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(54) **Environmentally friendly non-bleed polyester fabric and method of manufacturing the same**

(57) A method of manufacturing a polyester fabric with inherent color, the method including: providing a polyester fiber with inherent color; spinning polyester yarn from the fiber with inherent color; knitting the colored polyester yarn into knitted fabric which can combine with other yarn according to a requirement; washing the colored polyester fabric and heat-setting the fabrics with add-on functional finish to the fabric. The providing of polyester fiber with inherent color may include: cleaning and

drying polyester bottles; recycling polyester chips from clean bottles; mixing chips with pigment evenly and melting the chips with pigment; extruding the filament fiber with color; and drawing and cutting filament fiber into staple fiber. Further aspects of the present invention are directed to a colored polyester fabric and a method of manufacturing an article of clothing using a colored polyester fabric produced using the above-described method.

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Description

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of U.S. Provisional Application No. 61/874,934, filed on September 6, 2013 in the United States Patent and Trademark Office, the entire content of which is incorporated herein by reference.

FIELD

[0002] Aspects of embodiments of the present invention relate to a polyester fabric, a method of manufacturing a polyester fabric, and a method of manufacturing an article of clothing.

BACKGROUND

[0003] The textile manufacturing industry has for many decades been involved in heavy environmental pollution. This is mainly related to the need to color (dye) fabrics with chemicals, which in traditional dyeing methods are applied with dye stuffs put into dye baths and then dyeing by immersing the fabric into the colored water. The dye bath process is repeated multiple times for each dye lot, with the wastewater of each dye bath becoming wastewater. The cotton industry has relied on this way of coloring textiles over many decades, generating enormous amounts of wastewater. In discovering the very negative side effects of polluting wastewater, increasingly stringent regulations for wastewater treatment requirements have been demanded by governments and populations.

[0004] Synthetic fabrics such as polyester have in addition to the above problem also been faced with color migration issues from dyeing, such as "bleeding color" from one product to another in the washing machine, or one panel to the other on a garment style, or bleeding into the printed ink numbers on the back of an athletic wear (e.g., a basketball shirt).

[0005] As such, there has long been a need for a textile manufacturing process, in particular, in the athletic performance and team wear industry, to reduce the use of water and to overcome migration of color.

SUMMARY

[0006] Aspects of the present invention are related to the manufacturing processes along the whole supply chain, from source of raw material to end product.

[0007] Recycled polyester materials have emerged to be applied increasingly to consumer product manufacturing in the recent past. Such products are made by using polyester raw chips derived from recycled polyesters often without much restriction of the source of the recycled polyester materials. Such widely available recycled polyester raw materials contain crude impurities. Using such crude open source recycled polyester mate-

rials reduces the possibility of desirable performance of the filament fiber formed and hence any useful finishing application in base layer clothing category articles. According to an aspect of the present invention, in making base layer textile clothing materials, key steps have been identified along the entire supply chain manufacturing processes for the fabric to be developed with the specifically desired characteristics.

[0008] Filament fiber is originally produced from the recycled polyester chips and is subsequently cut into short staple fibers, and then spun into yarns (from the short staple fiber). The yarns are usually quite coarse (too coarse to be worn), and in order to be useful require a new process to produce a fabric soft enough to wear.

[0009] The present invention facilitates the use of polyester materials, such as recycled polyester materials, into a much softer fabric, making it suitable for the end use of a variety of base-layer garments, such as underwear, T-shirts, polo-shirts, etc., while achieving a much more environmentally friendly production process by a dramatic reduction of water, energy and chemical use, compared to traditional and current fabrics production methods.

[0010] To begin, this new process uses polyester raw chips, such as polyester raw chips narrowly selected and obtained from recycled polyester bottles. The bottles must be well cleaned in order to get consistent and high-quality recycled polyester chips. Alternatively, the polyester raw chips may be obtained from polyester bottles or polyethylene terephthalate (PET) chips. The polyester raw chips are loaded in a large tank where a melting and bleaching process is carried out at 260-285 °C. After the bleaching process, pigment color chips are loaded into the tank and melted together at 260-285 °C in the filament fiber formation stage to obtain already colored filament. Then the fiber is extruded at 270-285 °C from the spinneret in the form of colored filament.

[0011] The filament fiber will be well oiled and drawn to achieve optimal strength. The filament is then softened at normal temperature and then heat set to stabilize its properties. This is then followed by crimping the fiber. The crimping process is by mechanical molding to give crimp to the original straight filament. After that, the curled fiber will be heat set again and cut into proper size, for example 38 mm in length. The polyester staple fiber with inherent color is then formed. A number of color matching challenges have been overcome by engineering modifications to the very sensitive and difficult filament color matching process. Normal recycled polyester fibers are colored with available primary color raw chips so the colors are very limited and not able to hit specific colors. The process of the present invention involves mixing of primary color pigment raw chips with high sublimation resistance colorant under the monitor of Data Color CMC evaluation to control the LAB value so as to obtain delta E value within 1.0 against specific color standard.

[0012] The staple fiber with inherent color will go through a combing process to become slivers and will

then be drawn to make roving on a roving frame. Roving will be attenuated and twisted to form knitting yarn with higher twist at 370-390 twist factor instead of a normal 300-320 twist factor on the spinning frame so as to achieve better piling and cleaner surface. This polyester knitting yarn therefore achieves an inherent color with less hairy surface and higher strength. A single yarn spun under a normal twist factor of 320 has yarn strength of 350CN, whereas, according to embodiments of the present invention, under a twist factor of 370-390 a much higher yarn strength of 400CN is obtained for achieving a soft hand feel in the finishing process.

[0013] The now already colored staple fiber has been spun into yarn with a modified spinning technique by applying a higher twist factor of 370-390 instead of the normal 320 to give much stronger, cleaner, less hairy and softer yarn. These yarns are then knitted into a lightweight fabric with desirable stretch and recovery performance. The elongation at weft direction is set at 130% and wrap direction at 60% and recovery is over 96% under ASTM D2594 testing method. The above steps in coloring yarn have now completely eliminated the need for the heavy polluting traditional dyeing process.

[0014] The lightweight inherently colored knitted fabric of the present invention is then put through a customized washing process. A normal dyeing process takes much higher temperature at 130 °C and exhaustion time of about 7 hours, whereas according to the present invention, the fabric is pretreated and rinsed under low temperature of 45-55 °C and short washing time of 15-20 minutes so as to give a soft and comfortable hand feel as the much shorter washing cycle at much lower temperature causes less degradation on the hand feel of the fabric. In order to retain this soft hand feel, the polyester fabric is put through a stenter in a differently engineered way. Normal polyester fabric dyed with disperse dye which has a sublimation problem needs to be pre-heat set at a high temperature of 195 °C and then must wash away the unfixed dyestuff, and stentering is needed a second time. The polyester fabric according to the present invention is colored with pigment which has no sublimation problem, and the fabric only needs to be heat set once at 190-195 °C instead of two times. After the washing process chemicals are applied for specific functionality of a given fabrication: moisture wicking, anti-odor and anti-bacterial agents may be applied in a customized engineered manner, such as using silver-polymer and curing in the heat setting process for a specific functionality of withstanding home laundering more than 50 times, and the stenter process is also modified as explained above, compared to the standard. First, a lower temperature than standard is applied in the stenter process. Then, the fabric is only run through the stenter once at the modified temperature (versus the traditional polyester fabrics requiring and being subjected to the extremely high heat of the stenter process two times in order to stabilize the fabric but oftentimes also hardening the fabric in the process). All of the above engineering mod-

ification steps to the finishing process in combination with the careful selection of raw material chip at the best grade and yarn making and knitting process combine to produce and maintain a soft hand feel in an inherently colored fabric, with now far superior colorfastness (because the color is locked inside the yarn) resulting in a highly commercially viable and environmentally friendly base layer garment.

[0015] The present invention involves using several different polyester fabrics of different constructions as well as different functional finishes, in order to form a customized garment product to meet end users' specific wearing requirements. The end user will enjoy a garment product with improved colorfastness, without the need to use any water at all in the fabric dyeing process, resulting in a significant saving in water, energy, chemicals with lower emissions of toxic gases and other waste products polluting our environment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The novel features of this invention, both as to its structure and its operation, will be best understood from drawings, taken in conjunction with accompanying description, in which similar reference characters refer to similar parts, and in which:

FIG. 1 is a simplified schematic view of production equipment for manufacturing polyester clothing in accordance with an embodiment of the present invention;

FIG. 2A is a flowchart that outlines a process for manufacturing a polyester knitted fabric with inherent color and assembling it into an article of clothing, according to an embodiment of the present invention;

FIG. 2B is a flowchart that outlines a process for manufacturing polyester fabric, according to an embodiment of the present invention;

FIG. 3A is a front view of a men's underwear constructed from a combination of polyester fabrics made using a method of the present invention;

FIG. 3B is a rear view of the men's underwear illustrated in FIG. 3A;

FIG. 3C is a front view of a women's underwear constructed from a combination of polyester fabrics made using a method of the present invention;

FIG. 3D is a rear view of the women's underwear illustrated in FIG. 3C;

FIG. 3E is a front view of a T-shirt constructed from a combination of polyester fabrics made using a method of the present invention; and

FIG. 3F is a rear view of the T-shirt illustrated in FIG. 3E.

DETAILED DESCRIPTION

[0017] FIG. 1 is a simplified schematic view of produc-

tion equipment 10 for manufacturing articles of polyester clothing, or recycled polyester clothing, such as a men's or women's underwear or T-shirt illustrated in FIGS. 3A-3F, in accordance with one or more embodiments of the present invention. In one or more embodiments, the production equipment 10 includes a polyester fabric manufacturing section 11 where a finishing polyester fabric 26 with required function is manufactured, a material warehouse 28 where the fabric 26 and other accessories 27 are held, a cutting station 29 where one or more polyester fabric 26 and accessories 27 are cut into desired shapes and sizes, and a sewing station 30 where the fabric 26 and accessories 27 are assembled to produce articles 31 of polyester clothing, such as C1, C2 and C3 in FIGS. 3A-3F.

[0018] In the embodiment illustrated in FIG. 1, the polyester fabric manufacturing section 11 includes a polyester chip formation machine 13 for making polyester chips 14 from polyester bottles 12, a polyester fiber machine 15 to produce polyester fiber 17 in proper size, a yarn spinning frame 18 which will produce proper yarn 19 for knitting, a circular knitting machine 21, a washing machine 23, and a stenter 24.

[0019] Polyester bottles 12 go through a process of cleaning, drying, and are then chopped into small pieces and melted to form the polyester chips 14 by the chip formation machine 13. Because the polyester chips 14 contain much less impurities and are more consistent in terms of source of raw material, a stronger staple fiber is produced which facilitates spinning of finer yarns to produce lighter weight fabric which is strong yet soft, such as for an end use of intimate garments such as underwear and T-shirts.

[0020] The polyester raw chips 14 are mixed with pigment chips 16 (which have color), melted at 260-285 degrees Celsius, extruded through a spinneret at 270-285 degrees Celsius, oiled, crimped, and finally cut into staple fiber of a dimension, such as 1.5D x 38 mm. So the polyester staple fiber 17 (e.g., recycled polyester staple fiber) formed has the inherent color from the pigment chips 16.

[0021] Then, the colored polyester fiber 17 will go through the modified combing process in which one additional combing process is added to achieve better alignment of fiber along the yarn to give a smoother surface on the sliver and in which a drawing ratio is slightly reduced by 20 percent so that the size of the sliver formed under such combing process is finer than sliver of other normal recycled polyester, e.g., due to the stronger fiber 17 formed by better quality raw chips 14. Again, unlike a comparable process, more than one sliver (e.g., two to three, depending on final yarn size specification) are drawn into the roving frame with modified draft ratio of 20 percent reduction to form a softer roving. The roving is then spun under higher twist (above 800 tpm, or twist per minute) to make the proper count of knitting yarn 19 on the spinning frame 18, for example, 40s 100% polyester yarn in green color. The yarn formed as a result of

the modified combing, roving and spinning processes as described above is much softer, cleaner, less hairy, and much stronger. Then the polyester yarn 19 will be knitted into polyester fabric 22 on the circular knitting machine 21. The polyester knitted fabric 22 (e.g., recycled polyester knitted fabric) formed already has color and there is no need to dye the fabric under a traditional dyeing process. As a result, the polyester knitted fabric 22 produced under the present invention avoids many hours (e.g., seven hours) of severe high temperature and chemical treatment during the traditional dyeing process. The polyester knitted fabric 22 is able to maintain a much cleaner surface, softer hand feel and better physical performance in all respects.

[0022] After knitting, the polyester knitted fabric 22 which already has color will be washed in the washing machine 23, such as an open width washing range, in order to get rid of the dirt and oil obtained from the previous process. It is very much different from the washing process of normal polyester fabrics which require a traditional dyeing method as fabric after dyeing has to go through a prolonged washing process of 6 hours inside the overflow dyeing machine at 130 °C. According to an embodiment of the present invention the fabric is washed under low temperature of 45-55 °C and short washing time of 15-20 minutes.

[0023] After washed and de-watered, the fabric 22 will directly go into the stenter 24 for heat-setting at 190-195 °C at a speed of 20 meters per minute to get the finished polyester fabric 26 with stable dimension and weight. In an embodiment of the present invention, the fabric 22 only goes through the stenter 24 once, while comparable recycled polyester fabrics which require the traditional dyeing process have to go through a stenter at least two times as the grey fabric has to be washed before dyeing, and has to go through the stenter to get stabilized in dimension at a high temperature of 195 degrees Celsius to minimize distortion during the prolonged dyeing process. And after the dyeing process, the comparable dyed fabric has to go through stenter once again at a temperature of 180 degrees Celsius. The additional high-temperature stenter process, to a certain extent poses damage to the polyester fiber and contributes to harsh hand feel on the comparable recycled polyester fabrics.

[0024] Some functional chemical agents 25, such as wicking, anti-bacterial, anti-odor, etc., can be added onto the fabric during the stentering process to obtain the functional finished polyester fabric 26.

[0025] The finished polyester fabric 26 is now ready to be utilized in the final manufacturing of desired articles of polyester clothing, such as articles C1, C2, C3 in FIGS. 3A-3F. The material warehouse 28 holds one or more fabrics 26 and other accessories 27 which are to be used in making polyester clothing. Then one or more polyester fabrics 26 and accessories 27 will be cut into proper sizes and shapes in the cutting station 29. The cut fabric panels and accessories will be moved to the sewing station 30 and assembled into articles 31 of polyester clothing, such

as C1, C2, C3.

[0026] FIG. 2A is a flowchart that outlines a process for manufacturing a finished polyester knit fabric 26 (e.g., a recycled polyester knit fabric) and assembling one or more of the fabrics 26 with proper accessories into a desired articles of clothing, according to an embodiment of the present invention.

[0027] Step 201 involves obtaining polyester chips from polyester bottles, such as recycled polyester bottles. Alternatively, the polyester chips may be PET chips. Step 202 involves producing the colored fine polyester fiber from chips mixed with pigment chips. The pigment chips bring the inherent color to the fiber, and this color is permanently fixed inside the fiber during extrusion, so this fiber has very good colorfastness properties versus fabric produced under a traditional dyeing process, as does the yarn and fabric made from this fiber, that is, colorfastness to washing AATCC61-2A at grade 4.5 or greater, colorfastness to perspiration AATCC15-2006 at grade 4.5 or greater, colorfastness to water AATCC 107 at grade 4.5 or greater, colorfastness to hot press AATCC 117 at grade 4.5 or greater, dye transfer in storage AATCC 163-2007 90°C for 24 hours at grade 4.5 or greater, colorfastness to crocking AATCC 8-2013 at grade 4.5 or greater.

[0028] Step 203 involves spinning polyester yarn with this polyester fiber with inherent color. In this step, special combing, roving and spinning techniques as described above are used to get better yarn which is softer, cleaner, less hairy, and has better strength. Step 204 involves knitting the polyester fabric with the polyester yarn. Because this polyester yarn from step 203 has inherent color, the knitted fabric has inherent color too. Also, this polyester yarn can be knitted with other yarn or spandex to get a special pattern or elasticity, such as jersey, rib, interlock, pique, and double knit constructions. Step 205 involves washing the knitted fabric to remove oil and dirt. Step 206 involves heat-setting the fabric on a stenter. The knitted fabric will be heat-set at 190-195 °C at the speed of 20 meters per minute. Functional chemical agents, such as wicking, anti-bacterial, and anti-odor, can be added into the tank on the stenter, so that the polyester fabric can have the desired function after stentering.

[0029] Step 208 involves cutting the finished fabrics and other accessories (obtained from step 207). In this step, the fabrics and accessories will be cut into right sizes and shapes according to the pattern of the clothing, such as shown in FIGS. 3A-3F. Different parts of the clothing may use different constructed and finished fabric according to the requirements. For example, a certain area may need anti-bacterial fabric, and a certain area may need mesh construction to achieve better air permeability. Step 209 involves assembling the polyester fabric cut panels into desired clothing.

[0030] FIG. 2B is a flowchart that outlines a process for manufacturing a polyester knitted fabric (e.g., a recycled polyester knitted fabric) with inherent color, accord-

ing to an embodiment of the present invention. Step 210 involves cleaning and drying polyester bottles. Because the raw material may be selected from cleaned recycled polyester bottles, the recycled polyester raw materials have much less impurities and more consistent quality in terms of uniqueness of raw material source. Step 211 involves cutting the cleaned bottles to make the polyester chips, such as recycled polyester chips. Step 212 involves melting the chips together with pigment chips and extruding the polyester filament fiber. So, the polyester filament fiber has the inherent color which is permanently fixed inside the fiber, which leads to good colorfastness properties of the fabric. Step 213 involves drawing the fiber to get extra strength to the fiber and cutting the fiber into polyester staple fiber of proper size, for example 38 mm in length. Step 203 involves spinning the polyester staple fiber into yarns for knitting.

[0031] Step 204 involves knitting the colored polyester yarn on circular knitting machine. The polyester yarn can be knitted with spandex to get elasticity or with other yarn to get special pattern or structure. Step 205 involves washing fabric in open wider washing range or overflow dyeing machine at 45-55 degrees Celsius for 15-20 minutes after heating the water to 45-55 degrees Celsius.

After washing, the fabric is dewatered before the next step. Step 206 involves heat-setting the knitted polyester fabric on a stenter. During this step, the fabric may be finished with wicking, anti-bacterial, and other chemical agents to get the finished polyester fabric with color and with proper function.

[0032] FIGS. 3A to 3F are illustrations of a polyester men's underwear, a polyester women's underwear C2, and a polyester T-shirt C3, respectively. FIG. 3A is a front view of a men's underwear boxer C1, and FIG. 3B is a rear view of the underwear boxer C1. FIG. 3C is a front view of a women's underwear C2, and FIG. 3D is a rear view of the underwear C2. FIG. 3E is a front view of a T-shirt C3, and FIG. 3F is a rear view of the T-shirt C3. Fabric article 32 is a kind of finished fabric 26 having a specific construction and with wicking finish while fabric article 33 is another kind of finished fabric 26 but having a different construction and with wicking, anti-bacterial and anti-odor finish as according to specific locations and needs on garment C1, C2, and C3, respectively.

[0033] The manufacturing process of the garments C1, C2, and C3 involves getting the fabric articles 32 and 33, as well as accessories 27 from the materials warehouse 28, cutting both fabric articles 32 and 33, as well as the accessories 27, in the cutting station 29 according to their desired shapes and sizes on garments C1, C2, and C3, respectively, and an assembly station 30 where all the different cut panels of fabric articles 32 and 33 together with the accessories 27 are sewn together according to the design to produce the desired articles of polyester clothing C1, C2, and C3.

[0034] Although the drawings and accompanying description illustrate some exemplary embodiments of the present invention, it will be apparent to those skilled in

the art that the novel aspects of the present invention may also be carried out by utilizing alternative structures, sizes, shapes, and/or materials in embodiments of the present invention. Also, for example, while methods are described herein with respect to "steps," this is not intended to limit the present invention. That is, the above description of some exemplary embodiments is not intended to limit the steps to being performed in the order described herein or to preclude the omission or addition of one or more steps.

[0035] The preceding description has been presented with reference to various embodiments of the invention. Persons skilled in the art and technology to which this invention pertains will appreciate that alterations and changes in the described structures and methods of operation can be practiced without meaningfully departing from the principles, spirit, and scope of this invention.

Claims

1. A method of manufacturing a polyester knitted fabric with inherent color, the method comprising:
 - providing a polyester fiber with inherent color; spinning a colored polyester yarn from the polyester fiber with inherent color; and knitting the colored polyester yarn into a colored polyester fabric.
2. The method of claim 1, wherein providing the polyester fiber with inherent color comprises:
 - providing polyester chips; mixing the polyester chips with a pigment; extruding a colored filament fiber from the polyester chips mixed with the pigment; and cutting the filament fiber into a staple fiber.
3. The method of claim 2, wherein mixing the polyester chips with the pigment comprises melting the polyester chips with pigment chips having a color, and wherein the polyester chips are melted with the pigment chips at 260-285 °C, and the colored filament fiber is then extruded at 270-285 °C.
4. The method of claim 1, further comprising:
 - washing the colored polyester fabric for 15-20 minutes; and heat-setting the colored polyester fabric by passing the colored polyester fabric through a stenter only one time at 190-195 °C.
5. The method of claim 4, wherein heat-setting the colored polyester fabric comprises adding at least one of a wicking agent, an anti-bacterial agent, and an anti-odor agent to the fabric.
6. The method of claim 1, wherein finishing the colored polyester fabric includes washing and heat-setting the colored polyester fabric, and does not include any dyeing process to the colored polyester fabric having inherent color.
7. The method of claim 1, wherein the colored polyester fabric has colorfastness to washing AATCC61-2A at grade 4.5 or greater.
8. The method of claim 1, wherein knitting the colored polyester yarn into a knitted fabric comprises knitting the colored polyester yarn in combination with other yarns.
9. A colored polyester fabric manufactured using the method of claim 1.
10. A colored polyester fabric manufactured from polyester fiber with inherent color, wherein the colored polyester fabric has colorfastness to washing AATCC61-2A at grade 4.5 or greater.
11. A method of manufacturing an article of clothing, the method comprising:
 - providing a first polyester fiber with inherent color; spinning a first colored polyester yarn from the first polyester fiber with inherent color; knitting the first colored polyester yarn into a first colored polyester fabric; cutting the first colored polyester fabric to have a desired shape and size; and assembling the first colored polyester fabric into an article of clothing.
12. The method of claim 11, wherein providing the first polyester fiber with inherent color comprises:
 - providing polyester chips; mixing the polyester chips with a pigment; extruding a colored filament fiber from the polyester chips mixed with the pigment; and cutting the filament fiber into a staple fiber.
13. The method of claim 11, further comprising:
 - washing the first colored polyester fabric for 15-20 minutes; and heat-setting the first colored polyester fabric by passing the first colored polyester fabric through a stenter only one time at 190-195 °C.
14. The method of claim 11, wherein the first colored polyester fabric has colorfastness to washing AATCC61-2A at grade 4.5 or greater.

15. The method of claim 11, further comprising:

providing a second polyester fiber with inherent
color;
spinning a second colored polyester yarn from 5
the second polyester fiber with inherent color;
knitting the second colored polyester yarn into
a second colored polyester fabric having a dif-
ferent structure than the first polyester fabric;
cutting the second colored polyester fabric to 10
have a desired shape and size; and
assembling the second colored polyester fabric
together with the first colored polyester fabric
into the article of clothing.

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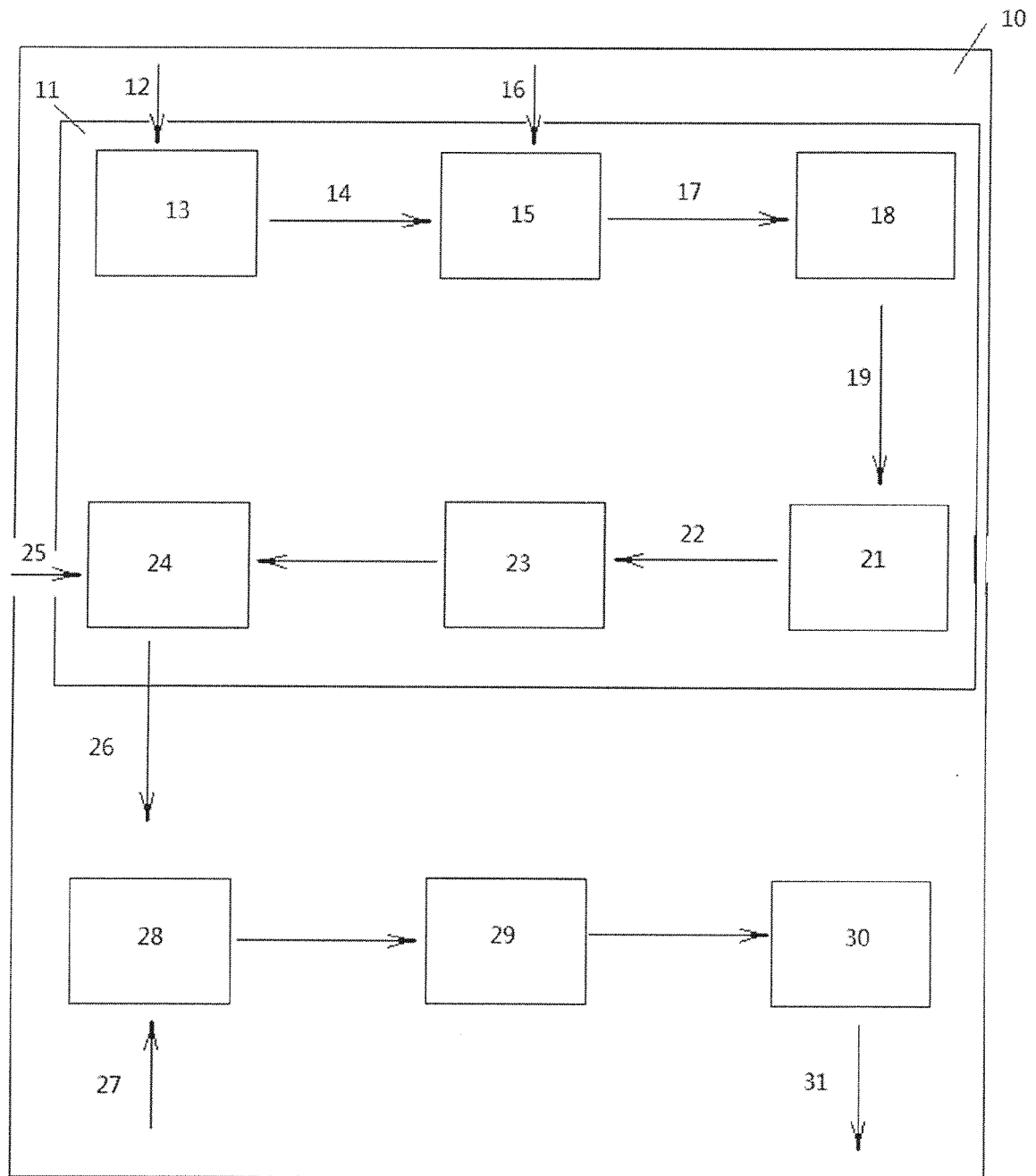


FIG. 1

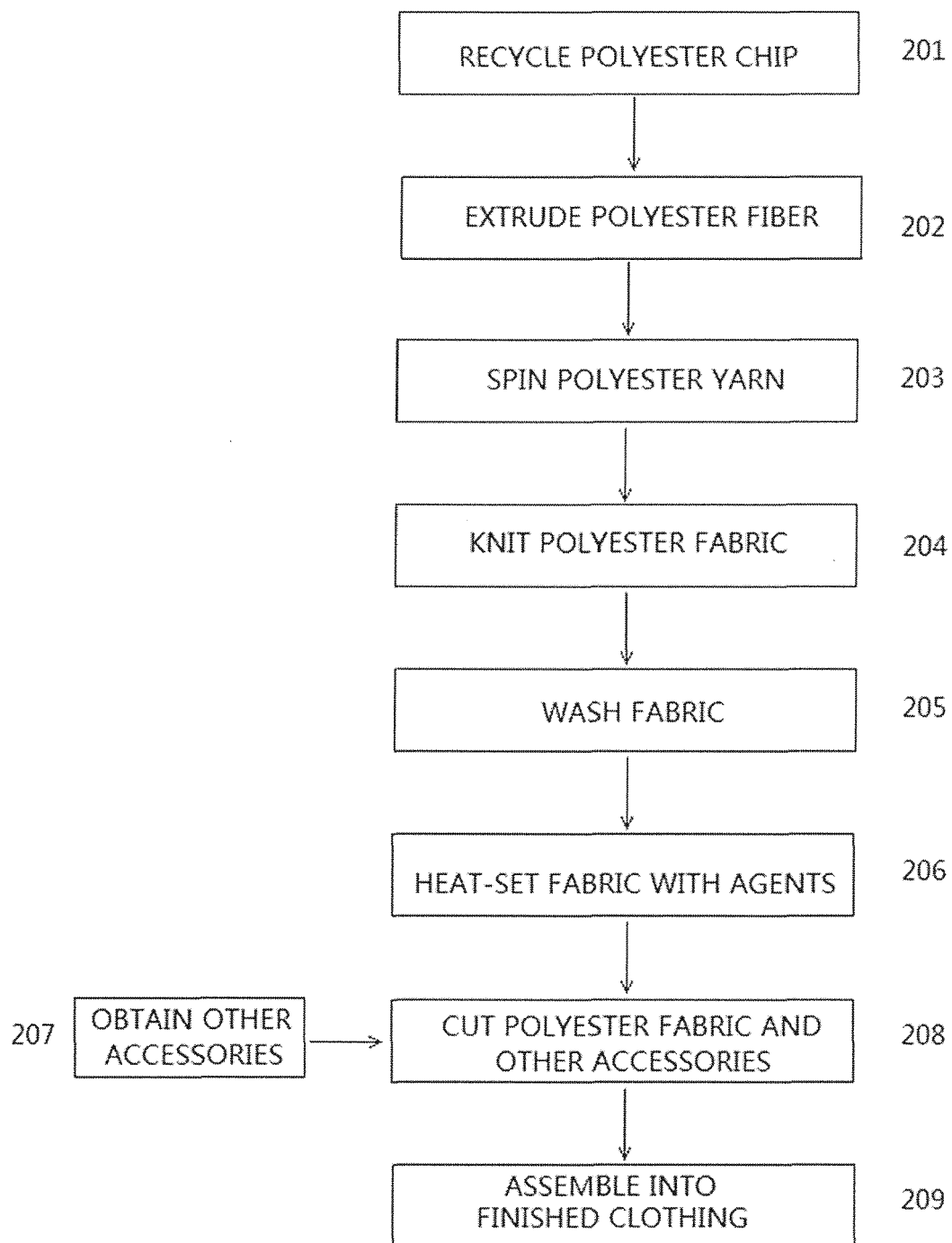


FIG. 2A

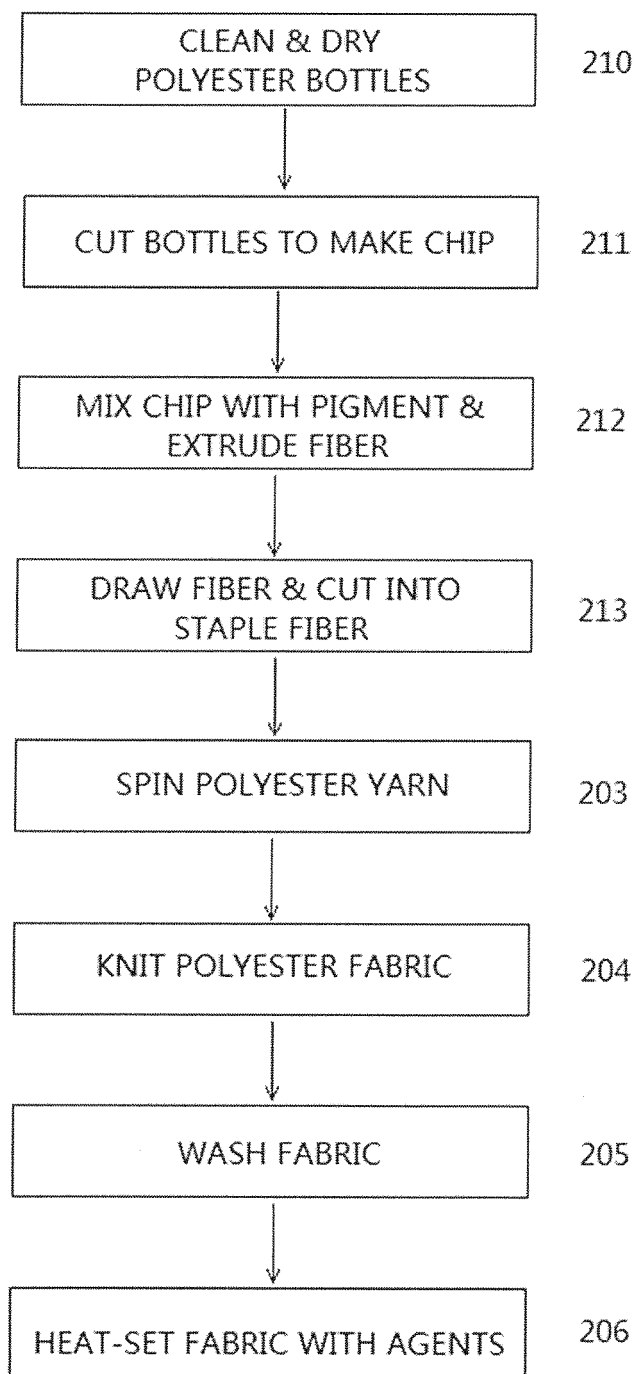


FIG. 2B

GARMENT C1 - MEN'S UNDERWEAR

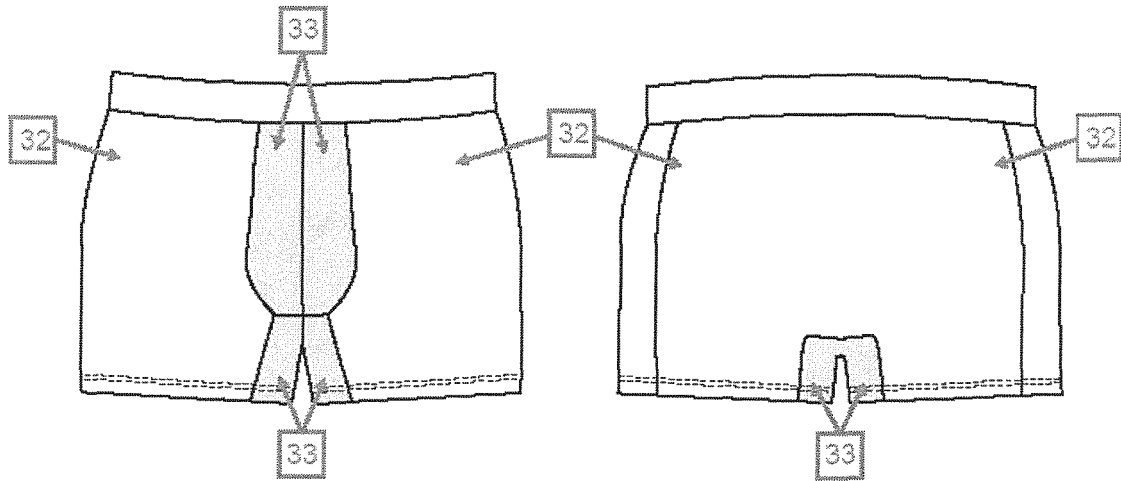


FIG.3A

FIG.3B

GARMENT C2 - WOMEN'S UNDERWEAR

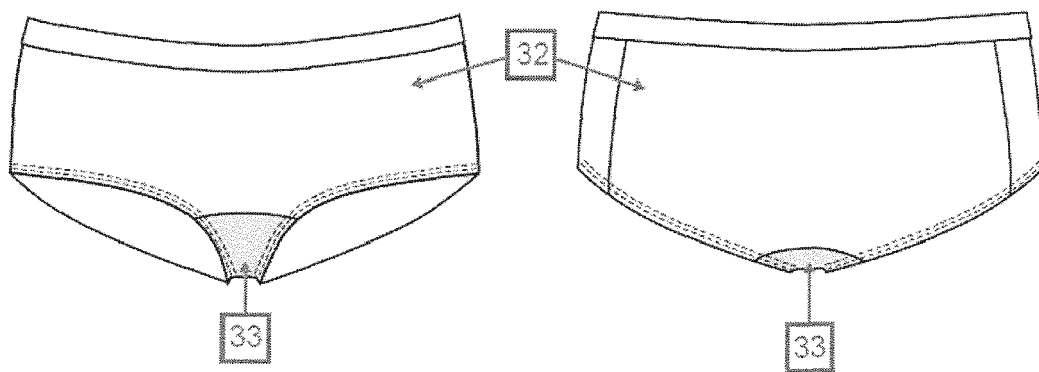


FIG.3C

FIG.3D

GARMENT C3 - T-SHIRT

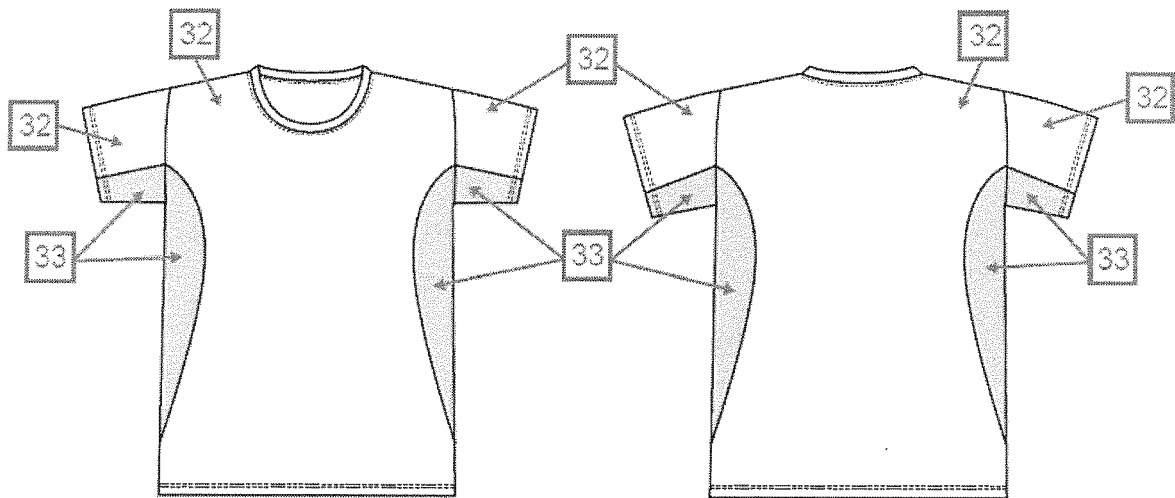


FIG.3E

FIG.3F



EUROPEAN SEARCH REPORT

Application Number
EP 14 18 3743

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			D01F D01D D04B C08J
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 14 January 2015	Examiner Malik, Jan
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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REFERENCES CITED IN THE DESCRIPTION

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