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(54) LOW TEMPERATURE FIBER SPINNING AND TEXTILE FINISHING METHOD

(57) Methods for spinning, weaving, and finishing fabric and/or cloth containing cotton fibers are disclosed. The methods of the invention are performed at lower ambient, solution and/or working temperatures than is previously known in the art. The reduced temperature processing improves various qualities of the resulting textile products and fabrics and lowers costs of operating the processing facility.

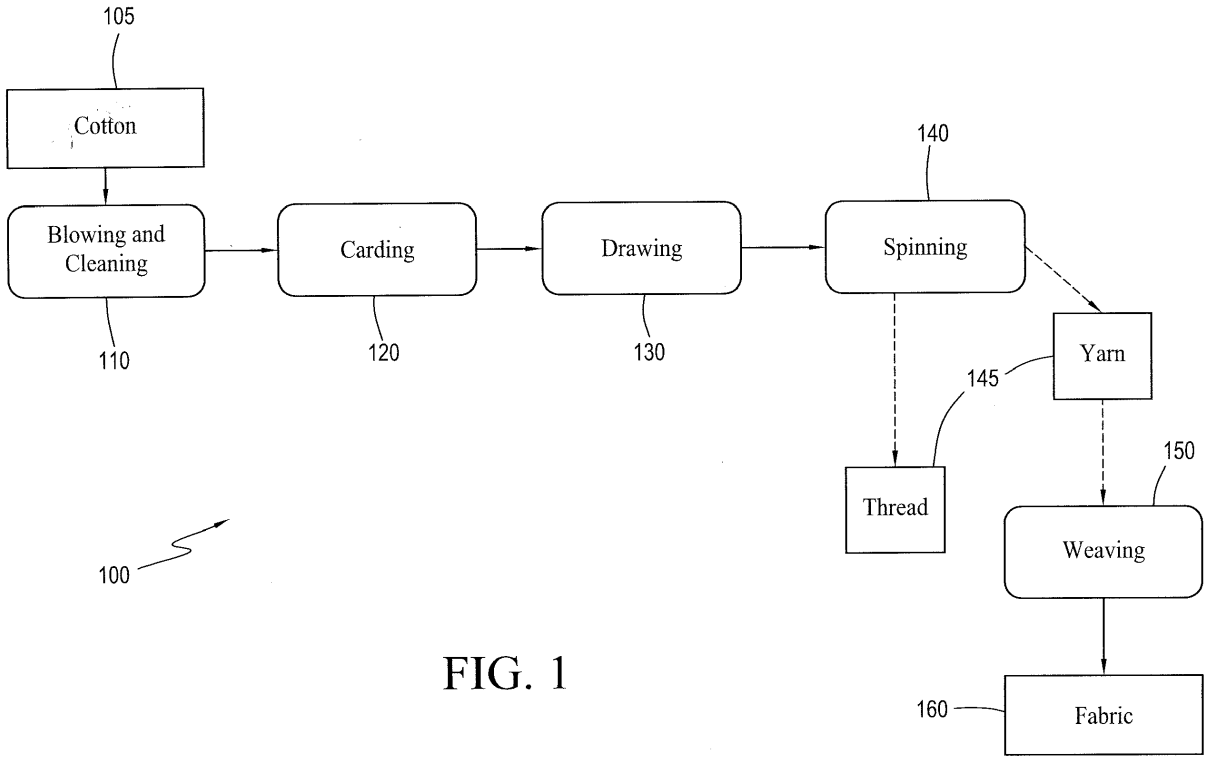

FIG. 1

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Description

BACKGROUNDOFTHEINVENTION

[0001] Embodiments of the present invention generally relate to methods for spinning textile fibers at low temperatures and finishing textiles at low temperatures. Said finishing includes low-temperature bleaching, low-temperature mercerizing, and/or low-temperature dyeing steps. The preferred fiber for the methods of the instant is cotton, but other textile fibers may also be used. The textiles may be composed of a single type of fiber, or may be a blend of fibers, preferably including cotton.

[0002] Processing raw fibers into usable textiles requires multiple steps. First, the raw fiber must be spun into usable thread or yarn, referred to herein as the "spinning step". Then the thread or yarn is woven into a textile, referred to herein as the "weaving step". Finally, the textile is finished. Each of these three steps includes multiple sub-steps, referred to herein as the "finishing step". The methods of this invention are improvements to the previously-known spinning and finishing steps.

[0003] The previously-known implementation of the spinning step generally includes blowing and cleaning, carding, drawing, simplex, spinning, and winding sub-steps. Some of these sub-steps may be omitted when using certain fibers or when producing certain types of thread or yarn. Spinning certain fibers and/or producing certain other types of thread and/or yarn may require additional substeps.

[0004] The previously-known implementation of the finishing step generally includes greige batching, singeing, desizing, scouring, bleaching, width setting, mercerizing, dyeing, finishing and sanforizing sub-steps. Some of these sub-steps may be omitted when using certain fibers or when the finished product is to have certain characteristics. Some additional sub-steps may be included when using certain fibers or when the finished product is to have certain characteristics.

[0005] The finishing sub-steps are used to give the finished textile desired finish, strength, and/or other qualities. The finishing sub-steps often rely on the completion of a previous sub-step, for example, dyeing a textile an even and vibrant color requires it first to be bleached to an even white.

[0006] Certain sub-steps are discussed further herein. Other than the modifications disclosed as part of an embodiment of the instant invention, when a sub-step is referred to herein, it is the form of the sub-step that is well-known in the textile arts.

[0007] Generally, the previously known and preferred modes of performing the spinning step and most sub-steps of the finishing step, particularly the bleaching step, mercerizing step, and/or the dyeing step are performed at a temperature significantly above the standard "room temperature" of approximately 21 degrees Celsius (71 degrees Fahrenheit). (Temperatures in degrees Celsius are hereinafter given as "C" and those in Fahrenheit as "F.") All temperature values given herein are intended to represent ranges and no particular value given is meant to exclude substantially similar temperatures in a range around the temperature given.

[0008] As an example, the spinning step is conventionally performed at a temperature of approximately 40-45C. Certain sub-steps of the finishing step are conventionally performed at even higher temperatures. For example, conventional bleaching is performed at approximately 100-102C, conventional mercerizing is performed at approximately 60-90C, and conventional dyeing is performed at 100-160C, depending on the dyeing process used.

[0009] The instant invention is directed to, *inter alia*, performing the spinning step and certain sub-steps of the finishing step, namely bleaching, mercerizing and dyeing, at substantially lower temperatures than conventional in the textile arts.

BRIEFSUMMARYOFTHEINVENTION

[0010] In one embodiment of a method of the instant invention, cotton is spun at a reduced temperature than the standard for industrial cotton spinning. The cotton may also be spun at higher revolutions per minute ("RPM") than is standard for industrial cotton processing.

[0011] In another embodiment of a method of the instant invention, textiles containing cotton are finished in a process including bleaching, mercerizing, and/or dyeing at a reduced temperature as compared to the standard temperatures for performing bleaching, mercerizing, and/or dyeing.

[0012] In a third embodiment of the instant invention, the first two embodiments are performed in sequence: cotton is spun as described, is then woven into a textile and that textile is finished, said finishing including bleaching, mercerizing, and/or dyeing at a reduced temperature as compared to the standard temperatures for performing bleaching, mercerizing, and/or dyeing.

[0013] Performing these steps at reduced temperatures has multiple benefits. Energy is saved because the spinning room, bleaching liquor, mercerizing solution, and dye do not require heating. The comfort and safety of workers is improved due to cooler ambient temperatures and absence of dangerously hot liquids. Additionally, there are significant improvements to the quality of thread and textile produced by the low-temperatures processes, as discussed more fully

herein.

[0014] The foregoing summary, as well as the following detailed description of preferred embodiments of the invention, will be better understood when read in conjunction with the appended drawings. For the purpose of illustrating the invention, there are shown in the drawings embodiments which are presently preferred. Dotted lines are used in the drawings for steps that are optional and either not considered an integral part of the depicted embodiment of the instant invention or that may be performed in the alternative. It should be understood, however, that the invention is not limited to the precise arrangements and instrumentalities shown. In the drawings:

FIG. 1 is a flowchart depicting the process flow of a method embodying the low-temperature spinning process of the present invention;

FIG. 2 is a flowchart depicting the process flow of a method embodying the low-temperature fabric finishing process of the present invention; and

FIG. 3 is a flowchart depicting the process flow of the preferred method of the present invention.

[0015] Where a term is provided in the singular, the inventors also contemplate aspects of the invention described by the plural of that term. As used in this specification and in the appended claims, the singular forms "a", "an" and "the" include plural references unless the context clearly dictates otherwise, e.g., "a machine" may include a plurality of machines. Thus, for example, a reference to "a method" includes one or more methods, and/or steps of the type described herein and/or which will become apparent to those persons skilled in the art upon reading this disclosure.

[0016] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. Although any methods and materials similar or equivalent to those described herein can be used in the practice or testing of the present invention, the preferred methods, constructs and materials are now described. All publications mentioned herein are incorporated herein by reference in their entirety. Where there are discrepancies in terms and definitions used in references that are incorporated by reference, the terms used in this application shall have the definitions given herein.

[0017] "Ambient temperature" as used herein refers to the approximate average and standard air temperature of the enclosure or area in which a given process is performed. The materials, machine, equipment, solution, and/or atmosphere immediately around a given machine or process may be outside a range given for ambient temperature without changing the ambient temperature.

[0018] Disclosed herein are methods for spinning cotton into thread and/or yarn at reduced ambient temperatures and finishing woven textiles comprised at least partially of cotton at reduced temperatures. As part of this method, thread, yarn, and or textiles with improved properties are produced under safer conditions and at reduced expense.

[0019] The instant method may be performed in a single facility, wherein cotton is processed from raw cotton to finished textile, or may be performed at separate facilities, wherein raw cotton is processed and spun into thread and/or yarn at a first facility, yarn is woven into textiles at a second facility, and/or the textiles are finished at a third facility. It is preferred that the method of the instant invention be performed at a single facility.

[0020] The preferred embodiment includes both spinning cotton and finishing textiles. However, in certain embodiments of the instant invention, only the low-temperature spinning is performed. In other embodiments, only the low-temperature finishing steps are performed.

[0021] The cold spinning process 100 of one method embodying the instant invention, as depicted in FIG. 1, includes a blowing and cleaning step 110, a carding step 120, a drawing step 130, a spinning step 140, and, in some embodiments, a weaving step 150. The aforementioned steps are, generally, performed as is well-known in the art, with the exception of the ambient temperature and, with respect to the spinning step 140, the spinning speed.

[0022] In the instant invention, the blowing and cleaning step 110, carding step 120, drawing step 130, and spinning step 140 are all performed at an ambient temperature of 25-30C, a temperature substantially less than the ambient temperature of 40-45C which is standard in the art for performing the corresponding steps of the standard spinning process. This reduced temperature permits spinning the fiber into yarn and/or thread at higher revolutions per minute without a corresponding increase in breakage of the cotton.

[0023] The blowing and cleaning step 110, carding step 120, and drawing step 130 of the cold spinning process 100 are performed as are standard in the art with the exception of the ambient temperature. Any machine or equipment known in the art for performing said steps may be used to perform said steps as part of the method of the instant invention. The steps may be performed in separate rooms of a facility or may be performed on machines disposed in a single room of a spinning facility, which may be part of a larger spinning, weaving, and/or finishing facility. Other fabric processes, such as embroidering, may also be performed in such a facility.

[0024] The blowing and cleaning step 110 processes raw and/or unspun cotton 105 into opened clean fibers and/or tufts as is known in the art. The carding step 120 completes the cleaning of the cotton and separates and aligns the fibers as is known in the art. The drawing step 130 evens the lengths of the fibers as is known in the art.

[0025] In the spinning step 140, the cotton fibers are spun into thread and/or yarn 145 on an open-ended spinning

machine 350. In the instant invention, the spinning step 140 is preferably performed at 25-30 degrees Celsius and is performed at up to 150,000 RPM, substantially faster than standard spinning processes in the art, which are performed at 20,000 RPM. Additionally, the spinning step 140 does not require the generally-required rewinding process of most spinning processes known in the art.

[0026] The increased revolutions per minute used in the spinning step 140 combined with the reduced ambient temperature provides multiple benefits as compared with the conventional process as known in the art. In particular, the yield of the spinning process 100 is 5% greater than that of the conventional process: the instant spinning process 100 has an approximately 88% yield by weight as opposed to a yield of 82-84% by weight in the conventional process. Yarn 145 produced using the instant spinning process 100 also has a reduced imperfection index ("IPI") and reduced hairiness as compared to conventionally produced yarns.

[0027] A variety of weights and types of yarns and/or threads 145 can be produced in the spinning process 100 of the instant method including, without restriction, 20/1 yarn for weaving. **TABLE 1**, below, lists the characteristics of 20/1 yarn produced using the conventional process and the method of the instant invention.

TABLE 1

Characteristics of 20/1 Carded Yarn

Yarn Characteristic	Value		
	Min / Max	New Method	Conventional Process
Yarn Count & Twist			
Deviation of Count	Max	20+ /-2.5%	20+ /-2.5%
Count Variation CVcb(%)	Max	1.8	1.8
Twist Multiplier alpha e	Max		4.4
Variation of twist CVt(%)	Max		3
Direction of twist		Z	Z
Yarn Evenness & Hairiness			
Evenness Uster CVm(%)	Max	14.5	15
Thin Places - 50% (1 /Km)	Max	14	12
Thick Places +50% (1 /Km)	Max	75	140
Neps	Max	20 (+280% 1/km)	160 (+200% 1/km)
Hairness	Range	4.0-6.1	5.3-7.6
CV Hairness (%)	Max	4	4
Yarn strength & Elongation at Conventional test speed 5m/min			
Single End Strength (cN/tex)	Min	12	17
Strength Variation CVb (%)	Max	8.2	8.5
Single End Elongation (%)	Min	5.6	5.5
Yarn strength & Elongation at High test speed 400m/min			
Single End Strength (cN/tex)	Min	13.5	19
Strength Variation CVb (%)	Max	8.9	9.2
Single End Elongation (%)	Min	5	5

[0028] Once the thread and/or yarn 145 is spun it may be sold and/or stored as-is. It may also be woven in the same or another facility in a weaving step 150. Preferably, the weaving step 150 is performed at an ambient temperature of 25-30C, a relative humidity of 75%-78%, and otherwise performed as is standard and well-known in the industry. Processing at a lower temperature as in the other steps of the spinning process 100 of the instant invention allows the weaving step 150 to be performed in the same facility as the other steps of the spinning process 100 and has similar benefits to the working environment. Additionally, less fluff is produced as compared to conventional weaving processes performed

at higher ambient temperatures and/or using thread and/or yarn produced using conventional processes. The reduction in fluff improves cleanliness of the spinning and weaving facility and reduces the health and safety risks related to increased fluff in such a facility, including, without restriction, fire risks.

[0029] Following the weaving step 150, the fabric 160 woven in the weaving step 150 may be finished using any finishing process known in the art. Preferably, however, the fabric 160 woven in the weaving step 150 is then finished using the cold-finishing process 200 of the instant invention as shown in FIG. 2. The full preferred method of the instant invention, including the cold spinning process 100 including the weaving step 150, followed by the cold finishing process 200, is shown in FIG. 3. The cold-finishing process 200 of the instant invention may be performed on any fabric 205 including, alternatively and without restriction, fabric 160 produced using the cold-spinning process 100, fabric produced using conventional spinning and/or weaving processes and/or on fabric produced by weaving, at conventional temperatures, yarn 145 produced using the cold spinning process 100.

[0030] The cold-finishing process 200 may be, without restriction, performed in the same facility as the spinning process 100 and or weaving step 150, performed in a different facility, or may be performed on stored fabric or purchased fabric at a specialized fabric-finishing facility. The ambient temperature of the fabric finishing facility is not restricted.

[0031] The cold finishing process 200 includes, preferably, a cold bleaching step 210, cold mercerizing step 220, cold dyeing step 230. The cold finishing process 200 also includes washing steps 240 and 260 following the cold bleaching step 210 and the cold dyeing step 230, respectively. The entire finishing process as depicted in FIG. 3 may include steps in addition to the cold finishing process 200. It is preferred that the cold bleaching step 210, cold mercerizing step 220, and cold dyeing step 230 all be performed, but the instant invention also includes embodiments of the cold finishing process 200 wherein one of said steps is omitted and embodiments wherein two of said steps are omitted.

[0032] The preferred embodiment of the cold finishing process 200 also includes a greige batching step 310 and singeing step 320. The greige batching step 310 and the singeing step 320 may be omitted, but if included are performed first. If the greige batching step 310 and singeing step 320 are performed, they are performed as is well-known and standard in the textile arts. If they are not performed, the cold bleaching step 210 is performed first. If the greige batching step 310 is performed and the singeing step 320 is performed, the cold bleaching step 210 is performed thereafter.

[0033] The cold bleaching step 210 is performed by immersing the fabric 205, through padding, in a bleaching liquor and rotating it in said bleaching liquor for 8-10 hours, said bleaching liquor being maintained at approximately 35C-40C. The constituents of the bleaching liquor are given in **TABLE 2** with the acceptable concentration range for each and the concentration for use in the preferred embodiment of the cold bleaching step 210 of the instant invention. For each constituent of the bleaching liquor, the preferred compound or chemical for use as that constituent is listed in parentheses, but any chemical or compound known in the art to be suitable for use with cotton fibers and fulfills that function may be used, without restriction. The formulation herein may be adjusted to produce desired whiteness levels, desizing as measured by the TEGEWA scale, and/or capillary properties as desired for the finished product or as required for later steps in the instant cold finishing process 100.

TABLE 2

Ingredient	Concentration Range	Preferred Concentration
Hydrogen peroxide (50%)	70-90 g/l	80 g/l
Caustic Soda 48 Be	50-70 g/l	60 g/l
Sodium Silicate 38 Be	20-40 g/l	30 g/l
Wetting Agent (Lavoton RGA, NonIonic/Anionic)	4-8 g/l	6 g/l
Sequestering Agent (Heptol BNF, Anionic)	1-3 g/l	2 g/l
Stabilizer (Contavon DSP, Anionic)	4-8 g/l	6 g/l
Oxidative Desizer (Sodium persulphate)	0.5-1.5 g/l	1 g/l

[0034] The cold bleaching step 210 as described herein replaces the need for separate scouring and desizing steps as required in conventional fabric finishing. This reduces the complexity of the instant cold finishing process 200and reduces time required to perform the instant cold finishing process 200.

[0035] Following the cold bleaching step 210, the preferred embodiment of the invention includes a first washing step 240 and width setting step 250. The first washing step 240 is necessary to the invention, but the width setting step 250 may be omitted. The first washing step is performed by washing the bleached fabric 205 in washing solution, preferably but without restriction water, maintained at 85-95C, preferably at 90C. The width setting step 250, if performed, is performed as is well-known and standard in the art.

[0036] After the first washing step 240 and, if included, the width setting step 250, the preferred embodiment of the invention includes a cold mercerizing step 220. The cold mercerizing step 220 is performed by immersing the fabric 205 in a caustic soda solution of 26 to 32 degrees Baume (hereinafter, "Be"), maintained at 15 to 18C. The caustic soda (Sodium Hydroxide/NaOH and referred to herein as "caustic soda") solution is preferably 30 Be. Fabric containing cotton fibers and mercerized as described herein as the cold mercerizing step 260 has superior characteristics to fabric containing cotton fibers mercerized in the standard process, which is performed at temperatures of 60C-90C.

[0037] Following the cold mercerizing step 220, the preferred embodiment includes a cold dyeing step 230. Proceeding to the cold dyeing step 230 without including an additional width setting step, as is required in the conventional and well-known fabric finishing processes, increases efficiency of the fabric finishing process. The cold dyeing step 230 is performed by immersing at least a portion of the fabric 205, through padding, in dye liquor maintained at 20C-25C. Preferably, all of a given piece of fabric 205 is immersed. The dye liquor in the preferred embodiment of the cold dyeing step 230 includes a dye having at least one vinyl sulphone reactive group, but other dyes appropriate for fabrics including cotton fibers may be used. Example dyestuffs commonly available and known in the art that are suitable for use in the cold dyeing step 230 include, without restriction, Bezaktiv (V/S range) Jakazol (VS/HLF/CE/DS/VS/ME range), and Everzol (ED/LX/LF range). The fabric 205 is held in the dye liquor for approximately 16 hours, and is rotated during the period it is held in the dye liquor.

[0038] After the cold dyeing step 230, the fabric 205 is subjected to a second washing step 260 to remove excess dye liquor. The second washing step 260 is performed using water at 85 - 95C, and preferably at 90C. The fabric 205 may be optionally treated with additional finishing steps 330 such as, without restriction, Sanforizing, Calendering, and/or other fabric finishing processes. These additional finishing steps 330 may be performed, without restriction, at ambient temperatures or at the temperatures well-known in the art for the performance of such steps.

[0039] When the full preferred embodiment of the cold finishing process 200 of the instant invention is used, that is, the fabric 205 is finished using the cold bleaching step 210, the cold mercerizing step 220, and the cold dyeing 230 step, the characteristics of the finished fabric are improved as compared to fabric finished using an industry-standard fabric finishing process. **TABLE 3**, below, gives the specifications of cotton fabric finished using the preferred embodiment of the cold finishing process 200 of the instant invention.

TABLE 3

Test		**Specifications**
Yarn Count		
ISO 7211-5	Warp (Ne)	20 (+/-5.0%)
	Weft (Ne)	20 (+/-5.0%)
Fabric Count		
ISO 7211-2	Ends/Inch	60 (+/-4.0%)
	Picks/Inch	60 (+/-4.0%)
Fabric Weight		
ISO 3801	Gm/m2	140(+/-5.0%)
	Oz/yd2	---
Pilling Resistance		
ISO 12945-2	Rating	>3
@ 2000 Cycles		
Tensile Strength		
ISO 13934-1	Warp(N)	≥ 250.0 N
	Weft(N)	≥ 250.0 N
Tear Strength		
ISO 13937-2	Warp(N)	≥8.0 N
	Weft(N)	≥8.0 N
Dimensional Stability to Wash		

(continued)

Test		Specifications
ISO 6330	Warp	+2%/-5%
	Weft	+2%/-5%
Formaldehyde		
ISO 14184-1		≤ 20.0ppm
Flammability		
16 CFR 1610		≥ 7.1 sec
Colorfasntess to Light		
ISO 105 B02	Rating	≥ 4-5
Colorfastness to Rubbing		
ISO 105 X12	Dry	≥ 4-0
	Wet	≥ 3-0

[0040] Fabric finished using the cold finishing process 200 may be used for any purpose fabric containing cotton fibers is used for in industry, fashion, and/or any other field.

[0041] Although the present invention has been described in relation to particular embodiments thereof, many other variations and modifications and other uses may become apparent to those skilled in the art. It is preferred, therefore, that the present invention be limited not by this specific disclosure herein, but only by the appended claims.

Claims

1. A method for manufacturing yarn or thread including cotton fibers, comprising:

   spinning cotton fibers into yarn or thread at an ambient temperature of 25-30 degrees Celsius.

2. The method of claim 1 wherein spinning the cotton is performed at greater than 50,000 revolutions per minute, such as at approximately 150,000 revolutions per minute.

3. A method for manufacturing yarn or thread including cotton fibers, comprising:

   blowing and cleaning unspun cotton at an ambient temperature of 38-40.5 degrees Celsius;
   then carding said cotton at an ambient temperature of 38-40.5 degrees Celsius;
   then drawing said cotton at an ambient temperature of 38-40.5 degrees Celsius; and
   then spinning said cotton into yarn or thread at an ambient temperature of 25-30 degrees Celsius.

4. The method of claim 3 wherein spinning the cotton is performed at greater than 50,000 revolutions per minute, such as at approximately 150,000 revolutions per minute.

5. A method for manufacturing fabric including cotton fibers, comprising:

   weaving yarn containing cotton fibers into a fabric at an ambient temperature of 25-30 degrees Celsius.

6. The method of claim 5, further comprising:

   immersing said fabric for between 8 and 10 hours in a bleaching liquor maintained at 35 to 40 degrees Celsius; and
   washing said fabric in a washing solution maintained at 85 to 95 degrees Celsius,
   wherein said washing solution is optionally water; and optionally further comprising immersing said fabric in a 26 to 32 degree Baume solution, such as a 30 degree Baume solution, of caustic soda maintained at 15 to 18 degrees Celsius.

7. The method of claim 6, further comprising:

immersing at least a portion of the fabric in a dye liquor bath maintained at 20 to 25 degrees Celsius;
rotating said fabric in said dye liquor bath for approximately 16 hours; and washing said fabric in water maintained at 85 to 95 degrees Celsius, such as approximately 90 degrees Celsius.

8. A method for manufacturing fabric including cotton fibers, comprising:

blowing and cleaning unspun cotton at an ambient temperature of 38-40.5 degrees Celsius;
then carding said cotton at an ambient temperature of 38-40.5 degrees Celsius;
then drawing said cotton at an ambient temperature of 38-40.5 degrees Celsius; then spinning said cotton into yarn at an ambient temperature of 25-30 degrees
Celsius; and
then weaving said yarn into a fabric at an ambient temperature of 25-30 degrees Celsius.

9. The method of claim 8, further comprising:

immersing said fabric for between 8 and 10 hours in a bleaching liquor maintained at 35 to 40 degrees Celsius; and washing said fabric in a washing solution maintained at 85 to 95 degrees Celsius,
wherein said washing solution is optionally water; and optionally further comprising immersing said fabric in a 26 to 32 degree Baume solution, such as a 30 degree Baume solution, of caustic soda maintained at 15 to 18 degrees Celsius.

10. The method of claim 9, further comprising:

immersing at least a portion of the fabric in a dye liquor bath maintained at 20 to 25 degrees Celsius;
rotating said fabric in said dye liquor bath for approximately 16 hours; and
washing said fabric in water maintained at 85 to 95 degrees Celsius, such as at approximately 90 degrees Celsius.

11. A method of processing fabric containing cotton fibers comprising:

immersing said fabric for between 8 and 10 hours in a bleaching liquor maintained at 35 to 40 degrees Celsius; and washing said fabric in a washing solution maintained at 85 to 95 degrees Celsius,
wherein the washing solution is optionally water; and optionally further comprising immersing said fabric in a 26 to 32 degree Baume solution, such as a 30 degree Baume solution, of caustic soda maintained at 15 to 18 degrees Celsius.

12. The method of claim 11, further comprising:

immersing at least a portion of the fabric in dye liquor maintained at 20 to 25 degrees Celsius;
rotating said fabric in said dye liquor for approximately 16 hours; and washing said fabric in water maintained at 85 to 95 degrees Celsius, such as at approximately 90 degrees Celsius.

13. The method of any of claims 7, 10 or 12 wherein said dye liquor includes a dye having at least one vinyl sulphone reactive group, wherein said dye is optionally selected from the group consisting of Bezaktiv dyes, Jakazol dyes, and Everzol dyes.

14. The yarn or fabric produced by the methods of claim 1, claim 8 or claim 10.

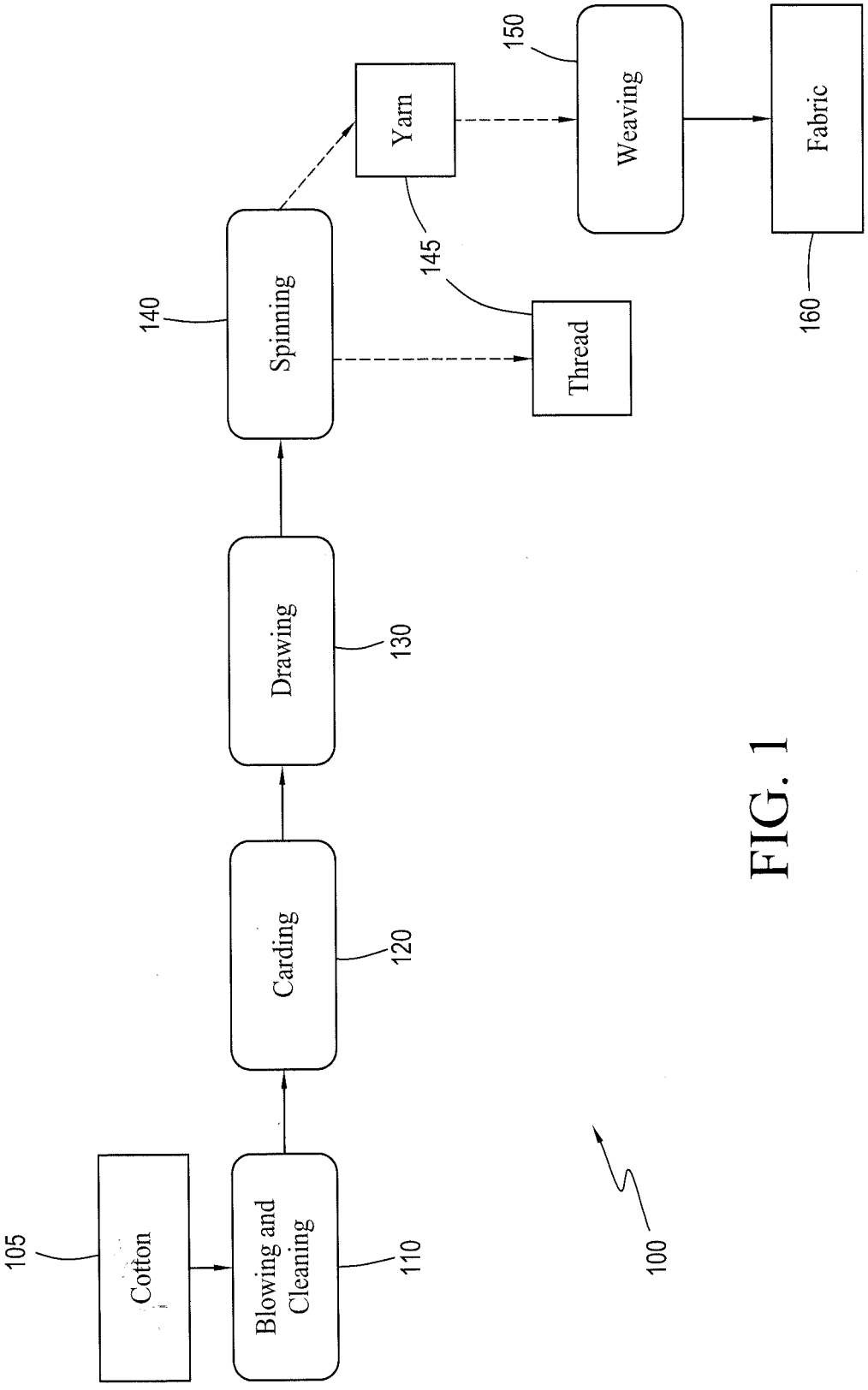
105
Cotton
Blowing and Cleaning
110
Carding
120
Drawing
130
140
Spinning
Yarn
145
Thread
150
Weaving
Fabric
160
100

FIG. 1

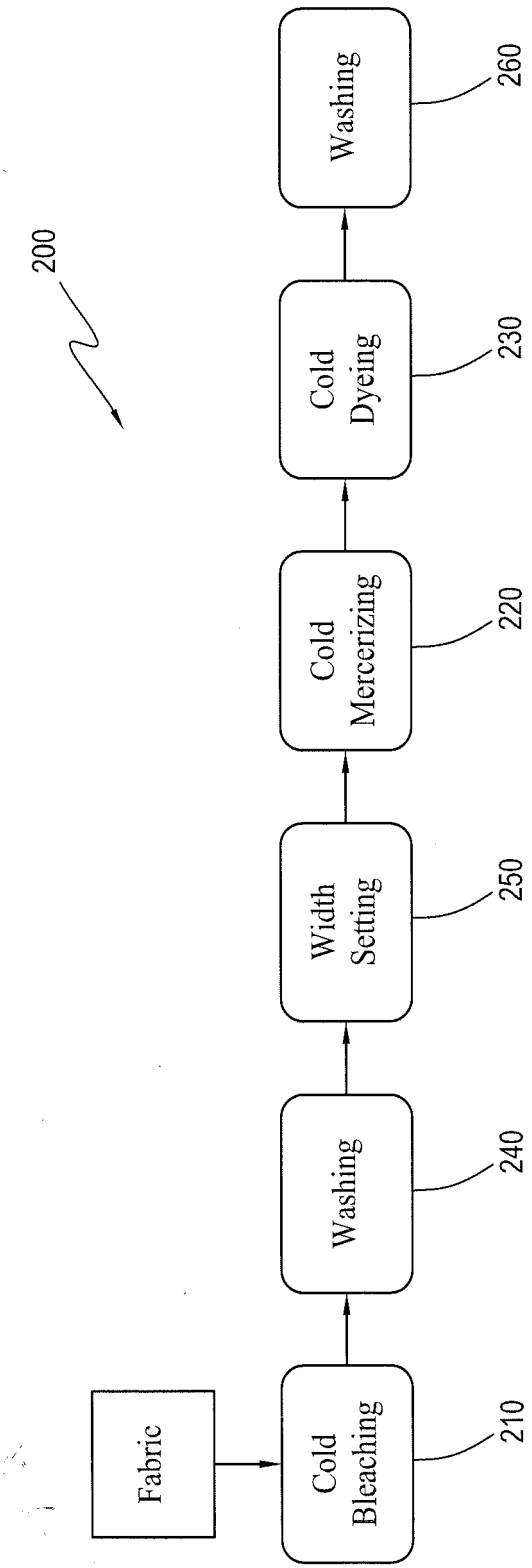
200
Fabric
Cold Bleaching
210
Washing
240
Width Setting
250
Cold Mercerizing
220
Cold Dyeing
230
Washing
260

FIG. 2

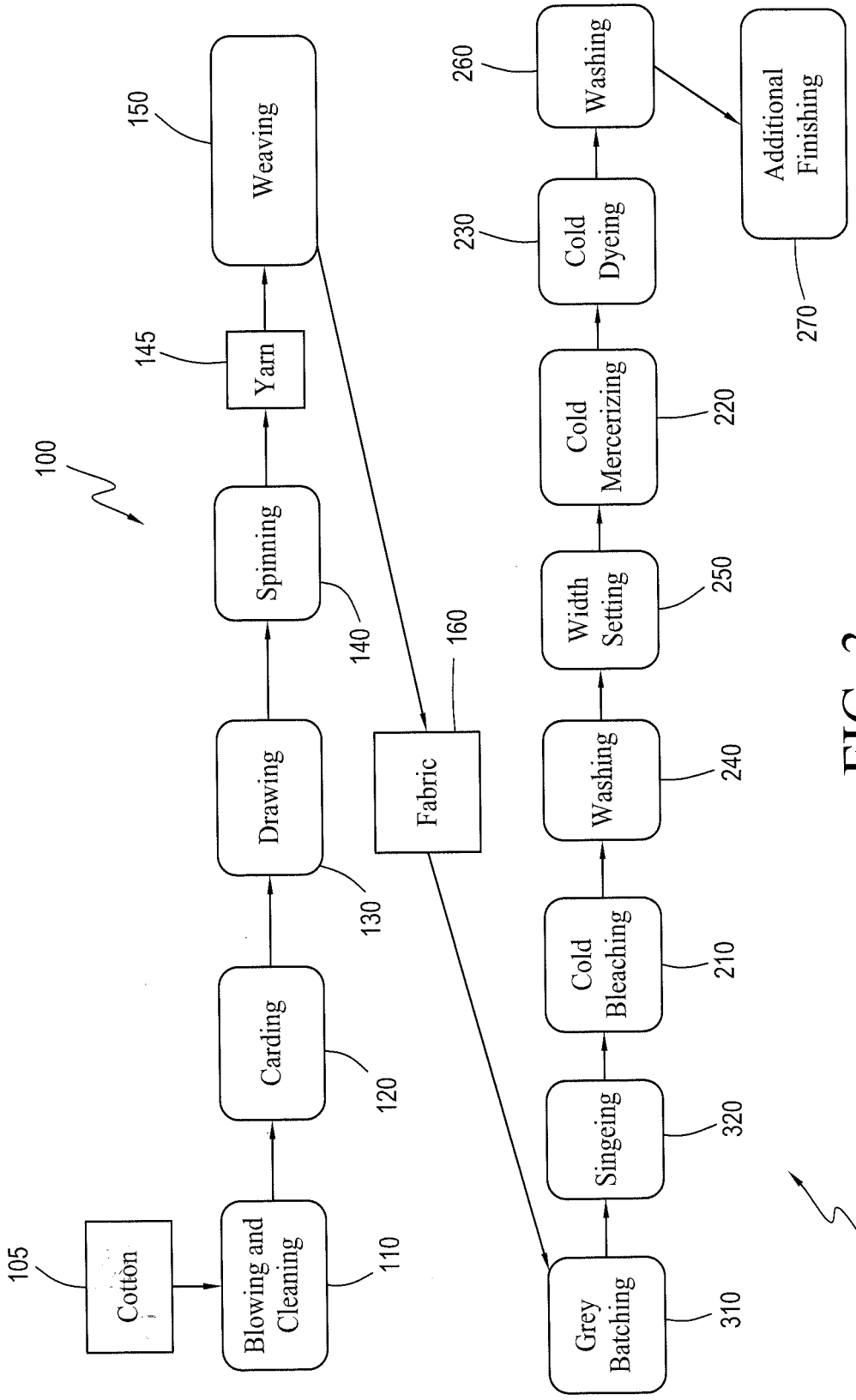
100
105
Cotton
110
Blowing and Cleaning
120
Carding
130
Drawing
140
Spinning
145
Yarn
150
Weaving
160
Fabric
300
310
Grey Batching
320
Singeing
210
Cold Bleaching
240
Washing
250
Width Setting
220
Cold Mercerizing
230
Cold Dyeing
260
Washing
270
Additional Finishing

FIG. 3