warp cross-sectional areas that are within about 30% (i.e. ±15%) of one another. As noted above, the total warp cross-sectional area=[(fabric mesh×warp yarn cross-sectional area)/unit width of fabric].

Step 7: Select those target fabrics identified in Step 5 which have PS warp fills that are within 10% (i.e. ±5%) of each other. As noted above, warp fill=warp yarn cross sectional area×mesh. Use the set of fabrics identified in Step 5 to determine the PS warp fill of the new SWP product. The warp fill of the SWP Product should preferably be within ±10% of the target fabrics identified in Step 6 whose platforms are to be consolidated into a single SWP platform, and more preferably it should be within ±5% of the target fabrics identified in Step 6. This will allow the SWP Product to more easily produce the papermaking characteristics required.

Step 8: Determine the ranges of concurrence for the fabrics identified and considered in each of Steps 6 and 7. From the set of fabrics identified in each of those Steps, select those fabrics whose total warp cross-sectional areas are between about ±15% of each other (Step 6), and whose PS warp fills are within about ±5% of each other (Step 7). This concurrence identifies the range of warp diameters and meshes appropriate for the new SWP Product that will satisfy both the basic mechanical and drainage requirements of the fabrics intended for the target basis weight range (i.e. paper grade), and which will also fit within the construction parameters of existing and proposed industrial textile structures.

Step 9: Determine optimal warp yarn diameter and mesh for SWP Product by weighting fabric properties relative to their importance to the target paper grade, including at least:

[0081] a) air permeability,

[0082] b) maximum frame length, and

[0083] c) PS drainage area.

[0084] The determination is performed by estimating the effect that warp diameter and mesh will have on the mechanical and papermaking qualities of the SWP Product. This can most easily be done by assigning a weighting factor (e.g. Low, Medium, High) to the importance of each property for the target basis weight and paper grade. Table 2 below provides an example of such weighting for various fabric properties used in fabrics intended for Packaging grades (Basis weight >80 gsm) and which are woven with warp yarns having circular cross-sections.

TABLE 2

Fabric Property Weightings for SWP Products Intended for Packaging Grades

Property	Warp Diameter	Mesh	Weighting/ Comments
Air Permeability	Smaller is better	Lower is better	High
Seam Strength	Larger is better	Higher is better	High
Shear Stability	Larger is better	Higher is better	High
Stiffness	Larger is better	Higher is better	High
Weft Count Range	Smaller is better	Lower is better	High
Cloth Caliper	Smaller is better	No effect	Medium
Drainage Area	Smaller is better	Lower is better	Medium
Frame Length	Smaller is better	Lower is better	Medium
Fibre Support Index	Smaller is better	Higher is better	Low
Sheet Smoothness	Smaller is better	Higher is better	Low

[0085] In Table 2 above, there are five parameters with High weightings; three of the five support the choice of larger warp diameters and higher mesh counts for this fabric application (Shear Stability, Stiffness & Seam Strength) while the remainder support the choice of smaller warp diameters and lower mesh counts. The choices for the SWP Product intended for the manufacture of paper products having this relatively high basis weight lean slightly towards choosing as large a warp diameter as possible with as high a warp mesh as possible. It should be noted that a small warp diameter and low mesh are indicated for all of air permeability, frame length and drainage area, but the latter two properties are assigned a weighting of "Medium" importance, thus leading the manufacturer towards a larger warp diameter and higher mesh count in the resulting SWP fabric due to the relative importance of these properties to the manufacture of the target paper grade.

[0086] After Step 9, two parallel groups of steps are conducted, the first group (Steps 10A, 11A) relating to providing and setting up the warp yarns on the loom, and the second group (Steps 10B, 11B and **12**) relating to selecting the fabric to be woven, and determining the weft parameters required. These two groups of steps can be performed in any order or concurrently.

Step 10A: Provide an industrial loom (the "SWP loom") having the number of sheds determined as appropriate in Step 3.

Step 11A: Provide the SWP loom with a set of warp yarns having the size and mesh determined at Step 9. The warp yarns are mounted on at least one back beam, the warp yarns being threaded through the reed openings in the heddles of the loom to provide a desired mesh, and the heddles arranged to provide the required number of sheds. The warp yarns may be threaded at a density of 1, 2, 3 or as many as 4 yarns per dent (reed opening) in the reed. The SWP Loom is configured according to the desired SWP platform, enabling the fabric manufacturer to consolidate the production of a plurality of industrial fabric structures having similar mesh (which would previously have been woven on multiple looms) onto one loom.

Step 10B: Select a fabric structure type, e.g. single layer, triple layer, for the first fabric to be woven.

Step 11B: Select a weave design for the first fabric to be woven, from existing or new designs.

Step 12B: Determine weft yarn diameters and knocking for the first fabric, having regard to the warp yarn size, mesh and total cross-sectional area selected for the SWP Product, to obtain the characteristics required for the fabric to be woven, to achieve the best compromise of fabric properties.

Step 13: Install weft yarn material selected in Step 12B into the loom, and adjust loom to provide appropriate knocking as determined in Step 12B.

Step 14: Weave and finish the first fabric, including heatsetting and seaming.

Step 15: Select a fabric structure type for a second fabric to be woven, in the same manner as for the first fabric in Step 10B.

Step 16: Select a weave design for the second fabric to be woven, from existing or new designs.

Step 17: Determine weft yarn diameters and knocking for the second fabric in the same manner as for the first fabric in Step 12B.

Step 18: Install weft yarn material selected in Step 17 into the loom, and adjust loom to provide appropriate knocking as determined in Step 17.

Step 19: Weave and finish the second fabric, including heatsetting and seaming.

Step 20: Repeat Steps 15 to 19 for third and subsequent fabrics.

Experimental Trials

[0087] Several fabrics were woven using the methods of this invention as expressed above and the results are presented in Tables 3 and 4 below in which SWP Products were made and their properties compared to comparable existing industrial textile structures. In Table 3 below, two existing industrial textile structures, one an extra support double layer (ESDL) fabric, and the other a triple layer sheet support binder (SSB) fabric, each of which were previously woven on separate looms, have been converted into SWP Products by means of the method of this invention.

TABLE 3

Comparison of Properties of Existing Industrial Textile Structures and SWP Products

	Existing Structure	SWP Product	Existing Structure	SWP Product
Sample No.	1	2	3	4
Weave Type	ESDL*	ESDL*	SSB**	SSB**
No. Sheds	8	24	24	24
Mesh (as woven)	98	112	112	112
Mesh (as heatset)	112	124	126	126
Yarn Count (No./in.)				
Total (heatset)	112 × 105	124 × 105	126 × 108	126 × 108
Paper Side	112 × 70	124 × 70	63 × 54	63 × 54
Machine Side	112 × 35	124 × 35	63 × 36	63 × 36
Warp Fill (%)	110	107	50	55
Yarn Diameters (mm)				
Paper Side MD	0.25	0.22	0.20	0.22
Machine Side MD			0.27	0.22
Paper Side CD	0.26	0.25	0.19	0.18
Paper Side Tie Strand	0.15	0.17	0.19	0.18
Machine Side CD	0.45	0.45	0.40	0.40
Fabric Characteristics				
Paper Side Drainage Area	40.0%	45.9%	30.0%	28.0%
Frames Count	1470/in.^{2}	1085/in.^{2}	3402/in.^{2}	3402/in.^{2}
Fibre Support Index (F.S.I)	95	88	114	114
Maximum Frame Length (mm)	0.576	0.556	0.280	0.290
Air Permeability	370 cfm @125 Pa	365 cfm @125 Pa	450 cfm @125 Pa	470 cfm @125 Pa
New Caliper (in.)	0.050	0.050	0.051	0.048
Drainage Index	21.0	20.2	24.3	25.4
Elastic Modulus	11400 pli	12000 pli	9800 pli	8600 pli

*ESDL = Extra Support Double Layer

**SSB = Sheet Support Binder

[0088] Table 3 provides a comparison between two known textile products (Samples 1 and 3), and textiles of the same structural type made using an SWP platform (Samples 2 and 4). Samples 1 and 2 were woven as extra support double layer fabrics, and it can be seen from Table 3 that their mechanical and papermaking properties and characteristics are closely similar, despite the changes in the warp and weft yarn parameters resulting from using the SWP.

[0089] Similarly, Samples 3 and 4, each woven as triple layer sheet support binder fabrics, can be seen to be closely similar. Thus each of Samples 2 and 4, produced from an SWP, can be seen to be acceptable replacements for Samples 1 and 3.

TABLE 4

Comparison of Properties of Existing Products and SWP Products

	Existing Structure	SWP Product	Existing Structure	SWP Product
Sample No.	5	6	7	8
Weave Type	ESDL	ESDL	SSB	SSB
No. Sheds	8	24	24	24
Mesh (as woven)	98	112	112	112
Mesh (as heatset)	112	122	126	128
Yarn Count (No./in.)				
Total (heatset)	112 × 87	122 × 90	126 × 108	128 × 107
Paper Side	112 × 58	122 × 60	63 × 54	64 × 53
Machine Side	112 × 29	122 × 30	63 × 36	64 × 35
Warp Fill (%)	110	106	50	55
Yarn Diameters (mm)				
Paper Side MD	0.25	0.22	0.20	0.22
Machine Side MD			0.27	0.22
Paper Side CD	0.25	0.25	0.19	0.20
Paper Side Tie Strand	0.16	0.16	0.19	0.20
Machine Side CD	0.40	0.40	0.35	0.35
Fabric Characteristics				
Paper Side Drainage Area	45.3%	45.1%	30.0%	25.9%

TABLE 4-continued

Comparison of Properties of Existing Products and SWP Products				
	Existing Structure	SWP Product	Existing Structure	SWP Product
Frames Count	1218/in.^{2}	1373/in.^{2}	3402/in.^{2}	3408/in.^{2}
Fibre Support Index (F.S.I)	82	85	114	114
Maximum Frame Length (mm)	0.716	0.687	0.280	0.277
Air Permeability	450 cfm @125 Pa	460 cfm @125 Pa	455 cfm @125 Pa	470 cfm @125 Pa
New Caliper (in.)	0.045	0.042	0.047	0.050
Drainage Index	21.2	22.4	24.6	25.0
Elastic Modulus	11,800	9,600	10,800	9,800

[0090] Table 4 shows a similar comparison to that of Table 3, in relation to two further known textile products (Samples 5 and 7), and two textiles of the same structural type using an SWP platform (Samples 6 and 8). Samples 5 and 6 were woven as extra support double layer fabrics, and Samples 7 and 8 were woven as triple layer sheet support binder fabrics.

[0091] As in the case of the SWP fabrics of Table 3, for each of the SWP fabrics of Table 4 their mechanical and paper-making properties and characteristics are closely similar, despite the changes in the warp and weft yarn parameters resulting from using the SWP. Thus each of Samples 6 and 8, produced from an SWP, can be seen to be acceptable replacements for Samples 5 and 7.

[0092] It is important to note that both the ESDL and SSB weft tied SWP products of Samples 2, 4, 6 and 8 were woven using the same warp yarn size and mesh (0.22 mm warp diameter and 112 yarns/in. mesh). However, the mesh (as heatset) of the ESDL and the SSB fabrics made using the SWP Process are slightly different. The heatset mesh of the ESDL fabrics were 124 (Sample 2) and 122 (Sample 6) while that of the SSB fabrics were 126 (Sample 4) and 128 (Sample 8), even though all fabrics were woven using the same mesh of 112. The reason for this is that these designs require somewhat different heatsetting parameters in order to optimize their mechanical properties and typically the degree of width reduction during heatsetting is about 2-3% higher for the SSB fabric due to the differences between its structure and that of the ESDL fabric.

[0093] A primary control variable for the heatsetting process is the total width shrinkage. Depending on the weave structure and intended end use of the fabric, differing width shrinkage targets of from about 5% to 15% may be required to achieve optimal fabric properties in the SWP Product. Therefore, although the as woven mesh of two fabrics may be the same, the finished (heatset) fabric mesh may differ by an amount in accordance with the 5% to 15% width shrinkage targets.

[0094] Thus, the SWP Process has resulted in the ability to consolidate two or more previously different warp platforms with differing warp yarn sizes into a single mesh and warp size, which eliminates the need for major changes to the loom set-up. This results in significantly reduced down time of the loom, in changing fabric production between the different fabrics in the group to which the platform is applicable.

[0095] As discussed above, the method of this invention is directed to looms equipped with at least one back beam; it can also be used in looms equipped with two or three back beams so as to accommodate differing warp path lengths in the fabric due to differing weave designs on each of the paper and machine side surfaces of the fabric. Further, the invention is directed to fabric designs which are woven using any number of sheds in the loom as are required to weave the chosen design; however fabric designs woven according to patterns requiring 2, 3, 4, 5, 6, 8, 10, 12, 16, 20, 24, 32, 36 and 48 sheds are particularly preferred. However, the invention is in no way limited to numbers of sheds required to weave a given fabric design, or to fabric structure (i.e. single, double, triple layer, etc.). The invention is also directed at fabrics whose structure requires the use of two warp yarn systems, such as triple layer sheet support binder fabrics and warp tie fabrics where the size and mesh of the warp on one fabric surface is different from that used on the other, however it is not so limited and has applicability to any industrial textile structure.

1-38. (canceled)

39. A method of manufacturing woven fabrics from warp yarns and weft yarns for industrial uses, the method comprising the steps of:

(a) identifying optimal fabric characteristics to correspond with at least one selected industrial use, and for each selected industrial use identifying a plurality of different suitable fabric constructions, to comprise at least one group of fabrics for that selected industrial use;

(b) selecting a set of shedding options for a loom and providing the loom with a shedding arrangement to provide the selected shedding options;

(c) selecting a first group from the at least one group of fabrics and identifying selected fabric properties to produce the optimal fabric characteristics for the first group;

(d) identifying a single set of optimal parameters for warp yarns to provide the selected fabric properties identified in step (c) for all of the fabrics of the first group of fabrics;

(e) selecting a fabric construction and a weave design for each fabric of the first group;

(f) installing warp yarns on the loom to correspond with the single set of optimal parameters identified in step (d);

(g) selecting a first fabric of the first group, identifying properties for weft yarns to correspond with a first weave design for the first fabric, setting the loom to correspond with the first weave design, and weaving the first fabric according to the first weave design; and

(h) selectively repeating step (g) for selected other ones of the fabrics in the first group.

40. A method according to claim **39**, wherein the identifying optimal parameters in step (d) comprises the steps of

(d.1) identifying optimal warp yarn sizes for the intended end use;

(d.2) determining fabric mesh;

(d.3) determining cross-sectional shape and size of the warp yarns;

(d.4) determining total warp cross sectional area per unit width of the fabrics; and

(d.5) determining paper side warp fill.

41. A method according to claim **39**, wherein the identifying properties for weft yarns in step (g) comprises determining weft yarn size and knocking measured as number of weft yarns per unit length of the fabric

42. A method according to claim **39**, wherein step (b) comprises providing a loom equipped with a number of back beams selected from one, two and three.

43. A method according to claim **42**, wherein the loom is equipped with two back beams.

44. A method according to claim **39**, wherein in step (f) the warp yarns are constructed of a material selected from polyethylene terephthalate (PET), polyethylene naphthalate (PEN), polyetheretherketone (PEEK), polyphenylene sulphide (PPS) and blends and copolymers thereof.

45. A method according to claim **39**, wherein in step (g), the weft yarns are constructed of a material selected from PET, polybutylene terephthalate (PBT), a polyamide selected from polyamide 6, 6/6, 6/10, and 6/12, and blends of thermoplastic polyurethane and PET.

46. A method according to claim **39**, wherein step (a) comprises determining a maximum of four groups of fabrics.

47. A method according to claim **39**, wherein the identifying properties in step (g) comprises selection of adjustable properties selected from at least one of weft yarn material, cross-section shape, size and knocking.

48. A method according to claim **47**, wherein the selection of adjustable properties is performed to correspond with product criteria for a paper product to be manufactured using the first fabric, wherein the product criteria comprise at least one of the basis weight and the paper grade of the paper product.

49. A method according to claim **39**, wherein the identified optimal parameters for warp yarns comprises warp sizes in ranges between 0.08 mm and 0.50 mm.

50. A method according to claim **49**, wherein the identified optimal parameters for warp yarns comprises warp sizes in ranges between 0.1 mm and 0.35 mm.

51. A method according to claim **39**, wherein the selecting a weave design in step (e) comprises modifying an existing design.

52. A method according to claim **39**, wherein the selecting a weave design in step (e) comprises preparing a new design.

53. A method according to claim **39**, wherein the shedding options in step (b) comprise using an integer multiple of 2, 3, 4, 6, 8, 12 or 24 sheds on the loom.

54. A method according to claim **53**, wherein the shedding arrangement requires 24 sheds.

55. A method according to claim **39**, wherein the selecting fabric construction of step (e) comprises selecting a type from single layer fabrics, semi-duplex fabrics, double layer fabrics, extra support double layer fabrics, triple weft fabrics, standard triple layer fabrics, triple layer sheet support binder fabrics, triple layer warp tie fabrics, and triple layer warp integrated sheet support binder fabrics.

56. A method according to claim **55**, wherein the selecting fabric construction of step (e) comprises selecting a type from extra support double layer fabrics, triple layer sheet support binder fabrics, triple layer warp tie fabrics, and triple layer warp integrated sheet support binder fabrics.

57. A method according to claim **56**, wherein the selecting a weave design of step (e) comprises selecting a design requiring two systems of warp yarns, wherein the warp yarn material, size, cross-sectional shape and mesh in each system is substantially the same.

58. A method according to claim **39**, wherein the warp yarns are polymeric monofilaments.

59. A method according to claim **39**, wherein the warp yarns are polymeric multifilaments.

60. A method according to claim **58**, wherein the warp yarns are selected from one of plied polymeric monofilaments and cabled polymeric monofilaments.

61. A method according to claim **59**, wherein the warp yarns are selected from one of plied polymeric multifilaments and cabled polymeric multifilaments.

62. A method according to claim **48**, wherein the paper product is selected from a member of one of three groups of paper products, wherein a first group has a basis weight in a range between 15 and 35 gsm, a second group has a basis weight in a range between 35 and 80 gsm, and a third group has a basis weight greater than 80 gsm.

63. A method according to claim **48**, wherein the paper product is selected from a member of one of three groups of paper product grades, wherein a first group comprises towel and tissue, a second group comprises printing and writing, and a third group comprises packaging and linerboard.

64. A method according to claim **39** wherein the PS weft yarns have a diameter in a range of between 0.08 mm and 0.50 mm.

65. A method according to claim **64**, wherein the diameter of the PS weft yarns is in a range of between 0.1 mm and 0.35 mm.

66. A method according to claim **64**, wherein the PS weft yarns are polymeric monofilaments.

67. A method according to claim **64**, wherein the PS weft yarns are polymeric multifilaments.

68. A method according to claim **66**, wherein the PS weft yarns are selected from one of plied polymeric monofilaments and cabled polymeric monofilaments.

69. A method according to claim **67**, wherein the PS weft yarns are selected from one of plied polymeric multifilaments and cabled polymeric multifilaments.

70. A method according to claim **64** wherein the warp yarns have a diameter which exceeds the diameter of the PS weft yarns by less than 0.10 mm.

71. A method according to claim **70**, wherein the warp yarns have a diameter which exceeds the diameter of the PS weft yarns by less than 0.05 mm.

72. A method according to claim **39**, further comprising after step (g) the step of (g.1) heatsetting the first fabric.

73. A group of at least two industrial textiles, wherein each industrial textile comprises a woven structure of polymeric warp and weft yarns, wherein (i) the woven structure of each industrial textile is different from the woven structure of each other industrial textile in the group, and is selected from one of a single layer, semi duplex, double layer, extra support double layer, triple weft, standard triple layer, triple layer sheet support binder, triple layer warp tie, and triple layer integrated sheet support binder fabric construction;

(ii) the warp yarns have warp yarn properties comprising size, shape, polymeric composition, and together have a mesh value; and

(iii) the warp yarn properties and mesh value of each industrial textile are substantially identical to the warp yarn properties and mesh value of each other industrial textile in the group.

74. A group of industrial textiles according to claim **73**, wherein the composition of the warp yarns comprises polyethylene terephthalate (PET), polyethylene naphthalate (PEN), polyetheretherketone (PEEK), polyphenylene sulphide (PPS) and blends and copolymers thereof.

75. A group of industrial textiles according to claim **73**, wherein each industrial textile is woven according to a pattern having a loom requirement for a number of sheds selected from an integer multiple of 2, 3, 4, 6, 8, 12 and 24.

76. A group of industrial textiles according to claim **73**, wherein each industrial textile is woven according to a pattern having a loom requirement for a number of sheds selected from an integer multiple of 5, 7, 9, 11, 13, 17, 19 and 23.

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