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(54) Title: A PROCESS FOR MANUFACTURING LINEN DENIM FABRIC AND PRODUCT OBTAINED THEREFROM

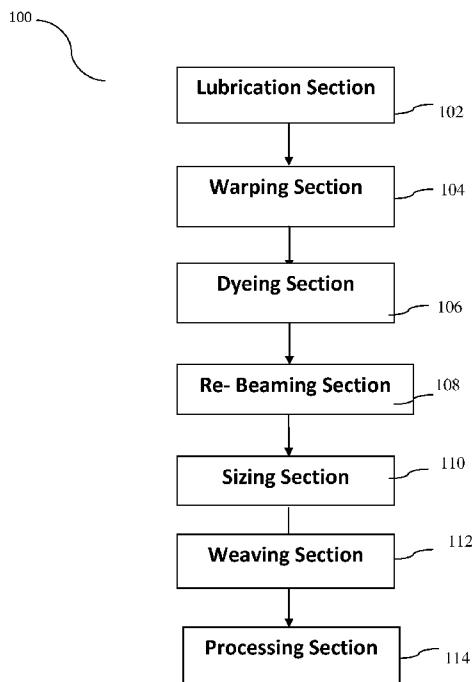


Figure 1

(57) Abstract: The present invention provides a linen denim fabric having linen yarns as warp, a process for manufacturing a linen denim fabric that overcomes all the difficulties in dyeing, weaving and processing of the linen denim fabric having linen yarns as warp and a method for producing linen yarn to be used as a warp. The present invention also provides a 100% linen denim fabric that is the fabric having linen yarns as warp and weft. Alternatively, the fabric of the present invention can have linen yarns as warp and weft as cotton, polyester, blends like cotton-polyester and many other yarns (synthetic and man-made). The finished linen denim fabric is soft and pleasant to handle. It has enhanced quality, workability and better drapeability.



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TITLE.: A PROCESS FOR MANUFACTURING LINEN DENIM FABRIC AND
PRODUCT OBTAINED THEREFROM

FIELD OF THE INVENTION:

- 5 The present invention relates to a linen denim fabric being woven having linen yarns as weft and process for manufacturing of the same.

BACKGROUND OF THE INVENTION:

10 Linen is the most ancient of all fabrics. It is highly valued for its exceptional coolness. It possesses excellent natural luster and comes under premium category. It is smooth, making the finished fabric lint-free, and gets softer on being washed. It is the only natural fiber from cellulose family, which has more natural moisture regain properties than cotton. Linen clothes are known to attract less lint which require relatively low maintenance as compared to silk
15 clothes and can be machine washed, dry cleaned or even steamed. It has a light massaging effect because of the microscopic breaks throughout the fabric; it suppresses live pathogenic bacteria, micro flora, and fungi and is not known to cause any allergies. The fabric stimulates blood flow and promotes relaxation. The linen is stronger than cotton, which can last up to 20 years. It is also
20 environmentally friendly and fully biodegradable.

Woven fabric consists of warp and weft. The warp is set of yarns along the length of the fabric, and the weft is inserted in between the warp shed during weaving with the formation of fabric at this stage. The good performance of yarn or fabric depends on yarn quality. The yarn should possess good strength and
25 elongation which will lead to fewer breakages. The unevenness or variation in

the yarn should be minimal with less thick and thin places, because if there are more thin places or uneven, the yarn will tend to break at that thin place.

Linen yarn in both conditions is on the poor side as it has very high thin places along with very less elongation at break as compared to cotton and other yarns.

- 5 The stiffness is nearly 2-3 times more than that conventionally used raw materials such as cotton therefore the drapeability is very low. Using the linen yarn for weft insertion is easy compared to warping, dyeing and re-beaming, as there is a straight path for weft insertion, but for warping and dyeing it traverses large zig- zag paths. Due to its poor drapeability it does not work well in such
- 10 type of process route and neither does it remain attached smoothly to the guiding apparatus.

The conventional denim fabric constitutes of warp as the 100 % cotton yarn and weft yarns of cotton, linen, polyester, blends like cotton-polyester and many other yarns (synthetic and man-made) are used. Linen being bast fiber is having

15 a very low elongation at break that is 1.5% to 2% as compared to cotton, which is having 5% to 6% elongation at break. It also has stiffer and higher unevenness than cotton, which makes it very difficult to use linen as warp because during the entire process of fabric formation it has to undergo several stresses and strains which are to be sustained. The characteristic properties of

20 linen fiber, such as low elongation and high stiffness make it difficult to work on continuous dyeing machine and weaving machines as it results in high yarn breakage rates during dyeing and weaving process.

Further, yarn dyeing in denim manufacturing is the most important process which is a continuous irreversible process. So each and every process through

25 which the yarn passes through has to be observed and optimized so that best results are obtained. Performance at different stages of denim manufacturing

like warping, dyeing, re-beaming, sizing, weaving and processing is a big challenge especially for manufacturing linen denim. The linen yarn has a major problem of slough-off, the layers/coils of yarn, slip-off during the unwinding at creel zone. It is also observed that during warping of linen the yarn unwinds
5 from package and slips out of tensioning disc.

SUMMARY OF THE INVENTION

Accordingly, the present invention provides in different embodiments/aspects, a linen denim fabric having linen yarns as warp, a process for manufacturing a
10 linen denim fabric that overcomes all the difficulties in dyeing, weaving and processing of the linen denim fabric and a method for producing linen yarn to be used as a warp.

In the first aspect, the present invention provides a linen denim fabric comprising a plurality of warp yarns and a plurality of weft yarns wherein warp yarns include
15 linen yarns only.

According to an embodiment, the linen denim fabric also comprises weft of linen yarns only to provide a 100% linen denim fabric.

In the second aspect, the present invention provides a process for manufacturing a linen denim fabric comprising steps of lubricating packages of
20 linen yarns for reducing stiffness of the linen yarns, warping the lubricated linen yarns to obtain a warp beam of the linen yarns for dyeing, dyeing the warped linen yarns, re-beaming the dyed linen yarns to obtain a warp beam of the dyed linen yarns, sizing the warped dyed linen yarns at a reduced stress and strain, and weaving the sized dyed linen yarns as a warp to produce the linen denim
25 fabric.

According to an embodiment of the method of the present invention, weft yarns of the fabric are linen yarns only to produce a 100% linen denim fabric.

According to the method of the present invention, lubricating step includes lubrication of the linen yarns by capillary effect. According to
5 preferable embodiment, lubrication is carried out by immersing the upper and lower rims of the packages of the linen yarns in a softener solution for a short time. Alternatively, lubrication is carried out by placing a wet cloth over the upper and lower rims of the packages of the linen yarns to lubricate the linen yarns by capillary effect.

10 In the third aspect, the present invention provides a process for manufacturing linen yarns to be used as warp, comprising steps of lubricating packages of the linen yarns for reducing stiffness of the linen yarns by a capillary effect using a softener solution of a low viscosity oil and water, and warping the lubricated linen yarns to obtain a warp beam of the linen yarns.

15 In the fourth embodiment, a process for manufacturing dyed linen yarns to be used as warp comprising steps of rope dyeing the warped linen yarn of the third aspect and re-beaming the dyed linen yarns after dyeing to obtain a warp beam of the dyed linen yarns.

The finished linen denim fabric is soft and pleasant to handle. It has enhanced
20 quality, workability and better drapeability.

BRIEF DESCRIPTION OF DRAWINGS:

Reference will be made to embodiments of the invention, examples of which may be illustrated in the accompanying figures. These figures are intended to be
25 illustrative, not limiting. Although the invention is generally described in the

context of these embodiments, it should be understood that it is not intended to limit the scope of the invention to these particular embodiments:

FIG 1: is a block diagram of the steps involved in a process for manufacturing of linen denim fabric in accordance with the present invention.

5 FIG 2: is a flow diagram of a warping section of FIG 1;

FIG 3: is an enlarged view of a tensioning disc of FIG 1 constructed in accordance with the present invention;

FIG 4: flow diagram of a dyeing section of FIG 1;

FIG 5: flow diagram of a re - beaming section of FIG 1;

10 FIG 6: flow diagram of a sizing section of FIG 1;

FIG 7: is a flow diagram of the weaving section of FIG 1;

FIG 7A: is a front view of the drop pin FIG 1 in accordance with the present invention;

15 FIG 7B: is an enlarged view of the drop pin of FIG 1 in accordance with the present invention;

FIG 7C: is a magnified image of an elliptical reed of FIG 1 constructed in accordance with the present invention;

FIG 8: is a flow diagram of a processing section of FIG 1 in accordance with the present invention; and

20 FIG 9: is a block diagram of the process involved in the processing section of FIG 1 in accordance with the present invention;

DETAILED DESCRIPTION OF THE INVENTION

25 The invention described herein is explained using specific exemplary details for better understanding. However, the invention disclosed can be worked on by a person skilled in the art without the use of these specific details. The foregoing

objects of the present invention are accomplished and the problems and shortcomings associated with the prior art, techniques and approaches are overcome by the present invention as described below in the preferred embodiments.

- 5 References in the specification to “preferred embodiment” means that a particular feature, structure, characteristics, or functions described in detail, thereby omitting known constructions and functions for a clear description of the present invention.

The present invention in general provides a linen denim fabric having linen
10 yarns as warp, a process for manufacturing a linen denim fabric that overcomes all the difficulties in dyeing, weaving and processing of the linen denim fabric having linen yarns as warp and a method for producing linen yarn to be used as a warp. The present invention also provides a 100% linen denim fabric that is the fabric having linen yarns as warp and weft. Alternatively, the fabric of the
15 present invention can have linen yarns as warp and weft as cotton, polyester, blends like cotton-polyester and many other yarns (synthetic and man-made).

Referring to Figure1, a process 100 of manufacturing a linen denim fabric in accordance with the present invention is shown. The process 100 includes a plurality of processing sections in a sequence, namely a lubrication section 102,
20 warping section 104, a dyeing section 106, a re-beaming section 108, a sizing section 110, a weaving section 122 and a processing section 114.

In the lubrication section 102, the linen yarn packages are given conditioning treatment. The linen yarns according to the present invention are lubricated by a capillary effect instead of dipping the packages of the linen yarns in the softener
25 solution. Various known ways can be used for lubricating of the linen yarns by capillary effect. In one of the preferable way, upper and lower rims of the

packages of the linen yarns are immersed for a short time in a softener solution for lubricating the linen yarns so as to lubricate the linen yarns by the capillary effect. The immersing period generally depends upon types of package yarn weight over the package and a person skilled in the art can easily find out the time require for lubricating the packages of linen yarns. In another alternative method, wet cloths of softener solution are placed over the upper and lower rims of the packages of the linen yarns to lubricate the linen yarns by capillary effect. The lubricated packages of the linen yarns are then taken for warping. This treatment makes the linen yarn softer and reduces stiffness of the linen yarns substantially, which in turn makes the linen yarns more pliable. The layers of the linen yarns on the packages are transversely built up so this method of application of solution on the rims helps to soften the yarn without wetting out the linen yarns. As the linen yarn layers unwind from the packages on the warping machine the softener helps to maintain the pliability of the yarn consistently with every layer. The softener is comprises water and low viscosity known lubricating oil and prepared by mixing water and low viscosity known lubricating oil in the ratio of 50% of water and 50% of the lubricating oil. The lubricating oil preferably used is super flex oil and is very well know in the textile field.

Referring to Figure 2 shows a warping section 104 having a ball warping system in accordance with the present invention. The warping of the yarns depends upon the dyeing method of the yarns. In the present invention, the warping method shown in Figure 2 is a ball warping method as the present invention utilizes a rope dyeing method as it is a preferable method according to the inventors of the present invention. Alternatively, other known warping and dyeing methods can be used.

As shown in Figure 2, the warping section 104 includes a first creel 202, a leasing reed 204, a tension stand 206, a traversing ring 208, a ball warper/warper beam 210 and a ball 212. The lubricated linen yarns from the packages are converted into a rope form and winded on the ball warper beam 210. The rope warping prepares the balls 212 out of the packages (cones/cheeses) of the linen yarns mounted individually on the first creel 202 by using the ball warper 210.

To prepare a ball warper/warper beam, a tensioning disc 300 mounted on the tension stand 206 in the warping section 104 is modified to reduce the tension on the linen yarns by an amount of about 5-10 grams than the tension on cotton yarns while preparing ball warper beam of the said cotton yarns. According to an embodiment of the present invention, the tensioning disc 300 is modified by increasing of diameter 302 of the tension disc by about 50 mm which ensures passage of the linen yarns through the tensioning disc 300 without slough offs from the periphery of the tensioning disc 300. In testing, inventors of the present invention found that linen yarn breakage while warping is reduced to 5 - 10 breaks /10⁶m.

Referring Figure 4 shows a rope dyeing section 106 in accordance with the present invention. This section includes known zones and equipments such as a second creel 402, a pre-wetting box 404, a plurality of pre washing boxes 406, a pre-wash bypass box 408, a plurality of indigo dye boxes 410, a plurality of post wash boxes 412, a plurality of post wash bypass boxes 414, a vertical drying system 418 and a coiler zone 420 along with a softener treatment box 416 between the post wash bypass box 414 and a vertical drying range 418.

In the dyeing section 106, the warped linen yarn is dyed by dyes which are selected from a group consisting of indigo, sulphur, reactive pigment,

indanthrene. According to the preferable embodiment of the dyeing of warp yarn is carried on a continuous yarn dyeing machine with one of the dyes. In the dyeing section 106, the rope of the linen yarns from the ball warper beam mounted on the second creel 402 of rope dyeing machine unwind and in a rope
5 form passes through different chemical, water boxes/tank 404 - 414. In this process, the yarn is passed through the dye boxes and then washed alternatively two to three times and then dried.

Generally, in prior arts the dyeing section 106 includes a pre-treatment zone, which includes pre wetting box 404 and pre-washing boxes 406, 408 at a higher
10 temperature. Further, the tensioning and strength of fabric are largely dependent on the temperature in the pre-treatment zone. In this the present invention, the temperature in the pre-treatment zone is preferably maintained within a range of 50°C - 60°C. Further, it is known that a stretch gets induced in the ropes in the dyeing section 106 which is of around 0.5% - 1 % per box due to passage of the
15 ropes through the various boxes/tanks. Therefore, in the present invention in order to reduce such stretch on the linen rope, the number of wash boxes through which the linen yarn passes are reduced to two boxes and the number of boxes 412, 414 at post wash stage is reduced to four in number.

In prior arts, in the a dyeing section 106, the alkaline condition in the pre-
20 washing zone is maintained in the continuous range. In the present invention, the alkaline condition is reduced or eliminated in order to prevent weakening of linen yarn by eliminating use of sodium hydroxide from the pre-wetting zone 404.

In the pre-washing zone 406 according to the present invention, pressure on
25 dancer rolls/tension rolls (not shown) is kept at around 3.5 kilos each to reduce

the stretch in the linen yarns to a certain extent which in turns increase pliability of the yarns.

In a preferred embodiment of the present invention, a softener treatment box 416 is introduced in a continuous range within the post-washing zone 412 so as to make the yarn flexible and less stiff. The softener treatment box comprises low viscosity oil such as super flex

Referring Figure 5 shows a re-beaming section 108 employed in the process after dyeing section 106 (Refer FIGURE 4). The re-beaming section 108 includes a can coiled rope 502, a drum eddy break 504, a rope guide 506, an accumulator 508, a reed 510 and a warper beam 512. The rope of yarn is laid to prepare a warper beam 512 thereby sizing on the re- beaming section 108. In the re-beaming section 108 there is an opening of the dyed linen yarn ropes into a sheet form onto the warper beam 512 so that the sheet is sized, as yarn sizing is possible in the sheet form. The rope from the coiled form in the can 502 is allowed to pass through a plurality of drums with eddy brakes 504 and a plurality of accumulator 508 from where the coiled rope 502 passes through a rope guide 506 which helps to open the rope into individual yarns. These yarns are further winded on to the warper beams 512.

The dyed linen rope is according to the present invention is taken to the re-beaming section 108 without delay in order prevent loss of moisture from the dyed linen yarns. The re-beaming section 108 is optimized to about 150 meter/min to ensure optimum re-beaming and less breakage rates. The re-beaming section 108 is allowed to run after separating the entanglements in the coiled ropes, if any in the cans 502. The rope yarn is continuously kept parallel to ensure that there is no breakage due to pulling on yarn for opening up the entanglement.

Referring to Figure 6 shows a sizing section 110 illustrated in detail which includes a third creel 602, a sow box 604, a drying cylinder 606, a second accumulator 618, a second leasing section 610 and a head stock 612 and weaver's beams 614.

5 The sizing section 110 involves a process that is known natural and/or with synthetic chemicals that are applied to the linen yarns to enable the linen yarns in withstanding against a mechanical force of weaving on loom. The warper beams obtained from the re-beaming section 108, are mounted on to the third creel 602 on the sizing section 110. The dyed linen yarns from the creels enter
10 into a sow box 604 in the form of sheet. Subsequently, the yarn sheet is dried. The yarn sheet is then passed through a set of stainless steel split rods that separate them into individual sheets which are equivalent to the number of section beams in the creel 602. The linen yarn sheets, after passing through the split rods, are collected into a single sheet and passed through an expansion
15 comb (leasing section 610) at the head stock 612 which separate individual yarns. The sizing section 110 includes an expansion comb (leasing section 610) that is adjusted to the desired loom beam width followed by wounding the linen yarn sheet onto the weaver's beam 614.

The efficiency of the sizing section 110 directly affects the fabrication and
20 performance of a weaving section 160. In the sizing section 110, conventional sizing recipes known in the textile field are used to render pliability of the linen yarns in the weaving. In the present invention, the sizing section 150 operated at a speed of about 40 rpm so that stress and strain on the linen yarns are reduced to a certain extent allowing pliability of the linen yarns without breakage. The
25 temperature of the sow box 604 is maintained at 90°C to reduce weakening of

the line yarns. The moisture content through drying cylinders 606 of the yarn sheet is improved to sustain the forces imparted during weaving.

Referring to Figure 7 shows a weaving section 112 which includes a filling yarn 702, a drop pin 704, a heald frame 706, warp yarns from the weaver's beam 710, a reed 712 and a woven fabric 714.

The weaving section 112 involves the stages of fabric construction on the loom where a weft is inserted horizontally in the longitudinal sheet of dyed linen yarns constituting the warp sheet. The weaving section 112 facilitates construction of the fabric wherein the warp sheet is exposed to maximum stress and tension. In the weaving section 112 the yarn is subjected to tension.

According to the present invention, the weaving is preferably carried on a rapier weaving machine due to positive weft carrier principle wherein tension on weft thread is controlled in order to improve the workability of the weft packages. The weaving section 112 facilitates unwinding of the weft packages by applying low viscosity oil through the help of a cloth rinsed in the solution on the horizontal top and bottom brims along the width of the packages of weft and allowed to dwell for a certain time period, for example around 5 minutes. In this one preferred embodiment, the tension on the warp sheet of dyed linen yarns is reduced to around 200 kg from 300-325 kg on the rapier weaving machine. The strain on the warp sheet is controlled by this tension adjustment of the weaving machine. The speed of rapier machine is reduced to 300-350 RPM according to one embodiment of the present invention.

Referring now to Figures 7 and 7A, the weaving section 112 includes a drop - pin 704 which enables a single end of the warp sheet to pass through the drop - pin 704. The drop - pin 704 falls down in case of breakage at the warp end without imparting excessive abrasion force or tension, thereby giving an

electronic signal to warp section to stop the motion followed by stopping the machine. According to the present invention, the drop pin 704 imparts less tension and weight on the individual linen yarns. The drop pin 704 is preferably of 3 mm thickness in this one embodiment.

5 As shown in Figures 7 and 7B, the weaving section 112 includes the heald frame 706 that is used for the formation of shed through which weft is inserted. The heald frame 706 consists of a heald eye 714 in every heald wire 716 through which end of the linen yarns is taken out. The diameter of the heald wire 716 used in the present invention is about 1.8 mm - 2.5 mm. The increase in the
10 diameter of the heald wire 716 reduces abrasion and friction on the linen yarn due to bigger sized hole 707 on the heald wire 716. For beat up to take place a reed 712 is used. During beat up heavy load/force is utilized on the wrap and weft threads.

Referring Figures 7 and 7C show the weaving section 112 includes a reed 712
15 that is made up of metal, preferably of stainless steel in this one particular embodiment. The reed 712 includes a plurality of reed wires 714 that are preferably elliptical in shape. The reed wires 714 beats up the laid weft to the fell of the cloth while its elliptical section ensures less abrasion on the linen yarns. It also separates the warp threads after shedding over in top and bottom shed line
20 without any abrasion. The reed 712 reduces tension on the linen yarns which eventually reduces the breakage thereof. According to the preferable embodiment of the present invention, the dyed linen warp is weaved with linen yarns as weft to produce 100% linen denim fabric. Alternatively, the weft yarns can be other than linen yarns such as cotton, polyester, blends like cotton-
25 polyester and many other yarns (synthetic and man-made).

Figure 8 shows the processing section 114 defining a last step of the process wherein the linen denim fabric is cleaned and physical parameters, like dimensional stability and slippage, are controlled. The processing section 114 includes a brusher 802, a singer 804, a finish pad 806, a skew 808, a rubber belt 810, a palmer 812 and a folder 814.

Referring to Figure 9, the processing section 114 involves a brushing stage 902, a singeing stage 904 a chemical padding stage 906, a width adjustment stage 908, a skewing stage 910, a partial drying stage 912 and a sanforization stage 914.

The brushing stage 902 is a stage wherein fabrics are brushed to remove the loose lint and loose fluff from the fabric surface. This preferably raises the protruding fibers on the fabric surface which are burnt in the singeing stage 904 wherein the fabric is singed in both or only faces side which burn off protruding fibers from the fabric surface. In the singeing stage 904, time of contact between the singeing flame and the fabric is of fractional seconds.

In the chemical padding stage 906, the fabric is subjected to a chemical pad treatment. In the skewing stage 910, the fabric is treated after being stretched by passing through the two pulling devices for width adjustment. In the skewing stage 910, the fabric has a tendency to skew after washing due to the weave of the fabric. The linen denim fabric is preferably skewed to facilitate subsequent fabrication.

In the partial drying stage 912, the fabric is passed through drying cylinders for partial drying of fabric wherein 75- 85% moisture is removed. In this stage, the denim fabric is preferably preshrunk so that the finished fabric does not show high shrinkage during subsequent washing. The amount of pre-shrinking depends upon the type of denim fabric processed. The amount of pre-shrink to

be applied is determined by washing a piece of unfinished denim fabric. The fabric is then dried and ironed on a felt calendar (Palmer) 812.

During the sanforization 914, a dimensional stability to fabric surface is controlled by chemical and mechanical process. The skew in fabric and pH of
5 fabric is also controlled during this step. The chemical process in the sanforization stage 914 reduces tendency of pilling in the fabrics which also maintain optical appearance during usage.

In order to overcome issues of seam slippage, known chemicals are used to increase fiber to fiber friction wherein anti-slippage properties are induced
10 without hampering the softness and hand feel properties of the linen denim fabric. The chemical process also reduces tendency to pilling in the fabrics which in-turn helps the fabrics to maintain their optical appearance during usage. The chemical process further improves the resistance to thread slippage and seam strength which prevents seam damage during garment wearing. Apart
15 from these the dimensional stability by controlling residual shrinkage, skew in the linen denim fabric and pH of linen denim fabric is controlled by normal known mechanical and chemical way on the machine. The finished fabric which is linen denim fabric is soft and pleasant to handle. It has enhanced quality, workability and better drapeability.

20 The process allows production of 100% linen denim fabric with minimizes breakages of the yarn during weaving, dyeing and processing. The linen denim fabric obtained from the process has enhanced quality as to texture and workability. The fabric linen denim is in the weight range of 2 ozs to 14 ozs/sq. yard. The linen denim fabric can be weaved in plain, oxford, twill or any other
25 dobby weave.

The final 100% linen denim fabric manufactured by the claimed method of the present invention is tested for properties as per the following standards shown in Table 1:

Table 1: Standards Used for finished fabric testing

Characteristic	Wash	Reference Test Method
Actual Quality	EPI	ASTM D 3775-03a
	PPI	"
Weight /sq.mt (gms)		ASTM D 3776-07
Weight /sq.yd (ozs)		"
Tear Strength (gms)	Warp	ASTM D 1424-2007
	Weft	"
Tensile Strength (kg	Warp	ASTM D 5034 - 95(2001)
	Weft	"
Original Width	cms	ASTM D 3774 - 96(2004)
Cutable Width	cms	"
%Shrinkage	Length	AATCC-135-2004-1-V-A-(i)
	Width	"
%Skew	A Side	LS & Co. Method 11-2003
	B Side	+AATCC -135-2004-1-V-A-(i)
%Skew Movement	A Side	"
	B Side	"
Stiffness (kgs)		ASTM D 4032-94 (2001)
%Stretch (Weft)		ASTM D 3107 - 2007(Modified)
%Growth (Weft)		"
%Stretch (Warp)		ASTM D 3107 - 2007(Modified)
%Growth (Warp)		"
%Elongation		"
Color Fastness to Crocking	Dry	AATCC 8 - 2007
	Wet	
pH		AATCC 81 - 2006
		ISO 3071-2005

5

The test results of the tested linen denim fabric are shown in below Table 2:

Table 2: Properties of the Fabric

Properties of the Linen Denim Fabric

Fabric Weave	3/1 right hand twill weave
Shade	Natural Indigo
Warp	9s Ne
Weft	9s Ne
Over all width (cm)	151.4
Cuttable width (cm)	149.5
Length Wise residual Shrinkage (%)	-1.6
Length Wise residual Shrinkage (%)	-2.7
Ends per inch	61
Picks per inch	47
Unwash Weght (Ozs/yd.sq)	9.58
Wash Weght (Ozs/yd.sq)	9.79
Stiff (Kg)	2.7
Tensile Strength Warp (Kg)	91.1
Tensile Strength Weft (Kg)	64.7
Tear Strength Warp (gms)	6533
Tear Strength Weft (gms)	7500

While the foregoing is directed to embodiments of the present invention, other and

5 further embodiments of the invention may be devised without departing from the basic

scope thereof, and the scope thereof is determined by the claims that follow:

CLAIMS :

1. A linen denim fabric comprising a plurality of warp yarns and a plurality of weft yarns wherein warp yarns include linen yarns only.
- 5 2. A linen denim fabric as claimed in claim 1, wherein the weft yarns are linen yarns only thereby providing a 100% linen denim fabric.
3. A linen denim fabric as claimed in claim 1 or claim 2, wherein fabric has a weight in the range of 2 Oz to 14 Oz/sq yard and can be woven in plain,
10 Oxford, twill or any other Dobby weave.
4. A process for manufacturing a linen denim fabric, comprising steps of:
lubricating packages of linen yarns for reducing stiffness of the linen yarns;
warping the lubricated linen yarns to obtain a warp beam of the linen yarns;
15 dyeing the warped linen yarn;
re-beaming the dyed linen yarns to obtain a warp beam of the dyed linen yarns;
sizing the warped dyed linen yarn at a reduced stress and strain; and
weaving the sized dyed linen yarns as a warp and processing to produce
20 the linen denim fabric.
5. The process as claimed in claim 4, wherein low viscosity oil is applied on weft yarns while unwinding the weft yarns.
- 25 6. The process as claimed in claim 4 or claim 5, wherein weft yarns of the fabric are linen yarns to produce a 100% linen denim.

7. The process as claimed in one of the preceding claims 4-6, wherein abrasion of warp dyed linen yarns during weaving is reduced by using wire healds of diameter between 1.8-2.5 mm.

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8. The process as claimed in one of the preceding claims 4-6, wherein excessive tension on the warp yarns in weaving is reduced by passing the warp yarns through elliptical reed wires.

10 9. The process as claimed in claim 4, wherein the lubricating step includes lubrication of the linen yarns by capillary effect.

10. The process as claimed in claim 9 wherein lubrication is preferably carried out by either immersing the upper and lower rims of the packages of the
15 linen yarns in a softener solution or placing a wet cloth over the upper and lower rims of the packages of the linen yarns to lubricate the linen yarns by capillary effect.

11. The process as claimed in claim 6, wherein the softener solution, preferably
20 comprises low viscosity oil and water in a ratio of 50:50.

12. The process as claimed in claim 4, wherein the warping is carried out at a reduced tension, preferably at 20 – 30 % or (5-10 grams) reduced warping tension than normally used for warping conventional cotton yarn.

25

13. The process as claimed in claim 4, wherein the yarns are preferably warped as a ball warp for using a rope dyeing method.

14. The process as claimed in claim 4 or claim 13, wherein the step of dyeing

5 includes pre-treatment zone, dyeing zone and post treatment zone wherein

a. a pre-washing zone of the pre-treatment zone has dancer rolls/ tension rolls with a preferred pressure around 3.5 kilos per dancer roll,

b. a post washing zone of the post treatment includes a softener treatment,

c. stretch in the linen yarn is reduced by reducing stages of a pre-washing
10 zone and a post washing zone, and

d. alkaline condition in the continuous range is reduced by eliminating the sodium hydroxide in the pretreatment zone to prevent weakening of linen.

15 15. The process as claimed in claim 14, wherein the pre-treatment zone of the dyeing step is maintained at a preferred temperature within a range of 50°C – 60°C.

16. The process as claimed in one of the claims 4, 13 to 15, wherein dyeing is
20 carried out at dyes in the dyeing step selected from the group consisting Indigo, sulphur, reactive pigment, indanthrene.

17. The process as claimed in claim 4, wherein the re-beaming of the linen yarns is carried out at 150 meter/min.

25

18. The process as claimed in claim 4, wherein sizing of the linen yarns is preferably carried at 40 rpm at 90°C.

19. The process as claimed in claim 4, wherein tension during weaving on the warp linen sheet is maintained at about 200 kg and speed of a loom is maintained at 300-350 rpm.

20. A process for manufacturing linen yarns to be used as warp, comprising steps of:

lubricating packages of linen yarns for reducing stiffness of the linen yarns by a capillary effect using a softener solution of a low viscosity oil and water; and

warping the lubricated linen yarns to obtain a warp beam of the linen yarns.

21. A process for manufacturing dyed linen yarns to be used as warp comprising steps of:

rope dyeing the warped linen yarn manufactured by a process as claimed in claim 20; and

re-beaming the dyed linen yarns after dyeing to obtain a warp beam of the dyed linen yarns.

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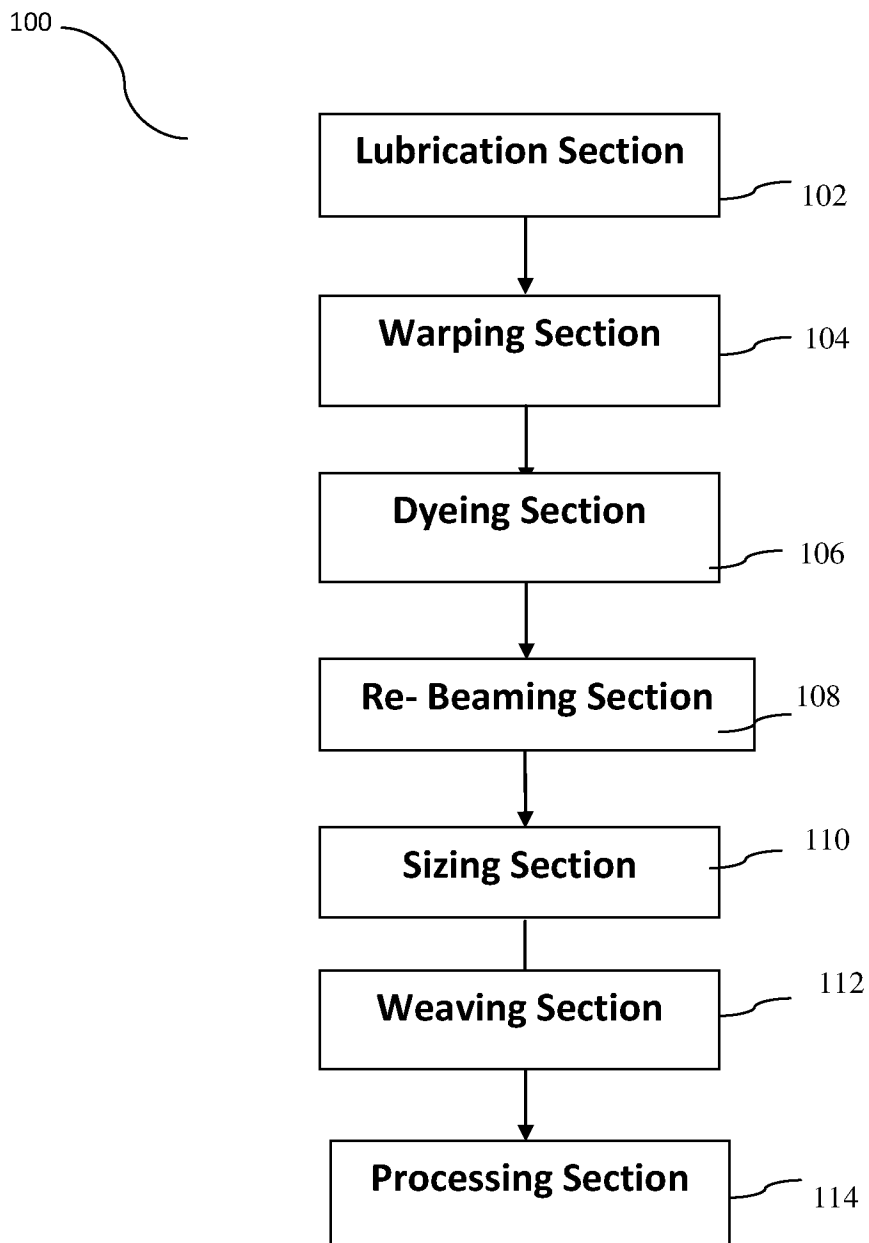


Figure 1

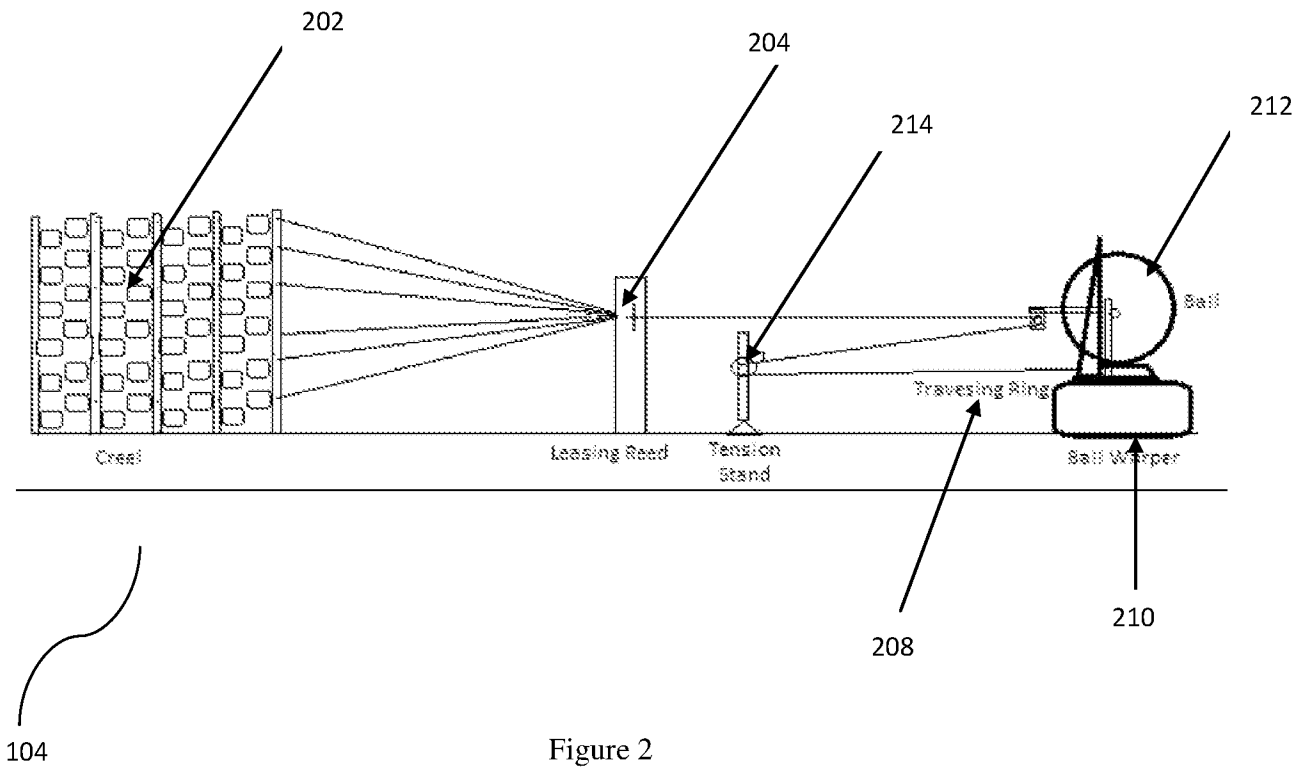


Figure 2

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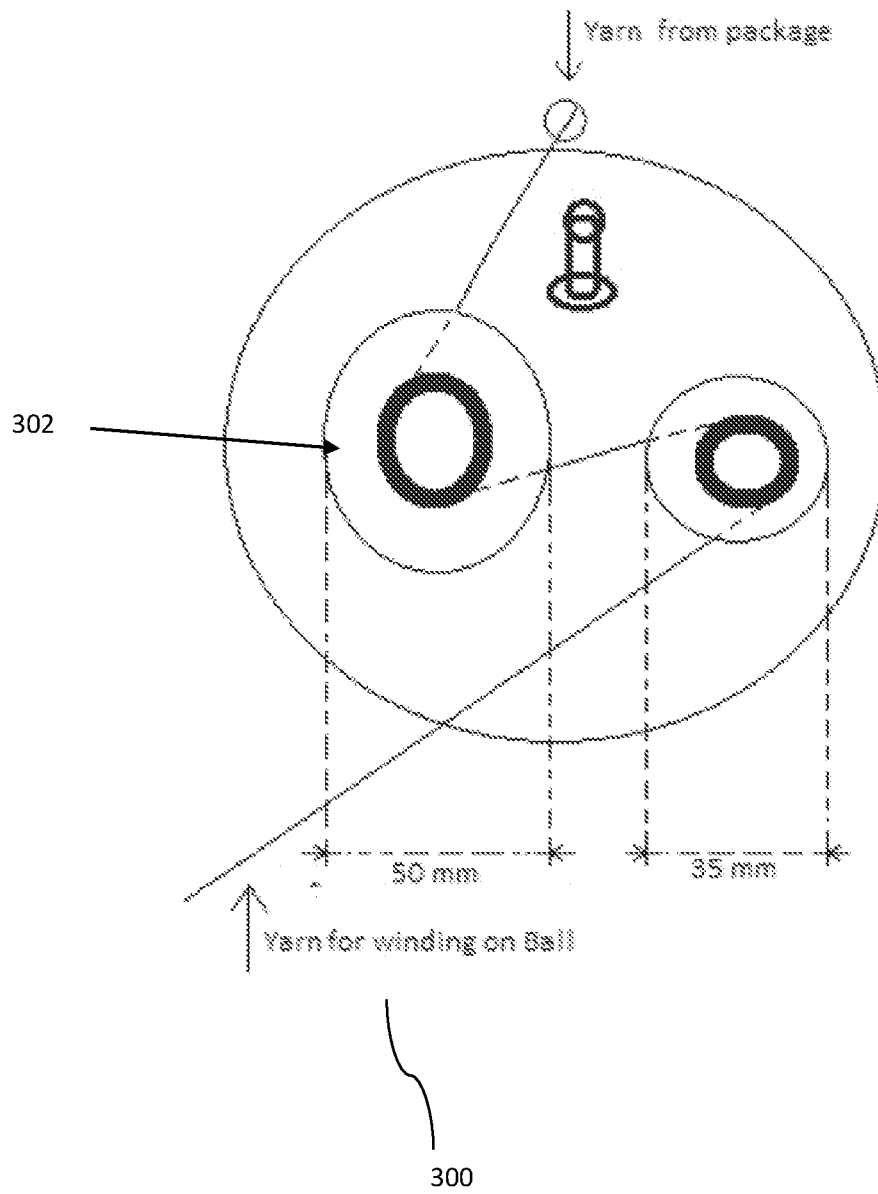


Figure 3

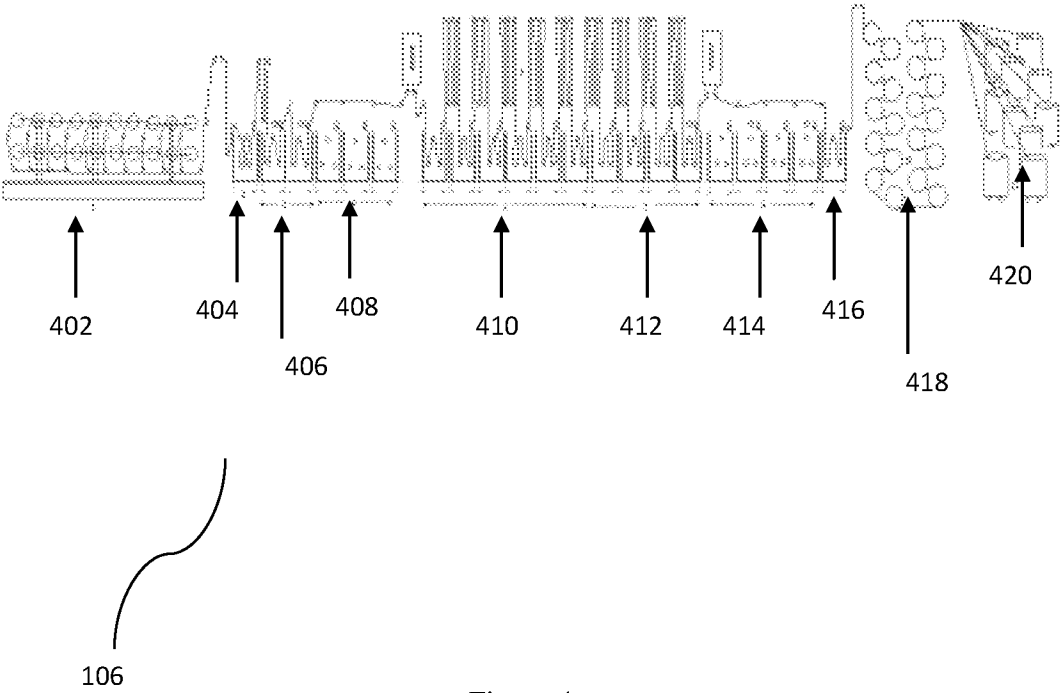


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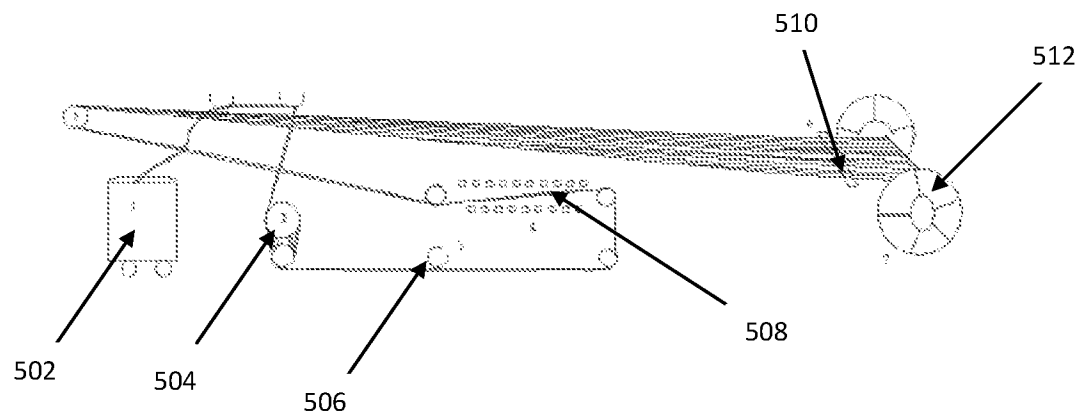


Figure 5

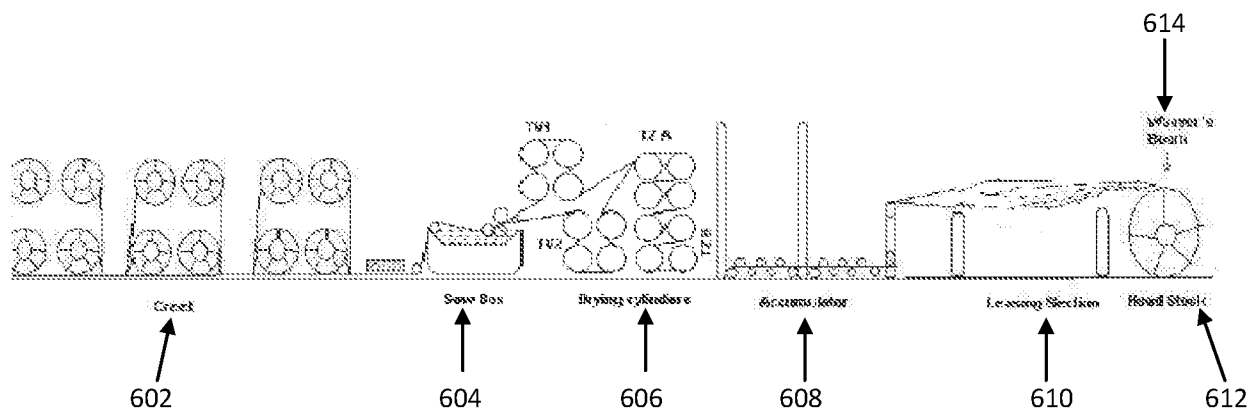


Figure 6

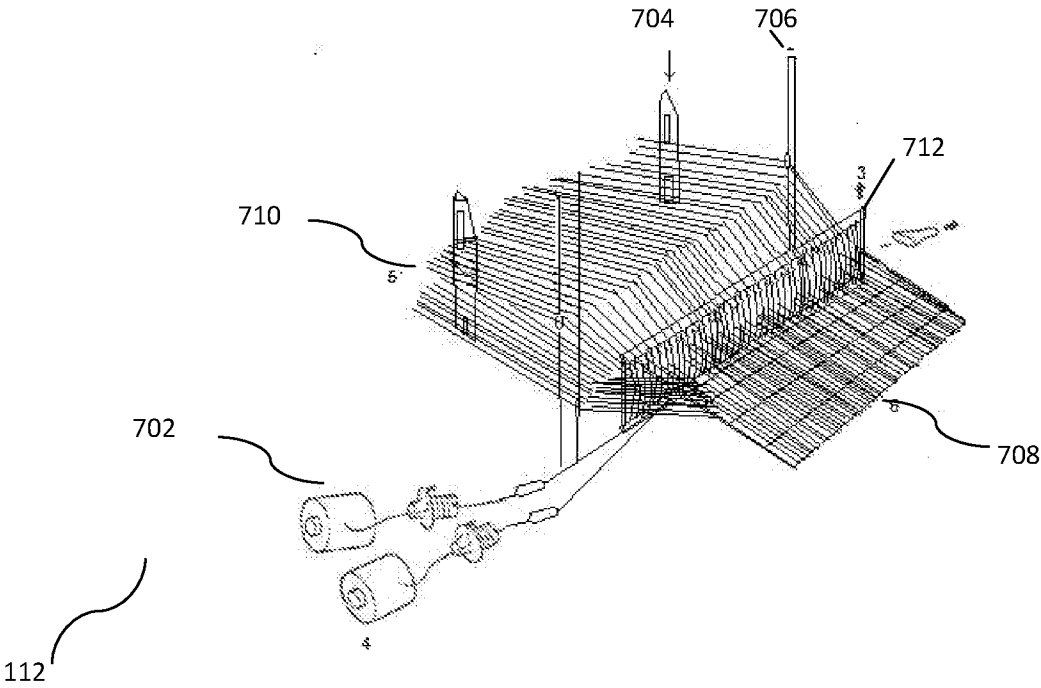


Figure 7

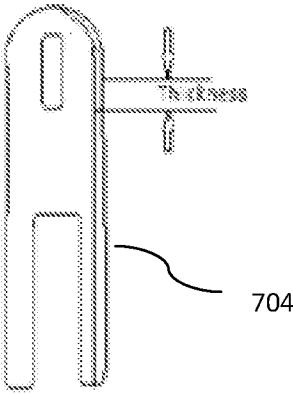


Figure 7A

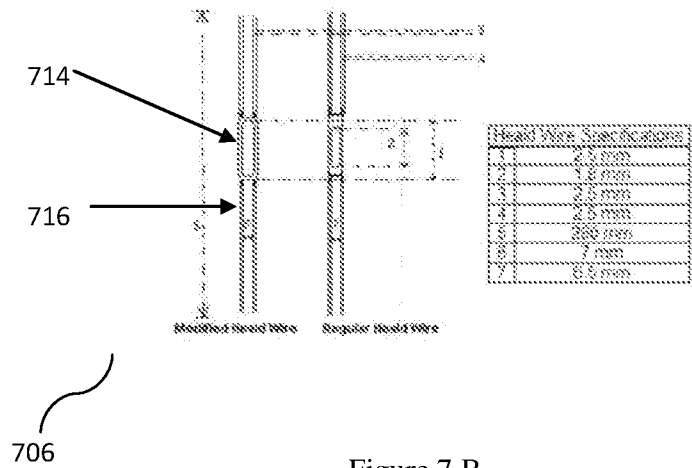


Figure 7 B

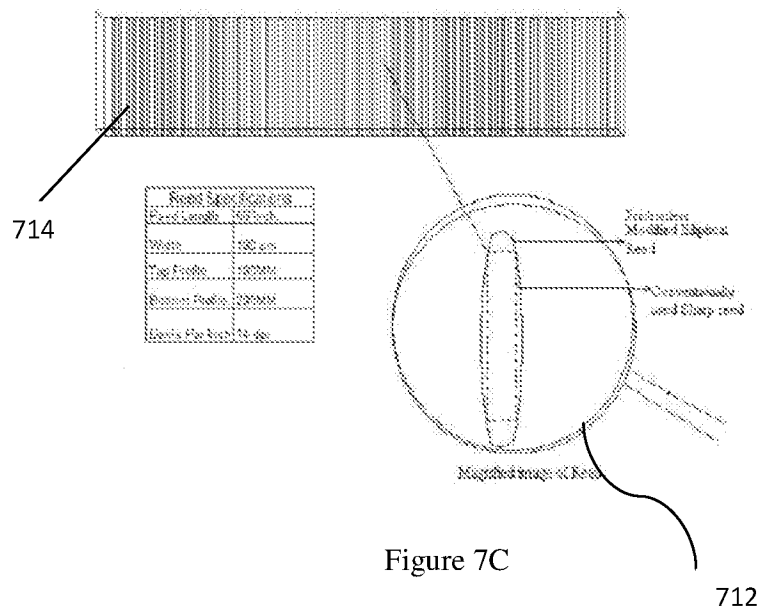
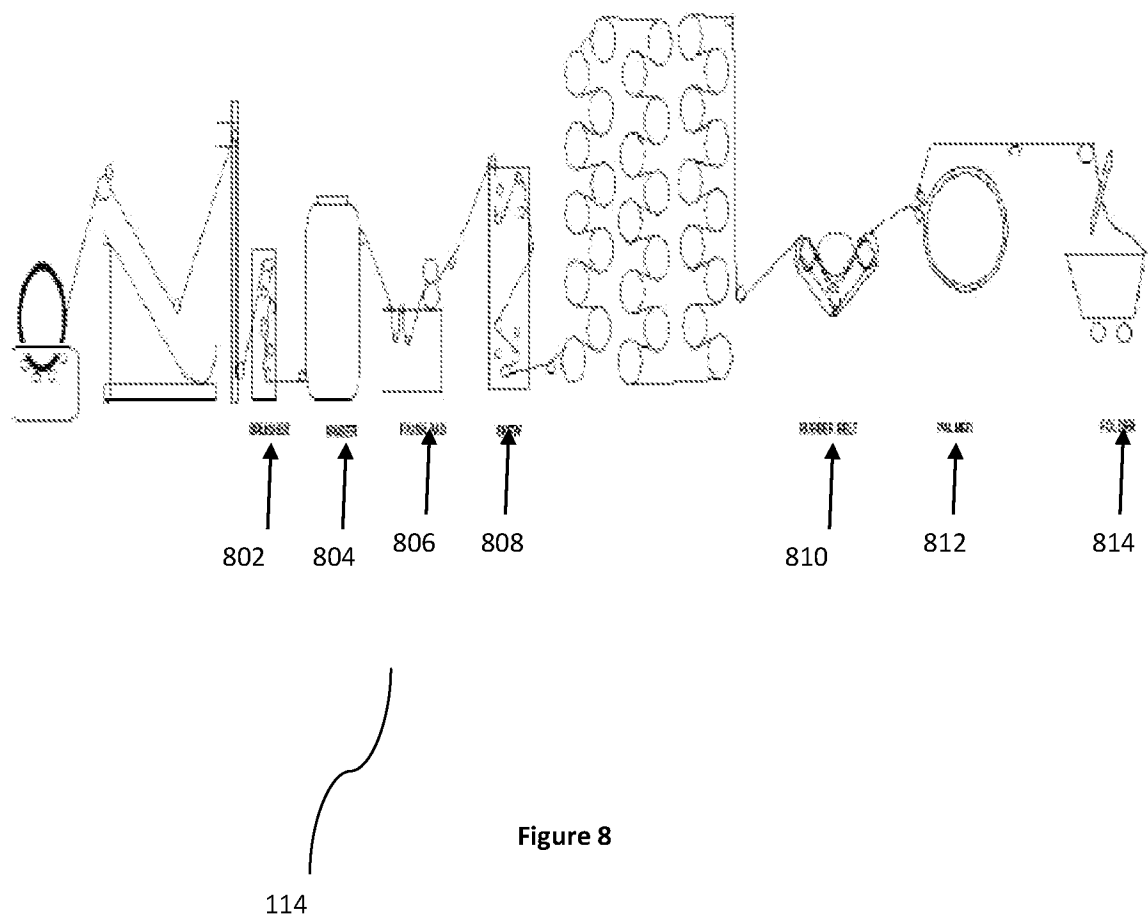


Figure 7C



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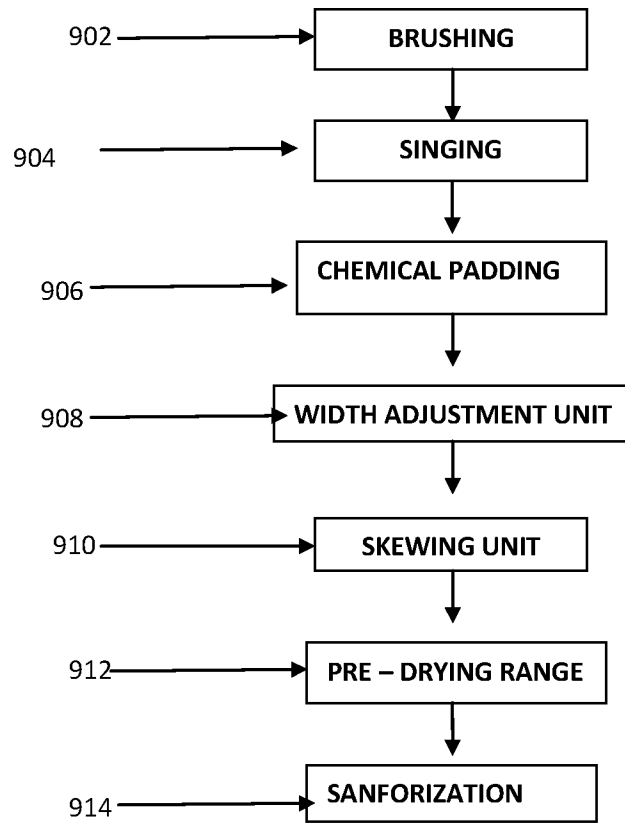


Figure 9