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J. L. MEADE

2,332,738

METHOD OF MAKING STOCKINGS

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Fig. 1.

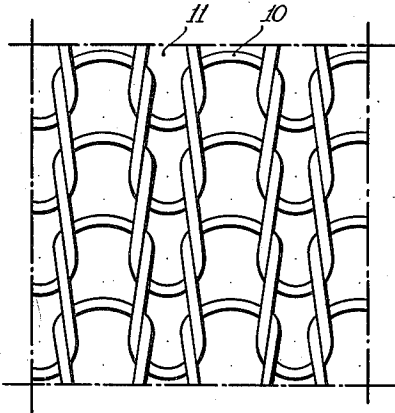


Fig. 2.

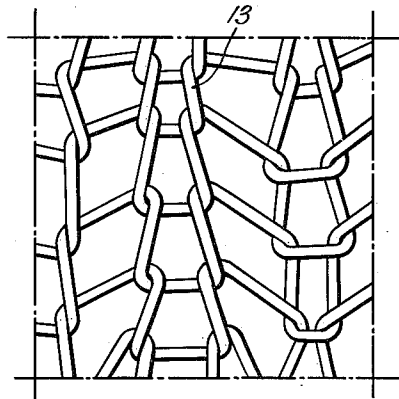


Fig. 3.

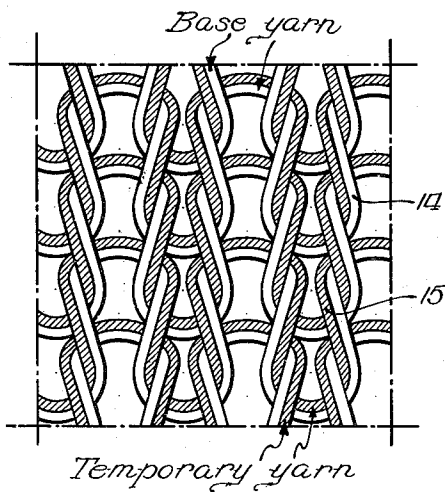


Fig. 5.

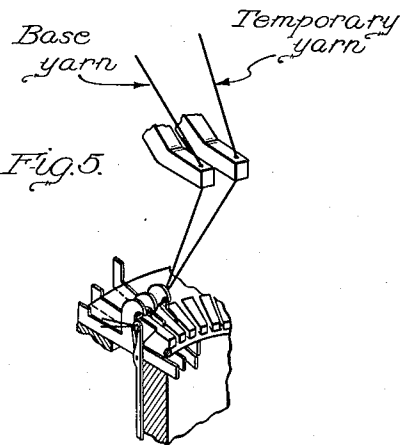
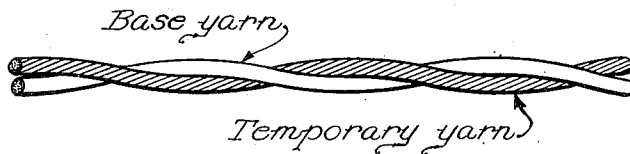


Fig. 4.



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UNITED STATES PATENT OFFICE

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METHOD OF MAKING STOCKINGS

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12 Claims. (Cl. 66—169)

This invention relates to fabric construction, for example, knitted articles, and a process for making the same, and more particularly to the knitting of a hosiery article, comprising in whole or in part yarns which involve difficulties when conventionally knit to form the relatively larger loops found necessary for maximum fabric stretch, as for example, yarns having relatively substantial resiliency, such as those derived from synthetic linear condensation polyamides, of which a specific type suitable for a textile yarn is polyhexamethylene adipamide, commonly termed nylon.

Certain kinds and constructions of yarn exhibit a definite "wildness" or resiliency and marked generation of static electricity and consequent behaviour in the knitting machine which makes it difficult to produce perfect loop formation for predetermined conditions of fabric stretch, both lengthwise and transversely of the fabric. For example, in knitting nylon on the well-known Scott & Williams Model K machine of, say, $3\frac{1}{2}$ inches diameter, 340 needles and 70 gauge, and having as an object the production of a welt having a transverse stretch of say 13", if the nylon is knit by usual methods, i. e. by loosening the knitting tension, the fabric is marred by a preponderance of distorted stitches. These are occasioned principally by the inherent "wildness" or relative resistance to bending possessed by that yarn, which exhibits itself as a tendency of the loops once formed by the knitting implements to distort from a true knitted loop form; by the creation of static electricity by contact of the yarn and fabric with the metal parts of the machine further distorting the stitch, and by the misbehaviour of the fabric caused by a combination of these two factors inhibiting proper take-off, particularly in the case of the turned welt characteristic of the Model K machine. Due to the manner in which such a welt is produced the weight of the fabric leaving the needles must provide its own take-off force and is assisted to some extent by the helical fins in the fabric tube below the dial. However, the accumulated static electricity aggravated further by friction of the exiting fabric against the revolving parts of the machine cause the fabric to "bunch up," twist against the said fins and not feed down as intended. This "bunching" and twisting only serves to multiply and accentuate the distorted stitches and the fabric is rendered unsuitable.

Conventional yarns, e. g., natural silk, cotton, rayons or combinations thereof ordinarily involve no special knitting problems as a result of the natural resiliency thereof since, for practical purposes, they are considered quite pliable except when highly twisted, and easily formed into knitted loops in conventional machines. Nor does the minor generation of static electricity by such

yarns involve any special problems. As a result, the production of fabric of a predetermined uniform stitch construction and hence acceptable appearance, is possible for a large variety of products knit on any particular machine. That is to say, if a ladies' seamless natural silk stocking is to be knit on the Model K machine, great latitude of transverse welt dimensions is possible, depending upon the size of the leg of the wearer the stocking is intended to fit. For example, on a machine of $3\frac{1}{2}$ inches diameter, 340 needles and 70 gauge, satisfactory stretch may be obtained by proper tension control alone and stitch formation is thoroughly uniform.

In this disclosure, when I use the terms "wildness" and "resiliency" I refer to those physical properties of the yarn which exhibit themselves respectively in a tendency to be uncontrollable and to resist bending or, broadly, as inability to substantially retain the shape into which it may have been formed from its natural relatively straight condition.

If a nylon fabric can be knit tightly, the resiliency can be controlled to a considerable extent as thereby the compactness of the loops substantially confines them in the knitted form. But if loosely knitted fabric is the object, then the resiliency evinces itself in distorted stitches caused by the looped yarn tending to return to its straight form, there being insufficient density in the fabric to inhibit such action. Accordingly, if, for example, it is desired to knit a seamless nylon stocking on a machine of the type and size referred to and possessing a stretch of about 13" at the top of the welt, the diameter of the needle cylinder suitable for the leg and foot portion will not permit a welt of sufficient diameter to yield the desired stretch unless the welt is knit very loosely. As a consequence, nylon alone, if so knit into the welt, results in a fabric so abounding in distorted stitches from this as well as the reasons aforementioned as to render the fabric unsaleable. Attempts to reduce the distorted stitches to the point where the appearance is, for practical purposes, acceptable, by increasing the tension of the fabric, reduces the welt diameter to approximately 11".

By "stretch" of the welt I refer to the mill practice of determining the transverse stretch limit of the welt by placing the open end of the welt over the finger tips or on a suitable machine and extending the fabric under definite force to its maximum transverse limit without rupturing the same.

I have found that yarns may be satisfactorily knit to yield a loosely constituted welt having the maximum stretch for a predetermined machine diameter combined with perfect fabric, by introducing to the needles with the body yarn, an auxiliary, temporary yarn which serves to con-

trol or stabilize the resiliency and wildness of the body yarn by adding bulk to the combined stitch whereby the stitches once formed are inhibited from shifting not only by the adjacency of the auxiliary yarn substantially twisted around the nylon yarn acting as a "leader" therefor, but by the confinement of the stitches to a smaller space, as will be hereinafter more fully explained.

Following the knitting in the manner aforesaid, the auxiliary yarn is removed by chemical or other means, leaving the body yarn alone to constitute the final fabric.

After removal of the auxiliary yarn the space between loops is increased over that prevailing during knitting or than it would be if the body yarn alone had been knitted, so that upon the application of transverse stretching the fabric may elongate to a greater diameter than would have otherwise been the case.

In view of the foregoing, the principal aim of my invention is to produce textile fabric having a predetermined zone of maximum stretchability together with optimum stitch structure from a yarn which, if knitted alone would be subject to the objectionable fabricating conditions above outlined.

More particularly said object resides in a process for knitting from a body yarn having these objectionable characteristics a fabric including said yarn and of desirable stretch in a selected zone or zones thereof, while maintaining uniform loop structure, consisting in combining the body yarn with an auxiliary, temporary yarn which is later removed to leave the body yarn in a properly knitted condition.

Still other objects reside in performing the method just outlined by pre-twisting the body and auxiliary yarns before knitting, or by combining them in random relation at the knitting station, or by plating them in a desirable manner upon feeding the yarns to the knitting needles or by appropriate manipulation of the knitting implements.

A further object, in the case of certain fabrics whose characteristic of retention of stitch formation is improved by a "setting" or equivalent operation, is the maintenance of the body and auxiliary yarns in their knitted relation during the setting process and then removing the auxiliary yarn.

In producing ladies' seamless stockings on a Scott & Williams Model K machine, a so-called picot edge is commonly introduced at the top fold of the welt, the dual function of which is to facilitate the folding of the welt on a predetermined line in the formation of the stocking and to simulate the true picot edge of a full-fashioned stocking. Such picot in seamless stockings is ordinarily comprised of a row or rows of tucked stitches which result in a row or rows of larger than normal stitch openings in the fabric and the practical duplication of flat knit picot courses.

Formation of acceptable non-plain loops for this or other purposes by conventional knitting of yarn possessing the objectionable characteristics already pointed out, e. g. nylon, alone, is quite difficult, as the distortion of the stitch caused thereby results in quite irregular formation and, if for a welt edge, in an uneven, wavy and ugly border. However, by my method the picot stitches are even more desirably pronounced than those produced solely by the employment of yarns of equivalent size or weight and not possessed of the undesirable characteristics of the body yarn.

Accordingly, a further object is the production of a fabric having stitches not of plain knit shape and possessing ornamental or functional uses, knit of a body yarn having the aforesaid undesirable characteristics combined with an auxiliary yarn to assist in the formation and retention of the proper shape of the body yarn loops, said auxiliary yarn being removed before the article is ready for sale.

Further objects will become apparent as the description proceeds, which is not intended to be limited to knitted fabrics but comprehends netted or lace work, woven fabrics and other textile fabrics and articles in which employment of the basic principle of my invention will facilitate production and the formation of perfect fabric. For simplicity the disclosure is limited to a knitted article, and as an illustrative example, a nylon ladies' stocking, but it will be apparent that utilization of my invention in producing other classes of fabrics and articles will follow substantially the process outlined for a knitted fabric.

In the drawing:

Figure 1 represents a section of knitted fabric of perfect loop formation;

Figure 2 represents a section of knitted fabric showing distortion of loops occurring when knitting with yarn having the undesirable characteristics alluded to;

Figure 3 represents a section of knitted fabric employing the principle of my invention but before removal of the auxiliary yarn;

Figure 4 shows a section of yarn composed of the body and auxiliary yarns twisted together for ease in knitting; and

Figure 5 shows, in a somewhat diagrammatic way, the feeding of both yarns to the needles separately.

First referring to Figure 1, it will be noted that all the loops of sinker wales 10 and needle wales 11 are of perfect form with all the loops in a selected wale of the same length and width. Production of such fabric for various degrees of tight and loose knitting on a selected diameter of machine is simple to attain when the yarn has no decided tendency to become resolved after loop formation into distorted stitches. For example, natural silk of normal twist, is such a yarn, and a predetermined zone of the stocking wherein substantial stretch is desired, e. g. the welt, can be knit of silk, and loosening of the tension within practical limits will not result in stitch distortion.

On the other hand, if said welt is to be knitted of nylon, loosening of the tension as contrasted with the tension at which the leg stitches are knit, to produce a welt having a high degree of diametral stretch will relax the nylon to such an extent that the resiliency of the loops makes itself evident in an attempt of the yarn to return to its natural straight condition, and static electricity magnifies this undesirable consequence, (see Figure 2). Therein it will be seen that needle loop 13 which is intended to be of the same shape and dimensions as a needle loop of Figure 1, has become deformed to such an extent that all loops adjacent thereto have been pulled out of shape, and when this condition is multiplied over the entire area of the fabric, the same is seriously marred. Due to unavoidable varying resiliency in a given length of yarn, and variations in generation of static electricity, some loops may become distorted to a greater or lesser degree than others so that the fabric takes on

a decided irregularly marked appearance and sleaziness. Furthermore, if it is attempted to decrease the tendency of the loops to distort themselves by increasing the tension, as detailed hereinabove, diametral stretch is reduced to the point where improper fit of the welt results, and is equally objectionable.

By the process of my invention I introduce with the main body yarn a temporary, auxiliary yarn of a kind or character that may be separated from the body yarn without harming the latter. Said auxiliary yarn may be of any origin, animal, vegetable or mineral and may be separated by any means, physical, chemical or otherwise. Moreover, I do not desire to limit myself to an additional auxiliary yarn, but may prepare the body yarn with a suitable covering, sizing or equivalent stabilizing medium that will assist in maintaining the desired loop formation and/or decrease the adverse effect of static electricity, and may later be removed by chemical or other means.

In Figure 3 is shown a section of fabric utilizing my invention in which the base or body yarn 14 and auxiliary yarn 15 are knit in closely adjacent relation to jointly form the knitted loops. In this manner, the auxiliary yarn exerts an anchoring or stabilizing effect on the basic yarn by balancing its inherent stitch form retentivity against the opposite effect of the basic yarn, and for this reason I prefer to use an auxiliary yarn exhibiting such opposing action. Although, for ease in clearly depicting the principle of my invention, the two yarns are shown in parallel relation it will be obvious to those skilled in the art that, unless accurate plating mechanism is employed, actually the two yarns will tend to twist one about the other, a result which does not adversely affect the directing or stabilizing effect of the auxiliary yarn. Yarns 14 and 15 may be fed to the machine in any known manner, together at random, plated, or pre-twisted as shown in Figure 4. In Figure 5 the yarns are shown being knit at random by the needles and sinkers of a simple, plain knit, circular knitting machine.

In addition to the effect of the auxiliary yarn in stabilizing the body yarn, it adds bulk to the loops to fill the inter-loop spaces, thereby confining said loops in their intended stitch formation and prohibiting movement thereof. Furthermore, the additional mass of the auxiliary yarn assists in the knitting-off of the fabric. Compare Figures 1 and 3.

Following the knitting as aforesaid, the auxiliary yarn is eliminated as will be hereinafter described in detail.

The complete process can be summarized by referring to the production of a nylon seamless stocking. I have found that natural silk is to be preferred over other yarns for use as the auxiliary yarn since it may be easily knit by the needles of the finer gauge machines employed for fine nylon seamless hosiery and can be readily removed by agents that are non-deleterious to the nylon. Hence I feed at random with the nylon basic welt yarn, say 70 denier, an auxiliary yarn of natural silk consisting of two ends of 20/22 denier, the tension being regulated as for natural silk alone. Upon completion of the welt, or shadow welt if one is desired, the auxiliary yarn feeding is discontinued and conventional knitting completed, whereupon the stocking is looped and, if desired, provided with a mock seam. The stocking may then be preset or pre-

boarded by methods commonly in use, e. g. that described in applications Serial No. 279,449, filed June 16, 1939, by George E. Dunn and Serial No. 351,654, filed August 7, 1940, by George E. Dunn and Henry Richter, or in Patent No. 2,157,119, dated May 9, 1939. If the basic yarn is of a type necessitating a "setting" different from those referred to, then such step is performed prior to that portion of the process now to be detailed in order to avoid stitch distortion resulting from agitation of the fabric while under conditions of heat and moisture, as is understood in the art.

Into a rotary dyeing machine, of say 100 lbs. nominal capacity, containing approximately 200 gallons of water, is introduced a mixture of 10 lbs. of soap and 5 lbs. of commercial caustic soda flakes previously dissolved in water. The resultant dilute solution is heated to 205° F. and 100 lbs. of goods added. The drum is rotated for 30 minutes while the temperature of 205° F. is maintained. Primarily this bath removes oils, the sizing from the nylon, and the sericin from the silk, but may have some solvent effect on the fibroin of the silk. After running off this bath there is prepared a bath consisting of 50 lbs. of caustic soda and 3 lbs. of soap previously dissolved in 200 gallons of water, and the goods are treated therein for 20 minutes at 205° F. This bath is then run off and followed by two hot rinses and one cold rinse to remove all traces of caustic. The concentrated caustic solution is intended to dissolve out all the fibroin of the silk auxiliary yarn. Thereafter the usual dyeing and finishing operations are performed. Tests show that the caustic treatment improves the elongation of nylon 16% to 20% over normal with no apparent effect on its original tensile strength.

After the auxiliary yarn has been eliminated the loops of body yarn are freed for greater movement within the fabric not only by the normal bending and sliding of the loops on one another, but due to the greater free space between loops. Consequently, stretching results in greater elongation of the fabric than was possessed by the fabric including the auxiliary yarn of than could be obtained by attempting to knit of body yarn alone by conventional methods. Moreover, the inherent elastic properties of the body yarn may evidence themselves and are enhanced by the increased elasticity resulting from the caustic treatment.

Many yarns are commonly available for use as the auxiliary yarn, and may be listed for convenience as follows:

- A. Mineral fibers, e. g. asbestos, glass.
- B. Cellulose derivatives.
 1. Lignocellulose, e. g. kapok, jute, hemp.
 2. Cellulose, e. g. cotton, flax.
 3. Swollen cellulose, e. g. mercerized cotton, rayons.
 4. Cellulose ester, e. g. acetate rayon.
- C. Protein fibers.
 1. Protein and mineral matter, e. g. weighted silk.
 2. Silk, e. g. true silk.
 3. Casein derivatives, e. g. Lanital.
 4. Hairs, e. g. wool, mohair, camel hair.

Wool is removable by a solution of ammonium hydroxide, NH_4OH , or potassium hydroxide, KOH ; cotton is soluble in dilute sulphuric acid, H_2SO_4 ; rayons, e. g. cellulose acetate, in glacial acetic acid, CH_3COOH , or acetone CH_3COCH_3 . These specifically mentioned dissolving agents

have little or no deleterious effect on nylon when used in the concentration, for the time, and at the temperature requisite to properly eliminate the temporary yarn. However, it is recognized that prolonged exposure of nylon to certain reagents, e. g. strong mineral acids or strong caustic alkalies will adversely affect it.

However, the aforementioned tabulation is intended as illustrative only, as the list of fibers, principally synthetic, is expanding apace and yarns as yet undiscovered or whose full uses are as yet unappreciated, could be found applicable to the purpose of this invention. Among these may be mentioned vinyon, a combination of vinyl chloride and vinyl acetate, having a melting point of about 150° F. so that an auxiliary yarn of this material could be eliminated without a separate operation, e. g. in the conventional scour and/or dye bath or application of heat at a temperature in excess of the melting point; or alginates, e. g. sodium alginate or calcium alginate, the former being soluble in water alone and the latter in a solution of soap and water. If such yarns became available commercially they would be of great advantage in the performance of the within process, the auxiliary yarn being removed in the standard scouring and/or dyeing, or in the particular case of nylon, the moisture present in the setting medium would dissolve out the temporary yarn.

The choice of the fiber constituting the auxiliary yarn forms no part of my invention, beyond having the broad characteristics of being separable from the basic yarn by an agent that is without deleterious effect on the basic yarn, adds bulk to the loops, and exerts a stabilizing influence on the distortive tendency of the body yarn.

I claim:

1. That process of knitting under low fabric tension a textile fabric including a body yarn possessing substantial resiliency resulting in resistance to the formation and retention of knitted loops which comprises as steps, fabricating the fabric conjointly of said body yarn and a controlling yarn and in feeding the said yarns to the machine in an intimate relationship to enable the controlling yarn to exert a stabilizing influence on the body yarn during fabrication, and then removing the controlling yarn.

2. That process of knitting under low fabric tension a knitted fabric including a body yarn possessing substantial resiliency resulting in resistance to the formation and retention of knitted loops which comprises as steps, jointly feeding to the knitting machine with said yarn a controlling yarn, said yarns being fed to the machine in intimate relation to enable said controlling yarn to exert a stabilizing influence on said body yarn, and then removing the controlling yarn.

3. That process of knitting under low fabric tension a knitted fabric including a body yarn possessing substantial resiliency resulting in resistance to the formation and retention of knitted loops which comprises as steps, jointly feeding to the knitting machine in intimate relation with said yarn a controlling yarn of less resiliency than said body yarn to enable said controlling yarn to exert a stabilizing influence on said body yarn during formation of the knitted loops, and then removing said controlling yarn.

4. That process of knitting under low fabric tension a knitted fabric including a body yarn

possessing substantial resiliency resulting in resistance to the formation and retention of knitted loops which comprises as steps, jointly feeding to the knitting machine with said yarn an auxiliary yarn possessing less resiliency than said body yarn, said yarns being fed in an intimate relation to enable said auxiliary yarn to exert a stabilizing influence on said body yarn during formation of the knitted loops, and then removing said auxiliary yarn by means that is without deleterious effect on the body yarn.

5. That process of knitting under low fabric tension a knitted fabric including a body yarn possessing substantial resiliency resulting in resistance to the formation and retention of knitted loops which comprises as steps, jointly feeding to the knitting machine with said yarn an auxiliary yarn possessing less resiliency than said body yarn, said yarns being fed in intimate relation to enable said auxiliary yarn to exert a stabilizing influence on said body yarn, treating the fabric to immobilize the loops in their desired form and then removing said auxiliary yarn.

6. That process of knitting under low fabric tension a textile fabric including a body yarn possessing substantial resiliency resulting in resistance to the formation and retention of knitted loops which comprises as steps, forming the fabric of said body yarn and an auxiliary yarn of lesser resiliency conjointly fed together in intimate relation to enable the auxiliary yarn to exert a stabilizing influence on the body yarn to preserve the desired fabric formation against the distortive effect of the body yarn.

7. That process of knitting under low fabric tension a textile fabric including a body yarn possessing substantial resiliency resulting in resistance to the formation and retention of knitted loops which comprises as steps, forming the fabric of said body yarn and an auxiliary yarn of lesser resiliency conjointly fed together in intimate relation to enable the auxiliary yarn to exert a stabilizing influence on the body yarn to preserve the desired fabric formation against the distortive effect of the body yarn, treating the fabric to neutralize the said distortive effect, and removing the auxiliary yarn under conditions having no deleterious effect on the body yarn or diminishing effect on the said treatment.

8. That process of knitting under low fabric tension a textile fabric including a body yarn derived from synthetic fiber-forming polymeric amides having a protein-like chemical structure, said yarn being characterized by substantial resiliency resulting in resistance to the formation and retention of knitted loops which comprises as steps, forming the fabric of said body yarn and an auxiliary yarn of different character from said body yarn fed to the machine in an intimate relation such that the auxiliary yarn may exert a neutralizing influence on the fabric-distorting effect of the body yarn, subjecting the fabric to a setting treatment to stabilize the body yarn substantially in the form in which it has been fabricated, and removing the auxiliary yarn under conditions having no deleterious effect on the body yarn or the form in which the same has been set.

9. That process of knitting under low fabric tension a textile fabric including a body yarn derived from synthetic fiber-forming polymeric amides having a protein-like chemical structure, said yarn being characterized by substantial resiliency resulting in resistance to the formation and retention of knitted loops which comprises

as steps, knitting the fabric of said body yarn and an auxiliary yarn of different character from said body yarn fed to the knitting implements in an intimate relation such that the auxiliary yarn may exert a neutralizing influence on the stitch-distorting effect of the body yarn, subjecting the fabric to a setting treatment to stabilize the body yarn loops substantially in the form in which they have been knit, and removing the auxiliary yarn under conditions having no deleterious effect on the body yarn or the form in which the loops have been set.

10. That process of knitting under low fabric tension a textile fabric including a body yarn derived from synthetic fiber-forming polymeric amides having a protein-like chemical structure, said yarn being characterized by substantial resiliency resulting in resistance to the formation and retention of knitting loops, which comprises as steps, forming the fabric of said body yarn and an auxiliary yarn of natural silk fed to the machine in an intimate relation such that the auxiliary yarn may exert a neutralizing influence on the fabric-distorting effect of the body yarn, subjecting the fabric to a setting treatment under suitable conditions of heat and moisture to stabilize the body yarn substantially in the form in which it has been fabricated, and removing the auxiliary yarn by subjecting the fabric to a caustic solution under conditions which will eliminate the auxiliary yarn without deleterious effect on the body yarn or disturbing the form in which the fabric has been set.

11. That process of knitting under low fabric tension a knitted fabric including a body yarn derived from synthetic fiber-forming polymeric amides having a protein-like chemical structure, said yarn being characterized by substantial resiliency resulting in resistance to the formation and retention of knitting loops, which comprises as steps, knitting the fabric of said body yarn and an auxiliary yarn of natural silk fed to the knitting machine in an intimate relation such that the auxiliary yarn may exert a neutralizing influence on the loop-distorting effect of the body yarn, subjecting the fabric to a setting treatment under suitable conditions of heat and moisture to stabilize the body yarn loops substantially in the form in which they have been knit, and removing the auxiliary yarn by subjecting the fabric to a caustic solution under conditions which will eliminate the auxiliary yarn without deleterious effect on the body yarn or disturbance of the form in which the loops have been set.

12. The method of improving the stretchability of hosiery which comprises knitting said hosiery with a composite yarn comprising a permanent nylon hosiery yarn and a transitory yarn, said transitory bulking yarn being of sufficient bulkiness to form knit loops of larger size than would otherwise be possible with good loop formation, and removing said transitory bulking yarn to leave an open knit fabric of good loop formation and improved stretchability.

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