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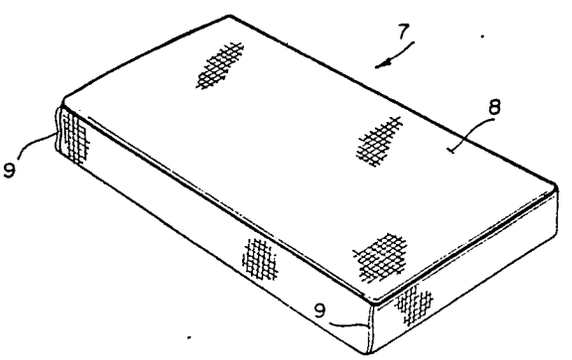
(54) Knitted sheeting products having sheath/core yarn construction.

(57) Method of forming top bedsheets (4), bottom bedsheets (7) or pillowcases (1) and the products produced by the method. The method includes making a sheath/core yarn having a sheath of primarily cotton fibers or cellulosic fibers having smoothness of hand properties comparable to cotton, and a core of primarily synthetic material having strength properties greater than the sheath fibers; circular knitting the sheath/core yarn into a knit fabric; and cutting and sewing the fabric to form top bedsheets, bottom bedsheets or pillow cases. An antimicrobial agent may be applied either before or after the products are formed.

FIG. 3



EP 0 249 074 A2

KNITTED SHEETNG PRODUCTS HAVING SHEATH/CORE YARN CONSTRUCTION

TECHNICAL FIELD

This invention relates to a method of forming top bedsheets, bottom bedsheets or pillowcases, and to the products produced by such method.

BACKGROUND AND SUMMARY OF THE INVENTION

Traditional bedsheet products made from woven fabric constructions have several disadvantages. For instance, the bottom fitted sheets oftentimes do not hold their fit position properly, and bottom sheets, top sheets, and pillow cases have potentially harsh hand if optimum laundering procedures are not followed. In addition, woven bedsheet products prepared from cotton wrinkle easily unless provided with permanent press resin finish. Sheets constructed with a fairly high percentage of synthetic fiber,such as polyester blended with the cotton, provide a smooth appearance after washing. However, the durable press resin finished sheets, and sheets made from conventional fiber blends, often have a harsh hand.

In order to overcome the problems associated with woven fabric constructions of bedsheets and pillow cases, sheets have been prepared (particularly bottom fitted sheets) from 100 percent cotton in a jersey knit construction, such as shown in U.S. patent 3,789,441. While such sheets solve the harsh hand problem, at least during early stages of their life, and have a no-iron construction, such sheets have problems of their own. For instance, the 100 percent cotton fabric is weak, tears easily, absorbs and maintains moisture too readily, and often becomes harsh over time.

It has also been suggested to form fitted sheets from a nylon tricot-knitted fabric. While this material is lighter in weight than cotton, it often feels harsh and has poorer absorbency than cotton.

According to the present invention, a sheeting product is provided which overcomes the problems inherent in the prior art as discussed above. The invention relates generally to the construction of top sheets, bottom (fitted contour) sheets, and pillow cases which have numerous advantages compared to one or all of the prior art products discussed above. The invention relates specifically to sheeting products, and a method of producing sheeting products from a conventional sheath and core yarn.

In accordance with one exemplary embodiment of the invention, the composite yarn consists essentially of a core comprising primarily synthetic material, together with a sheath comprising preferably primarily cotton or other cellulosic fibers. The core synthetic material, which should have greater strength than the sheath fibers, may be either in staple or continuous filament form. Polyester is the preferred synthetic material, but nylon or other synthetic materials could be used, so long as they are comparable to polyester in terms of strength, softness and wicking properties.

The composite yarn in this first embodiment is composed of at least 50 percent cotton or other cellulosic fiber and less than 50 percent of the synthetic material.

The sheath and core yarn in this first embodiment may be prepared in the manner as set forth in Japanese patent publication 53-35051 published April 1, 1978, in the name of the Murata Machine Manufacturing Co., Ltd., or as set forth in Japanese patent publication 11775 issued March 17, 1981 in the name of Unitika Co., the disclosures of which are hereby incorporated by reference. Other methods of making sheath/core yarns may be used, including the method disclosed in commonly-owned U.S. application Serial Number 813,569 filed December 26, 1985, the disclosure of which is also incorporated herein by reference.

In another exemplary embodiment of the invention, the sheath fibers, which completely cover the core fibers, comprise more than 50 percent of the yarn, and preferably about 68-83 percent of the yarn. The sheath fibers are short staple fibers, such as cotton or cellulosic fibers having smoothness of hand properties comparable to cotton (when constructed into a fabric). The core fibers have properties distinctly different from the sheath fibers. Preferably the core fibers are long staple synthetic fibers, which, as in the first embodiment, have enhanced strength compared to the sheath fibers. The preferred core fiber is polyester, or synthetic polymer fibers that are comparable to polyester as far as strength, softness, and wicking properties are concerned.

The sheath and core yarn according to this alternative embodiment of the invention preferably is produced as set forth in co-pending U.S. application serial number 824,788, filed January 31, 1986 entitled "Roving Blending for Making Sheath/Core Spun Yarn", the disclosure of which is hereby incorporated by reference.

In the practice of the present invention, the sheath/core yarn is circular knit into a fabric, and preferably into a jersey knit configuration on a conventional circular knitting machine. Typical fabric weight is about four ounces per square yard utilizing a yarn count of thirty two singles (32/1). The knit fabric is also preferably finished to give a relaxed shrinkage of about five percent in both the length and the width dimensions. The fabric is then formed into a top bedsheet, bottom bedsheet, or pillow case by conventional techniques.

In another aspect of the invention, it has been discovered that improved sheath/core yarn construction knitted bedding components can be even further improved by a bacteriostatic and fungistatic treatment using the improved antimicrobial agent DC 5700™, marketed by Dow Corning Corporation for the BIOGUARD™ treatment of socks and other hosiery items, conventional sheeting woven from polyester/cotton blended yarn, carpets comprised wholly of synthetic fibers and wholly of wool fibers, and uniforms comprised wholly of synthetic fibers or of blended fiber yarns.

For either of the yarn constructions described hereinabove, the amount of the agent added is normally less than 3 percent by weight of the fiber, and preferably in the range of 0.1 to 1.0 percent. The DC 5700™ agent may be added by spraying or by aqueous treatment, after the fabric to be treated is scoured.

The sheeting products according to the present invention have the following advantages compared to one or all prior art constructions discussed above: They have longer wear life than 100 percent cotton. They remain softer (especially when formed with a staple fiber core) after repeated washing and tumble drying over a longer period of time. They absorb moisture more quickly and dry more quickly because the moisture is wicked through the polyester core from moist to dry areas, and during drying will return moisture from the wet core to the drying cotton sheath areas. The product is stronger than 100 percent cotton knit sheeting, having better abrasion resistance, greater bursting strength, and greater tearing resistance. The sheeting according to the invention also has superior stretch and recovery properties compared with 100 percent cotton, and is more wrinkle resistant, with improved no-iron characteristics. It also has improved moisture absorbency, good hand and good surface characteristics.

In addition, it has been found that the BIOGUARD™ treatment will not interfere with the normal moisture absorbing properties of the cotton or other cellulosic sheath fibers, and will not interfere with the normal hydrophobic and wrinkle resistant properties of the synthetic core fibers or filaments.

The BIOGUARD™ treatment will improve the performance of sheath/core yarn bedding products by preventing the growth of bacteria and fungi in the synthetic fibers and filaments of the yarn core while it is wicking moisture absorbed by the cotton sheath.

The BIOGUARD™ treatment on the cotton sheath will also prevent bacteria and fungi from growing on fibers in the cotton sheath during the time that it is holding moisture or when such fibers are otherwise subjected to conditions that would normally give rise to growth of bacteria, fungi and mildew.

It is the primary object of the present invention, therefore, to provide top sheets, bottom sheets, and pillow cases (and a method of producing the same) having good hand and surface characteristics, and good strength.

It is another object of this invention to provide bacteriostatically and fungistatically treated top sheets, bottom sheets and pillow cases prepared from fabric having a sheath/core yarn construction. Other objects of the invention will become clear from inspection of the detailed description of the invention which follows.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a perspective view of an exemplary pillow case according to the present invention;

FIGURE 2 is a perspective view of an exemplary top bedsheet according to the present invention;

FIGURE 3 is a perspective view of a typical bottom (fitted contour) bedsheet according to the present invention;

FIGURE 4 is a schematic view of exemplary apparatus for producing a sheath/core yarn in accordance with one embodiment of the invention which may be utilized in the construction of the products of FIGURES 1 through 3;

FIGURE 5 is a drawing simulating the enlargement of a photomicrograph of a yarn produced by the apparatus shown in FIGURE 4, with polyester fibers in the core and cotton fibers in the sheath;

FIGURE 6 is a side schematic view of exemplary apparatus for producing a sheath/core yarn in accordance with an alternative embodiment of the invention, which also may be utilized in the construction of the products of FIGURES 1 through 3;

FIGURES 7 and 8 are schematic cross-sectional views of a sliver and roving prior to drafting, and the final composite roving after drafting, re-

spectively, which are produced during the manufacture of sheath/core yarn by the apparatus shown in FIGURE 6;

FIGURE 9 is a drawing simulating an enlargement of a photomicrograph of a yarn produced by the apparatus shown in FIGURE 6, with polyester fibers in the core and cotton fibers in the sheath.

DETAILED DESCRIPTION OF THE DRAWINGS

An exemplary pillow case that may be produced according to the present invention is illustrated by reference numeral 1 in Figure 1, having a fabric body 2, and sewn edges 3. An exemplary top sheet according to the invention is illustrated by reference numeral 4 in Figure 2, having a main fabric body 5 and sewn hems 6. An exemplary bottom (fitted contour) bedsheet according to the invention is shown at 7 in Figure 3, having a main fabric body 8, and seams 9.

The fabric forming the bodies 2, 5 and 8 of the sheeting products illustrated in Figures 1 through 3 is produced, according to the present invention, from a sheath/core yarn. The sheath/core yarn has a configuration illustrated schematically at 22 in Figure 5. The composite yarn 22 consists essentially of a core comprising primarily continuous filaments 25, preferably polyester, together with sheath fibers comprising primarily cotton staple fibers 26. At the sheath/core interface, there is significant blending between the fibers 26, and the filaments 25 so that the sheath is well-rooted in the core. It is to be understood that while the sheath fibers are illustrated in Figure 5 as being all cotton, the sheath may include relatively small amounts of synthetic fibers, such as polyester staple fibers, so long as the composite yarn contains more than 50% cotton fibers.

The yarn 22 is made into the sheeting products 1, 4, 7 according to the invention preferably by circular knitting the yarn into a fabric on a conventional circular knit machine A jersey knit configuration is preferred. Such knitting can be practiced on a Monarch knitting machine, Model RL4 with 2520 needles in a circumference of 94 inches.

The fabric 2, 5, 8 according to the invention, may have various weights depending upon the particular market to which it is directed. However, preferably the weight is approximately four ounces per square yard, utilizing a yarn count of thirty two singles (32/1). Also, after production of the knit fabric 2, 5, 8, it is preferably finished utilizing a conventional compressive shrinking machine, to give a relaxed shrinkage of approximately five percent in both the length and the width dimensions.

Exemplary apparatus and method for producing the yarn 22 for use in this invention is illustrated schematically in Figure 4. The apparatus includes a set of back feed rollers 10 for feeding a sliver of staple fibers to an apron 11 (or the like drafting means), a pair of front rolls 12, a first vortex air nozzle 13, and a second vortex air nozzle 14. The vortex nozzles are preferably the conventional components of a Murata airjet spinner. The nozzles may be, e.g., brass or ceramic, with 3, 4 or 6 jets per nozzle, preferably all disposed in the same plane. It will be apparent that, as exemplified by the companion roll depicted in outline above roll 12, similar companion roll and an apron (neither shown) lie above roll 10 and apron 11, each functioning as a working pair with its mate.

Combined with the components 10-14 are means for feeding a non-torqued filament strand S (to become the core) into operative association with the staple fibers F (to become the sheath) downstream of the apron 11 and rolls 12. These means comprise a supply of core filament 16, an eyelet 17 comprising a guide means for the strand S from the supply 16, a tension disc or like tensioning means 18, gripping means such as the solenoid gripper 19, and feeding means such as the pneumatic feeder 20. A detector 21 actuates the solenoid gripper 19 to grip the strand S to stop the feeding of filaments in the event of a stop in the vortex jet or take-up portion of the apparatus. The strand S breaks once stopped, and after processing parameters have been corrected, start-up is effected by the pneumatic feeder 20. The pneumatic feeder 20 preferably comprises a simple aspirating jet which is actuated to feed the strand S back into operative association with the front rolls 12 and fibers F.

The staple fibers when fed to the vortex air stream of the first air jet nozzle 13 are subjected to a torque which makes them twist in the direction of the torque applied (a false S-twist in the Figure 4 embodiment). Tension is supplied by the jet 13 pulling against the rolls 12 at the same time, causing a ballooning action to take place similar to the yarn ballooning action in a ring spinning process. The continuous filament strand S fed into the same vortex stream in jet 13 under controlled tension (as determined by the rolls 12 and tension disc 18) is subjected to the same torque and ballooning action. However, since the filament strand has no free ends, it cannot migrate to the outside of the yarn, and tends to stay very close to the center of the yarn. By virtue of the turbulent vortex action in the jet 13, the filament strand S and the staple fibers F experience a certain degree of blending at their interface; apparently the twisting and ballooning action of the jet on strand S and fibers F open up strand S, permitting staple fibers F to be embed-

ded to a significant degree in the body of the core filament strand S. In effect, the core filament strand displaces the staple fibers F at the center of the yarn, this action meanwhile being accompanied by a significant measure of effective blending at their interface.

In the second jet nozzle 14, the twist imparted by the first nozzle 13 is removed by applying an opposite twist (a false Z twist in the Figure 1 embodiment), imparting a fasciated surface appearance by wrapping many of the surface fiber ends in a helical manner. The resulting yarn has the distinct structure illustrated in Figure 5.

In an alternative exemplary embodiment of the invention, the sheath/core yarn has a configuration illustrated schematically in FIGURE 9. As is readily apparent from an inspection of FIGURE 9, the core 30 which comprises fibers 32 is extremely cohesive, while the sheath 34, comprising amoeba-shaped fibers 36, completely covers the core 40 with little intermixing between the core and the sheath.

The sheath fibers 36 in the yarn accordng to the invention, preferably comprise short staple fibers. Cotton, or cellulosic fibers having smoothness of hand properties comparable to cotton (when produced into a fabric) are the preferred fabrics, particularly cotton. The fibers 36 illustrated in FIGURE 9 are cotton.

The core fibers 32 for the yarn used in the production of products according to the invention, have distinctly different properties from the sheath fibers 36. The core fibers 32 preferably are long staple synthetic fibers, particularly polyester or other synthetic polymer fibers having strength, wicking, and like properties comparable to those of polyester. Polyester fibers are illustrated in the drawing in FIGURE 9.

The core 30 is completely covered by the sheath 34 in the yarn, as can be readily illustrated by producing the core and sheath of differently colored fibers. The sheath fibers comprise more than 50 percent of the yarn fibers, and preferably comprise between about 68-83 percent.

As in the previous embodiment, the yarn is made into the sheeting products 1, 4, 7 according to the invention preferably by circular knitting the yarn into a fabric on a conventional circular knit machine. A jersey knit configuration is again preferred, as may be accomplished using the same Monarch knitting machines previously described.

The fabric according to this embodiment of the invention may also have a weight of approximately four ounces per square yard utilizing a yarn count of thirty two singles (32/1). Similarly, after production of the knit fabric, it too is preferably finished utilizing a conventional compressive shrinking machine to give a relaxed shrinkage as in the first embodiment.

Exemplary apparatus for producing the yarn according to this alternative embodiment of the invention is illustrated schematically in FIGURE 6. The apparatus is more fully described in said copending U.S. application serial number 824,788 filed January 31, 1986. The apparatus includes sliver can 40 from which a sliver 42 of first fibers (to become the sheath) is drawn, a drafting apparatus 44 which comprises a pair of rear rolls 46, a pair of front rolls 48, and an apron 50 intermediate the rolls 46, 48, and a roving spinning frame 52. In addition, there is provided a supply 54 of a roving 56 of second fibers (to become the core), which have distinctly different properties than the first fibers. For instance the sliver 42 can be of cotton or like short staple fibers, while the roving 56 from roving supply 54 is of polyester or like synthetic long staple fibers. A trumpet 58 is disposed between the supplies 40, 54 and the rolls 46. The roving 60 which is produced has a distinct sheath and core arrangement, and to make the roving 60 into yarn one passes it through a conventional second draft stage 62 and then to a yarn spinning frame 64 for ring spinning the roving into yarn. The drafting apparatus 44 typically would apply a draft ratio of about 10-1, while the second draft apparatus 62 would typically apply a draft ratio of about 6-1.

In order to ensure good cohesiveness of the core of the composite roving being produced, various properties thereof will be controlled. One way to control core cohesiveness is by controlling the twist imparted to the roving 56 (that is the twist that the roving 56 has when it is utilized in the apparatus of FIGURE 6). The apparatus is operable to produce the desired yarn according to the present invention when the twist multiple of the roving 56 is anywhere within the range of about 0.25-1.25 turns per inch, however it is desired that the twist multiple of the roving 56 be within the range of about 0.25-0.8 turns per inch, and preferably within the range of about 0.5-0.75. Another way to control core cohesiveness is by controlling the relative frictional properties of the fibers of the roving 56 and the sliver 42. For instance the roving 56 can be treated with finish so that the fibers thereof have higher friction than the fibers of the sliver 42. Where the fibers of the roving 56 naturally have higher frictional properties (such as when the roving 56 is polyester and the sliver 42 is cotton), such finishing may not be necessary, but may be desirable even under such circumstances in order to properly and precisely control the core cohesion. Another way of controlling core cohesion is to

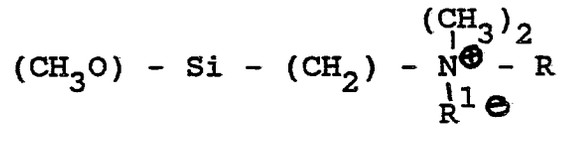
make sure that the roving 56 is placed at the exact center line of the sliver 42, and maintaining a slight tension as by utilizing the trumpet 58 heretofore described.

The sliver 42 preferably has a flat configuration (see FIGURE 7) when it exits trumpet 58, having about a 3 to 1 width to height ratio.

The roving 60 is illustrated schematically in FIGURE 8, having a core 30 that is cohesive and essentially completely distinct from the sheath 34, the sheath 34 completely covering the core, and the core comprising the second fibers and the sheath 34 comprising the first fibers.

As previously stated, it is a further feature of this invention to provide a bacteriostatic and fungistatic treatment for sheath and core construction yarns of the type described hereinabove.

The antimicrobial agent utilized in this invention is a bioactive silyl quaternary amine compound. The preferred material is 3-(trimethoxysily)-propyloctadecyldimethyl ammonium chloride which is described in U.S. Patent No. 3,730,701, the disclosure of which is hereby incorporated by reference. A class of suitable bioactive silyl quaternary amine compounds have the formula:



in which R is C_{11-22} alkyl group and R^1 is chlorine or bromine. The preferred silicone quaternary amine is 3-(trimethoxysilyl)-propyloctadecyl dimethyl ammonium chloride and is available as 42% active solids in methanol from Dow Corning Corporation of Midland, Michigan under the designation DC-5700™ (formerly Q9-5700). This material, marketed under the name BIOGUARD™, is well accepted in commerce and has been approved not only as a bacteriostatic textile treatment but also as a bacteriocidal component for medical device/non-drug applications.

This material can be applied to the fabric topically, e.g., by spraying, or by aqueous treatment, after scouring the fabric. The amount of agent added is low, normally less than three (3) percent by weight, and preferably in the range of 0.1 to 1.0 percent. Optimum bioassay performance is achieved when 0.75 percent is added, based on the weight of fiber. Optimum antimicrobial performance is obtained by aqueous treatment after hydrolyzing the agent at a liquor to goods ratio of 20 to 1 at warm temperatures, preferably about 110-115°F. Temperatures above 115°F should be avoided to prevent homopolymerization. After application, a twenty minute dwell time is satisfactory, followed by extraction and drying of the fabric.

The antimicrobial agent is preferably applied during the finishing stage of the fabric manufacturing process. For example, after the sheath/core yarn is prepared in accordance with the examples given above, it may be circular knit into a fabric, preferably a jersey knit configuration, on the Model RL4 Monarch Knitting Machine Model described above; the Monarch LRE MD MY Circular Knit eyelet machine, 18 or 20 cut, 30 inch diameter (as a single jersey); or on a Monarch RWSY single knit pattern wheel, 18 or 20 cut, 30 inch diameter machine.

Typically, the fabric weight will be as previously described, and may be similarly finished to give a relaxed shrinkage of 5 percent in both length and width dimensions.

The antimicrobial agent may be applied before or after the shrinkage treatment hereinabove or, alternatively, before or after the final formation of the fabric into bottom sheets, top sheets, or pillow cases.

The combination of knitted products of sheath/core yarn construction and the antimicrobial agent DC-5700™ offer a particular advantage because it has been discovered that the agent permanently bonds to the fiber surface. Nevertheless, the small amount of agent added to the fabric does not interfere with the normal performance of the fibers in terms of properties. On the other hand, the permanent bonding of the agent to individual fabric fibers ensures that the bacteriostatic and fungistatic characteristics of the sheeting products will be retained even after repeated launderings.

In accordance with this invention, an exemplary method of producing bacteriostatically and fungistatically treated sheeting products comprises the following steps:

(1) providing yarn of sheath,core yarn construction wherein the sheath fibers comprise cotton or other cellulosic fibers comparable to cotton in smoothness of hand, and wherein the core fibers or filaments have properties different than the sheath fibers and are preferably staple fibers or filaments of polyester or other comparable polymers, and wherein the fabric is at least fifty percent cotton;

(b) circular knitting the sheath/core yarn into a jersey knit fabric;

(c) finishing the fabric on a compressive shrinkage machine to give the fabric a relaxed shrinkage of five percent in both length and width dimensions;

(d) scouring the fabric;

(e) applying an antimicrobial agent, preferably a bioactive silyl quaternary amine compound;

(f) forming the fabric into sheeting products such as bed sheets and pillowcases.

In an alternative embodiment, step (e) may be carried out after step (f).

It will thus be seen that in accordance with this invention, improved sheeting products are produced in conjunction with a process for bacteriostatic and fungistatic treatment. While the invention has been disclosed in what is presently conceived to be the most practical and preferred embodiments thereof, it will be apparent to those of ordinary skill in the art that other modifications may be made therein which are nevertheless within the scope of the claims which follow.

Claims

1. The method of forming top bedsheets, bottom bedsheets or pillowcases characterized by the steps of:

(a) making a sheath/core yarn having a sheath of primarily cotton fibers or cellulosic fibers having smoothness of hand properties comparable to those of cotton and a core of primarily synthetic material having strength properties significantly greater than the sheath fibers;

(b) circular knitting the sheath/core yarn into a knit fabric;

(c) cutting and sewing the fabric to form top bedsheets, bottom bedsheets or pillow cases.

2. The method as defined in claim 1, and further characterized in that the sheath fibers comprise primarily staple cotton fibers and the core comprises continuous filament polyester.

3. The method as defined in claim 1, and further characterized in that the sheath fibers comprise primarily staple cotton fibers and the core comprises staple polyester fibers.

4. The method as defined in claim 1 characterized in that step (a) is practiced by:

(i) moving a sliver of staple fibers and a distinct core filament strand composed of a plurality of continuous filaments, together in a generally linear direction;

(ii) acting upon the sliver and core filament strand to effect ballooning and twisting of the core filament strand and staple fibers, to effect blending of the core filaments and the staple fibers at their interface; and

(iii) further acting upon the staple fibers and the core filament strand to remove the twisting imparted in step (ii), and to produce a composite yarn having a core comprising mainly continuous filaments, a cover comprising mainly staple fibers, and considerable interfacial blending so that the cover is well rooted in the core.

5. The method as defined in claim 1 characterized in that step (a) is practiced by:

(i) feeding a sliver of sheath fibers, and a roving of core fibers, to the drafting apparatus so that the roving of core fibers is at the center line of, and on top of, the sliver of sheath fibers;

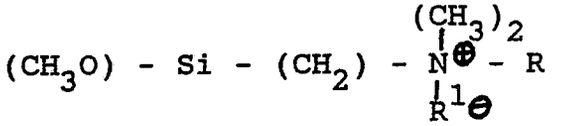
(ii) passing the roving and sliver together through the rear rolls, apron, and front rolls of the drafting apparatus to produce a drafted composite sliver; and

(iii) mechanically imparting a twist to the drafted composite sliver thereby providing a yarn having a sheath and core configuration with the sheath completely covering the core and comprising more than 50 percent of the yarn.

6. The method as recited in claim 5 further characterized in that step (a) is practiced so that the sheath fibers comprise between about 68-83 percent of the yarn.

7. The method as recited in claim 1 characterized by the further step of applying an antimicrobial agent to the fabric.

8. The method as recited in claim 7 characterized in that the antimicrobial agent is bioactive silyl quaternary amine compound having the formula:



wherein R is an alkyl of 11 to 22 carbon atoms and R^1 is a bromine of chlorine.

9. A top bedsheet, bottom bedsheet, or pillow case characterized by a circular jersey knit fabric made of yarn having a sheath and core configuration, the sheath fibers comprising predominantly cotton or cellulosic fibers having smoothness of hand properties comparable to those of cotton, and the core comprising predominantly synthetic material having strength properties significantly greater than the sheath fibers.

10. A top bedsheet, bottom bedsheet or pillow case as defined in claim 9 and further characterized in that the fabric has an antimicrobial agent applied thereto.

FIG. 1

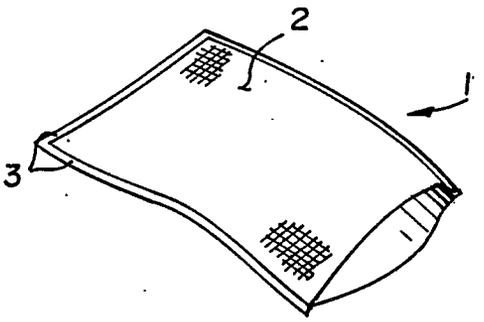


FIG. 2

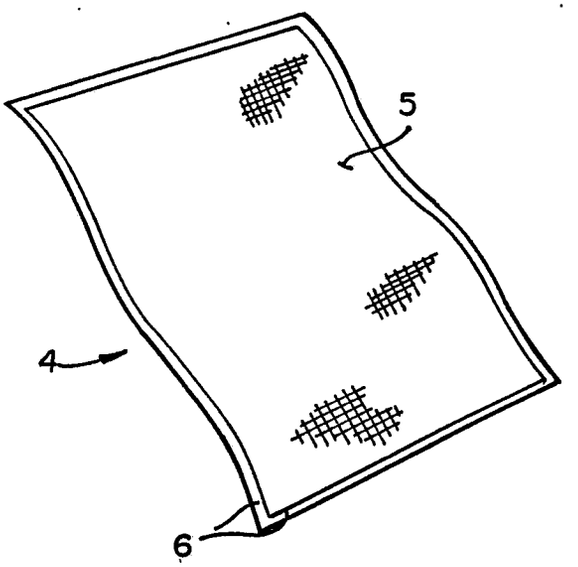
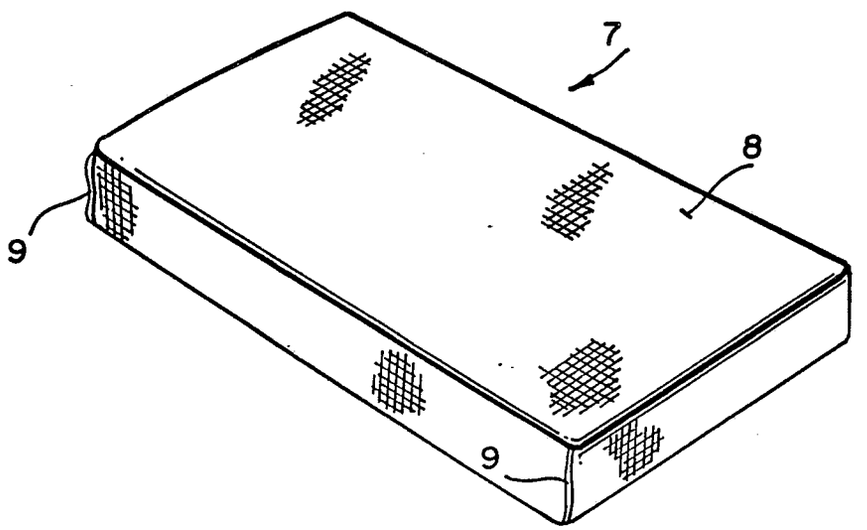


FIG. 3



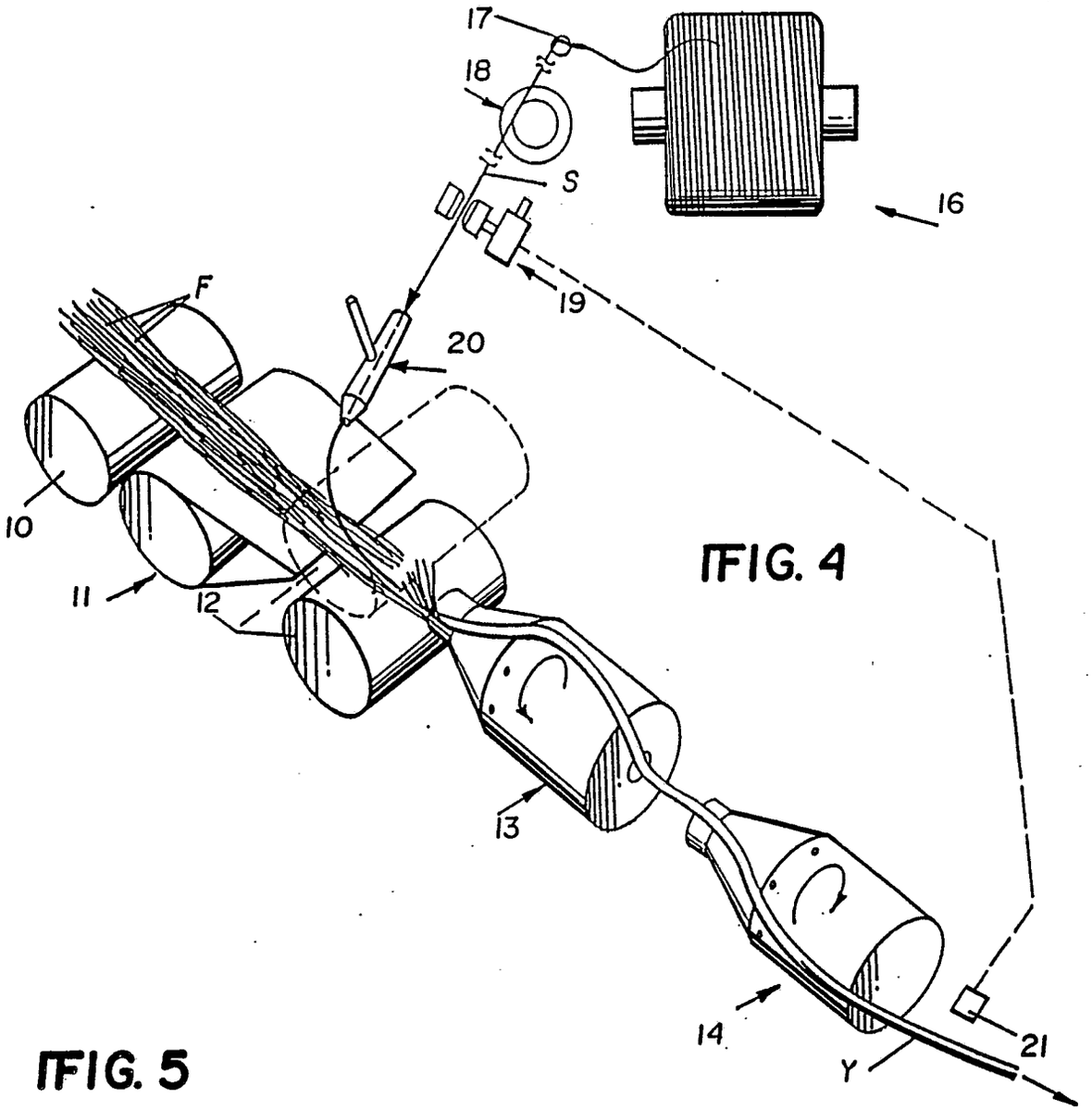


FIG. 4

FIG. 5

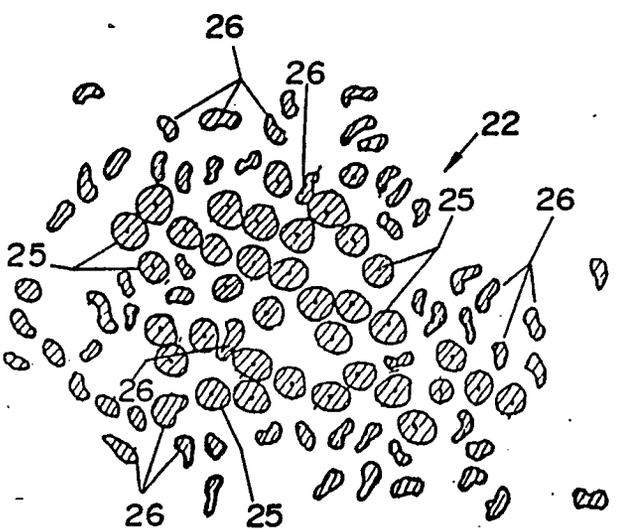


FIG. 6

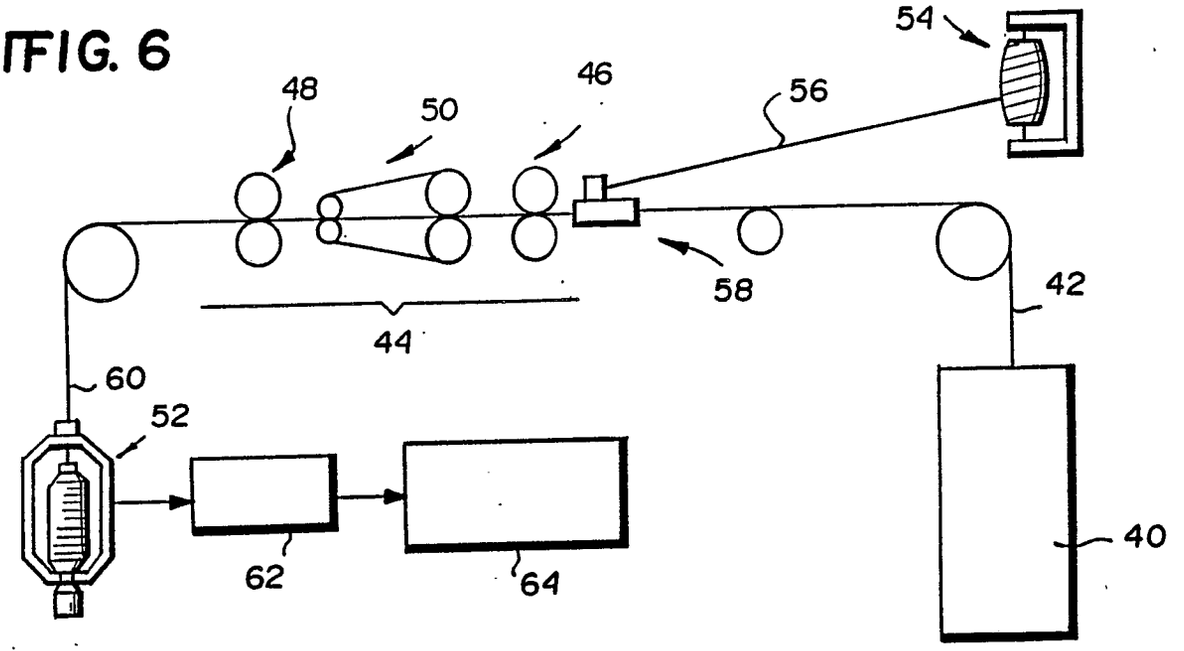
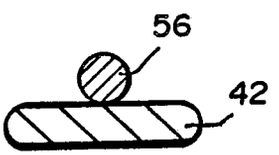


FIG. 7



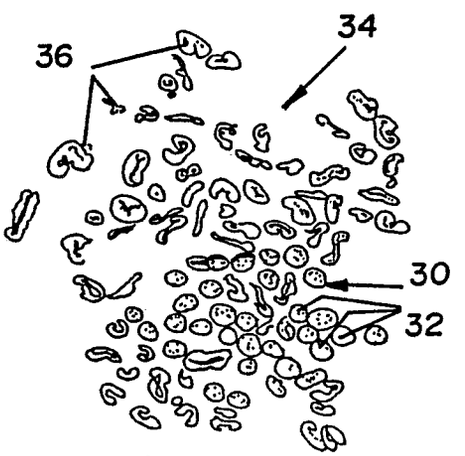


FIG. 9

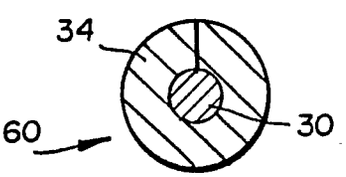


FIG. 8