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W. J. LEATH ET AL

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YARN AND METHOD OF PRODUCING THE SAME

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Fig. 1

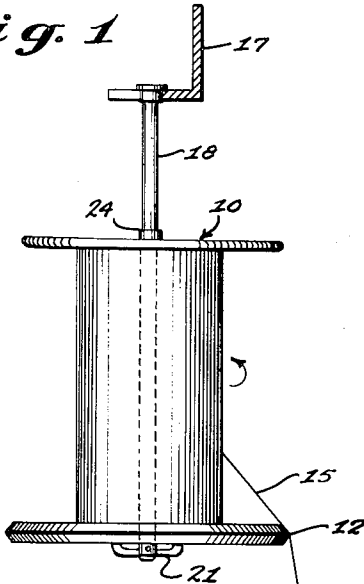


Fig. 3

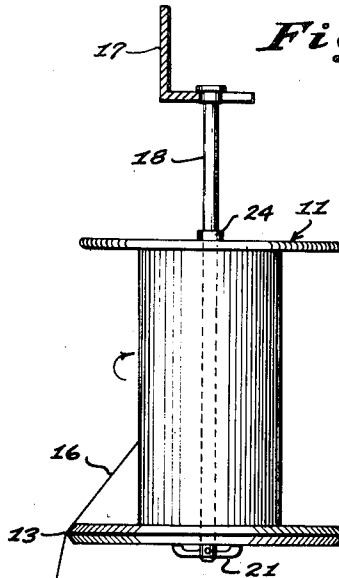


Fig. 2

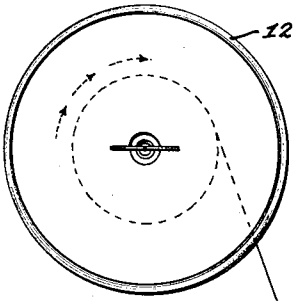


Fig. 4

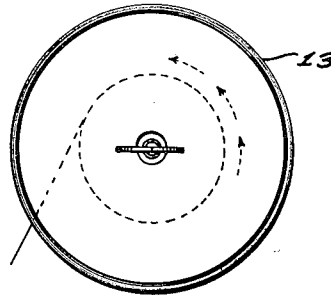


Fig. 5

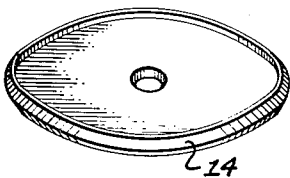
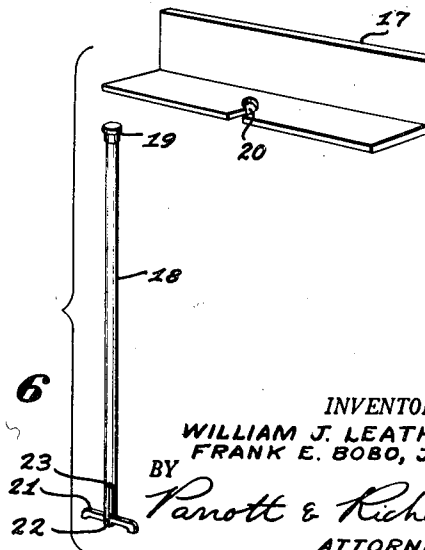


Fig. 6



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YARN AND METHOD OF PRODUCING THE SAME

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28 Claims. (Cl. 57—140)

This invention relates to a new form of twisted yarn and to a method and means for preparation of the yarn and for handling thereof in the production of stretchable knitted fabrics.

One of the features of this invention is to impart to nylon or other yarn a lively or wildness characteristic which will result in stretchable properties in knitted fabric formed of this yarn.

Another commercially valuable feature of this invention is the handling of the twisted nylon yarn in such a manner that its wildness characteristic is kept under control when the yarn is delivered from the carrier on which it is wound, to the knitting machine so that it will not snarl or become tangled or knotted between the time that it is delivered or unwound from the carrier, and is knitted into the fabric.

The twisted and treated yarn produced in accordance with this invention has unique and novel characteristics distinctly different from twisted yarns proposed heretofore for use in stretchable hose or other stretchable fabrics. The prior forms of stretchable yarn are characterized by multitudinous deformations in the yarn. These deformations may be in the form of crimped portions or in the form of a number of fine coils similar in shape to a coiled spring, or they may have a coil construction similar to a corkscrew, as well as other varying forms.

The novel yarn of the present invention is characterized by its freedom from coils and absence of crimped or other such deformations in the yarn. On the contrary, the yarn of this invention has a smooth, continuous, substantially straight form and exhibits little or no elasticity or stretchability of the yarn as such, and, furthermore, does not depend upon the elongation of coils or crimps in the yarn to provide a stretchability property in the hose or other knitted fabric produced from this yarn.

The stretchable property in hose or fabrics knitted from this yarn is obtained from the lively or wildness characteristic of the yarn that is controlled temporarily during the knitting operation, but which after knitting causes the loops or stitches in the hose or knitted fabric to deform or orient out of their normal positions, and yet upon stretching of the fabric permits these stitches or loops to orient into their normal positions. This movement or change in disposition of the loops or stitches provides the novel stretchable characteristics in the knitted product.

The method of twisting the yarn to produce the lively characteristic in accordance with the present invention comprises, generally, a first twisting of one end of the nylon yarn, multifilament or monofilament, in one direction, say to the right, so as to provide an S twist, then heating to a temperature sufficient to "set" the yarn and which temperature will be higher than all subsequently encountered temperatures in the treatment of the yarn or product made therefrom, followed by twisting the yarn in the opposite direction, that is to the left, and providing therein a Z twist. This reverse or backtwisting operation will determine principally the amount of liveliness

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or wildness in the yarn and the extent of twist will depend upon the degree of this property desired in the yarn.

The first twist applied to the yarn as described just above may vary substantially in extent, or number of twists applied, a typical range being 20 to 50 turns twist. At the end of this first twisting operation, especially if as many as 40 or 50 or more turns are applied, the twisted yarn will possess a substantial liveliness or wildness sufficient to form a stretchable fabric, upon knitting or weaving. However, subsequent high temperature treatments of the twisted yarn or fabric produced therefrom, such as normally occur in the manufacture of full fashioned hosiery, would substantially remove the lively characteristics and stretchability of the yarn or fabric because of the fact that the yarn at this stage, immediately after the first twisting, has not been set with heat. Thus it is important in carrying out the method of this invention, to incorporate a heat-setting of the nylon yarn at an appropriate point and to have this heat-setting operation carried out at a temperature appreciably higher than any subsequently encountered temperature.

As above indicated, it is important, and in fact essential, to heat-set the yarn at the proper time and at an adequate temperature to avoid losing the lively effects induced in the yarn by the twisting operation when the hose knitted therefrom are subjected to subsequent higher temperature treatments. In the method of this invention, this heat-setting treatment may be carried out after the first twisting operation and prior to the second or backtwisting operation and, in fact, this is the presently preferred procedure. However, worthwhile benefits may be obtained from the method of this invention when carried out as described above except for changing the time or point in the process of the heat-setting operation. For example, we have produced yarn having substantial stretchability and produced ladies' full fashioned hose therefrom, in which the heat treating operation was applied to the yarn prior to twisting of the yarn. In this modification, no second or reverse twisting of the yarn is required; only the initial heat treating, followed by twisting the desired number of turns such as, for example, about 10 to 50 turns.

In the manufacture of nylon full fashioned hosiery, the twisted yarn would usually be heat-set at a temperature of about 270° F. for a sufficient length of time, e. g., one half hour, to effect the desired heat-setting. This heat-setting temperature could be higher if desired, but the important point is the use of a temperature sufficiently higher than the subsequent processing temperatures to avoid damaging effects of the latter. In the manufacture of full fashioned hosiery, the subsequent processing temperatures encountered in the dyeing and finishing operations are in the order of 250° F. or about 20° lower than the above-mentioned 270° F. heat-setting temperature, which is found to be a safe margin. If the subsequent temperature equals or exceeds the previous heat-setting temperature, the twist effect in the yarn will be substantially completely lost.

Another important feature of the twisting and heat-setting operations of this invention is that of twisting the yarn adequately following the first twisting and heat-setting operations, because the heat-setting operation substantially removes or neutralizes the liveliness imparted to the yarn by the first twisting operation. This being so, the yarn, after heat-setting, requires further twisting to effect the desired liveliness. The amount of twisting employed after heat-setting will depend upon the desired degree of liveliness or stretchability desired in the yarn or fabric made therefrom. This twisting after heat-setting may vary substantially as to the number of twists and may be of the order of the first twisting operation described above prior to heat-setting or it may be more

or less than the first twisting operation, e. g., 20 to 60 turns twist. A typical example of the twisting operations that has given very good results is a first twist of 30 turns followed by heat-setting and then a backtwisting of 23 turns.

Also, it is usually of advantage to employ in this second twisting operation, a twist that is opposite in direction to the original twist, i. e., a Z twist for the second twisting operation where an S twist has been employed in the original twisting operation. A reverse or backtwist of this type, after heat-setting, will increase desirably the liveliness in the yarn as compared to a continuation of twist in the same direction as the original twist. Furthermore, the strength and other physical properties of the yarn will be better maintained by the use of a reverse or backtwist for the second twisting operation.

When multifilament yarns are used in these twisting operations, it is desirable to extend the reverse or backtwisting operation at least some few turns more or less than the twist in the original twisting operation, so that the several filaments comprising the yarn will be integrated more completely by the additional turns twist than would be the case if the backtwist equaled the forward twist and left the filaments in substantially untwisted or parallel position. An example of twists used with the multifilament yarns is 30 turns for the forward twist and 37 or 23 turns for the backtwist.

Further specific but non-limiting examples of the twisting and heat-setting operations described generally above, which we have employed satisfactorily in the production of yarn for knitting ladies' sheer nylon stretchable hose, are as follows:

One end of monofilament nylon yarn is twisted 30 turns per inch in a Z or left twist direction. Another end of the same nylon yarn is twisted 30 turns per inch in an S or right twist direction. These two separately twisted nylon yarns are subjected to treatment with live steam in suitable equipment such as a pressure or vacuum retort and at a temperature of approximately 265° F.-270° F. for a sufficient length of time to effect proper penetration. After this treatment with live steam, the yarn is transferred to twister bobbins and twisted 23 turns in the opposite direction of the original twist.

In accordance with the present invention we have discovered a method and means for controlling the lively characteristic of the twisted nylon yarn during the delivery of the yarn from the yarn carrier to the knitting machine. This new and improved procedure comprises the feature of delivering or unwinding the twisted yarn, from its carrier, in a direction opposite to the direction of the twist previously applied to the yarn. The yarn delivery arrangement also comprises training of the yarn end over and around a projection on the yarn spool or carrier which tends to maintain the yarn in a straight disposition between the spool and the knitting machine.

Further details of the present invention will be understood from the following description taken in conjunction with the accompanying drawing in which:

Fig. 1 is an elevational view of a yarn carrier in the form of a double head spool and having wound thereon a supply of yarn previously twisted in a left or counterclockwise direction, and arranged to deliver the yarn therefrom in a right or clockwise direction;

Fig. 2 is a bottom end view of the carrier shown in Fig. 1;

Fig. 3 is an elevational view of a yarn carrier of the same type shown in Fig. 1 and having wound thereon a supply of yarn previously twisted in a right or clockwise direction, and arranged to deliver the yarn therefrom in a left or counterclockwise direction;

Fig. 4 is a bottom end view of the carrier shown in Fig. 3;

Fig. 5 is an elevational view of a draw cap adapted to be mounted on the bottom end of the yarn carrier as shown in Figs. 1 and 3; and,

Fig. 6 is an elevational, exploded, view of a hanger and key for use in mounting the yarn carrier as shown in Figs. 1 and 3.

Referring now to the several figures in the drawing, it will be noted that the two yarn spools 10 and 11, shown in Figs. 1 and 3, are counterparts of each other and are associated in a twin arrangement for delivery of the oppositely twisted yarns from each of these spools to a knitting machine (not shown) below. These oppositely twisted yarns, when used for knitting of ladies' full fashioned nylon hose, are fed separately to two carriers on the knitting machine such that the yarns can be knitted in alternating courses to provide a balanced stretchable knitted fabric as disclosed in our copending application, Serial No. 447,600, filed August 3, 1954.

As indicated by the arrows in Figs. 1 and 3, the yarn wound on the spool in Fig. 1 has been twisted in a left or counterclockwise direction, whereas the yarn wound on spool 11 has been twisted in a right or clockwise direction. We have found it important in delivering these yarns to the knitting machine free of snarls or knots to deliver or unwind the yarns in the direction opposite to that in which they have been previously twisted, and this is indicated by the arrows shown in the bottom end views in Figs. 2 and 4. If the yarn is attempted to be unwound from the spool in the same direction in which it was previously twisted, substantial snarling or distorting of the yarn is encountered thereby rendering the knitting operation difficult and producing defects in the knitted fabric. These difficulties and defects are avoided by unwinding the yarn from each spool in a direction opposite to its original twist as described above.

For further ease of delivery of the yarn from the spools and to prevent snagging or breaking of the yarn, the bottom or delivery end of each spool is covered with a suitable smooth surface draw cap shown at 12 and 13 in Figs. 2 and 4, respectively. This draw cap, which is also shown at 14 in Fig. 5, may be made of any suitable smooth-surface material and we have found that a hard rigid molded resin draw cap will provide a smooth snag-free surface for delivery of the yarn.

In addition to unwinding of the yarn in the direction opposite to which it has been twisted and providing a smooth contact surface at the bottom of the yarn spool, as described above, it is also advantageous to stress the yarn slightly as it is being unwound. This is accompanied, at least in part, by training the yarn ends 15 and 16 over and around the draw caps 12 and 13, respectively, shown in Figs. 1 and 3.

The mounting arrangement for the yarn spools above the knitting machine, as indicated in Figs. 1 and 3, comprises an angle iron hanger 17 and a short shaft or key 18, shown connected in Figs. 1 and 3, and separated in Fig. 6. The shaft 18 has a boss or enlargement 19 at the top end for engaging the slot 20 in the bracket 17. The other end of the shaft 18 has a key 21 which is pivotally mounted at point 22 so that it can be disposed in alignment with the shaft 18 by nesting in the slot 23, thereby enabling the shaft 18 to be inserted in the bore 24 of the bobbin. After insertion in the bobbin, as indicated in Figs. 1 and 3, the key 21 may then be oriented so that it is positioned at right angles to the shaft 18 and thereby forms a suspension point for the draw cap 12 as well as the entire yarn bobbin.

As a further aid in handling of the yarn during the knitting operation, that is, to overcome temporarily the wildness of the yarn so that it will not snarl or distort in passing from the yarn supply spool to the knitting machine, we have found that the yarn may be treated with a thin oil or oily liquid. This treatment may be carried out by immersing the spools of wound yarn, such as illustrated, in Figs. 1 and 3 in the accompanying drawing, so that the thin oily liquid will penetrate the supply of wound yarn on the spool. After a thorough soaking of the spools in this manner, they are then removed from

the liquid bath and the excess liquid permitted to drain off.

This treatment of the yarn with the oily liquid does not adversely affect the desired lively or wildness characteristic of the yarn and, in fact, has no permanent effect on the yarn but, nevertheless, does render the yarn temporarily limp so that it may be handled more easily in the knitting operation. The oily liquid used for this purpose may be any suitable liquid which will penetrate the yarn easily and have some softening or plasticizing effect such that the yarn can be handled satisfactorily in knitting. A typical example of a satisfactory liquid which we have used successfully is a light petroleum distillate product in the nature of deodorized kerosene and contains a small percentage of wax or degreas dissolved in the liquid.

It will be understood that the above described mechanical arrangement and also the liquid treating of the yarn are not limited to any particular type of twisted yarns and may be used generally where a lively or wildness characteristic of the yarn needs to be controlled during the knitting operation. The twisted yarn may, as above suggested, be used in the knitting of ladies' sheer hosiery, either full fashioned or seamless types, or in the production of other knitted fabrics. Similarly, while nylon yarn is the presently preferred commercial form of yarn best suited for this purpose, other types of synthetic yarn, such as "Dacron" and "Orlon," which are adaptable for handling in accordance with the present invention may be used. Technical identifications of these three yarns are as follows:

Nylon—A group of thermoplastic linear long-chain superpolyamides.

"Dacron"—A condensation polymer of terephthalic acid and ethylene glycol.

"Orlon"—Acrylonitrile polymer, usually combined with other substances.

Throughout the specification and claims herein in each instance where reference is made to "turns" in the twisted yarn, it is to be understood that this is based upon turns per inch, as already stated in one instance hereinabove.

Various modifications and changes may be made in the above described process, materials and conditions without departing from the scope of our invention as defined in the appended claims.

We claim:

1. A heat set and then twisted synthetic resin yarn having a permanent pronounced tendency to untwist resulting in substantial wildness that causes the yarn to snarl when relaxed, the twist being sufficient to cause substantial stitch distortion which imparts substantial stretchability and retractability to a fabric produced therefrom.

2. A synthetic resin yarn as defined in claim 1 and in which the yarn is monofilament.

3. A synthetic resin yarn as defined in claim 1 and in which the yarn is multifilament.

4. A synthetic resin yarn as defined in claim 1 and in which the yarn is monofilament nylon yarn.

5. A synthetic resin yarn as defined in claim 1 and in which the yarn is twisted at least 10 turns per inch.

6. A synthetic resin yarn as defined in claim 1 and in which the yarn is a thermoplastic yarn.

7. A synthetic resin yarn as defined in claim 1 and in which the yarn is a condensation polymer of terephthalic acid and ethylene glycol.

8. A continuous filament nylon hosiery yarn which has been heat set and subsequently twisted between 10 and 50 turns per inch without further heat setting and having a permanent liveliness sufficient to cause the yarn to snarl when relaxed whereby hosiery knitted of said yarn has desirable stretchable characteristics.

9. A continuous filament knitting yarn selected from the group of yarns consisting of nylon, condensation polymers of terephthalic acid and ethylene glycol, and acrylonitrile polymers, said yarn being heat set and subsequently twisted without further heat setting and having

a permanent pronounced tendency to untwist resulting in a substantial, permanent, normally objectionable, liveliness sufficient to cause the yarn to snarl when relaxed and prevent knitting thereof in conventional manner, but when knitted under controlled tension causes substantial distortion of the stitches and thereby imparts desirable stretchable characteristics to the knitted fabric.

10. A continuous monofilament knitting yarn selected from the group of yarns consisting of nylon, condensation polymers of terephthalic acid and ethylene glycol, and acrylonitrile polymers, said yarn being heat set and subsequently twisted without further heat setting and having a permanent pronounced tendency to untwist resulting in a substantial, permanent, normally objectionable, liveliness sufficient to cause the yarn to snarl when relaxed and prevent knitting thereof in conventional manner, but when knitted under controlled tension causes substantial distortion of the stitches and thereby imparts desirable stretchable characteristics to the knitted fabric.

11. A continuous multifilament knitting yarn selected from the group of yarns consisting of nylon, condensation polymers of terephthalic acid and ethylene glycol, and acrylonitrile polymers, said yarn being heat set and subsequently twisted without further heat setting and having a permanent pronounced tendency to untwist resulting in a substantial, permanent, normally objectionable, liveliness sufficient to cause the yarn to snarl when relaxed and prevent knitting thereof in conventional manner, but when knitted under controlled tension causes substantial distortion of the stitches and thereby imparts desirable stretchable characteristics to the knitted fabric.

12. A continuous filament nylon yarn, heat set and subsequently twisted without further heat setting and having a permanent pronounced tendency to untwist resulting in a substantial, permanent, normally objectionable, liveliness sufficient to cause the nylon yarn to snarl when disposed in relaxed, untensioned position and prevent knitting thereof in conventional manner but when knitted under controlled tension causes substantial distortion of the stitches and thereby imparts desirable stretchable characteristics to the knitted fabric.

13. A continuous filament knitting yarn selected from the group of yarns consisting of nylon, condensation polymers of terephthalic acid and ethylene glycol, and acrylonitrile polymers, said yarn being twisted, heat set and subsequently twisted without further heat setting and having a permanent pronounced tendency to untwist resulting in a substantial, permanent, normally objectionable, liveliness sufficient to cause the yarn to snarl when relaxed and prevent knitting thereof in conventional manner, but when knitted under controlled tension causes substantial distortion of the stitches and thereby imparts desirable stretchable characteristics to the knitted fabric.

14. A continuous filament knitting yarn selected from the group of yarns consisting of nylon, condensation polymers of terephthalic acid and ethylene glycol, and acrylonitrile polymers, said yarn having a permanent pronounced tendency to untwist resulting in a permanent wildness which causes the yarn to snarl when disposed in relaxed non-tensioned position and requires tensioning control when used in a knitting operation, and which wildness causes substantial distortion of the stitches and thereby imparts substantial stretchability and retractability to a fabric produced from said yarn, said wildness of the yarn being imparted thereto by a first twisting of the yarn in one direction, then heat-setting of the yarn at a temperature higher than any subsequent processing temperatures to which the yarn will be subjected, and then twisting in a direction opposite to the first twist to re-establish a substantial and permanent wildness in said yarn.

15. A continuous filament knitting yarn selected from

the group of yarns consisting of nylon, condensation polymers of terephthalic acid and ethylene glycol, and acrylonitrile polymers, said yarn being twisted in one direction about 20 to 50 turns per inch, heat set and twisted in the opposite direction about 20 to 60 turns per inch without further heat setting and having a substantial permanent, normally objectionable, liveliness sufficient to cause the yarn to snarl when disposed in relaxed, untensioned position and prevent knitting thereof in conventional manner but when knitted under controlled tension imparts desirable stretchable characteristics to the knitted fabric.

16. A continuous filament knitting yarn selected from the group of yarns consisting of nylon, condensation polymers of terephthalic acid and ethylene glycol, and acrylonitrile polymers, said yarn being twisted in one direction about 30 turns per inch, heat set and twisted in the opposite direction about 23 turns per inch without further heat setting, and having a substantial, permanent, normally objectionable, liveliness sufficient to cause the yarn to snarl when disposed in relaxed, untensioned position and prevent knitting thereof in conventional manner but when knitted under controlled tension imparts desirable stretchable characteristics to the knitted fabric.

17. A continuous filament knitting yarn as defined in claim 8, and in which the yarn is a monofilament yarn.

18. A method of producing a continuous filament synthetic resin yarn having a permanent pronounced tendency to untwist resulting in substantial wildness that causes the yarn to snarl when relaxed, but which wildness imparts substantial stretchability and retractability to a fabric produced therefrom, comprising heating said yarn to stabilize the twist, to be imparted to the yarn, against the effects of subsequently encountered temperatures, and then twisting said heated yarn to an extent sufficient to produce said substantial wildness in the yarn and to cause substantial stitch distortion in the fabric produced from the yarn.

19. A method of producing a continuous filament synthetic resin yarn as defined in claim 18, and in which the synthetic resin yarn is nylon yarn.

20. A method of producing a continuous filament synthetic resin yarn as defined in claim 18, and in which the synthetic resin yarn is a monofilament yarn.

21. A method of producing a continuous filament synthetic resin yarn as defined in claim 18, and in which the synthetic resin yarn is a multifilament yarn.

22. A method of producing a continuous filament synthetic resin yarn as defined in claim 18, and in which the synthetic resin yarn is a monofilament nylon yarn.

23. A method of producing a continuous filament knitting yarn selected from the group of yarns consisting of nylon, condensation polymers of terephthalic acid and ethylene glycol, and acrylonitrile polymers, said yarn having a permanent pronounced tendency to untwist resulting in such wildness that it will snarl when freely delivered from a carrier without tension, but which wildness causes substantial distortion of the stitches and thereby imparts desired stretchability and retractability to a fabric knitted from said yarn, comprising first twisting said yarn in one direction, then subjecting the yarn to a heat-setting treatment at a temperature higher than processing temperatures to which the yarn is subsequently subjected and which heat treatment substantially removes the wildness initially imparted to the yarn by said first twisting operation, and following the heat treatment then twisting the yarn in a direction opposite to that of the first-mentioned twist and sufficient to impart to the yarn a permanent wildness that will cause the yarn to snarl.

24. A method of producing a continuous filament knitting yarn selected from the group of yarns consisting of nylon, condensation polymers of terephthalic acid and ethylene glycol, and acrylonitrile polymers, said yarn having such wildness that it will snarl when freely delivered from a carrier without tension, but which wildness imparts desired stretchability and retractability to a fabric knitted from said yarn, comprising first twisting said yarn in one direction about 20 to 50 turns per inch, then subjecting the yarn to a heat-setting treatment at a temperature higher than processing temperatures to which the yarn is subsequently subjected and which heat treatment substantially removes the wildness initially imparted to the yarn by said first twisting operation, and following the heat treatment then twisting the yarn, in a direction opposite to that of the first-mentioned twist, about 20 to 60 turns per inch sufficient to impart to the yarn a permanent wildness that will cause the yarn to snarl.

25. A method as defined in claim 17, and in which the yarn is a monofilament yarn.

26. A method of producing a continuous filament synthetic resin yarn having a permanent pronounced tendency to untwist resulting in substantial wildness that causes the yarn to snarl when relaxed, but which wildness imparts substantial stretchability and retractability to a fabric produced therefrom, comprising heating said yarn to stabilize the twist, to be imparted to the yarn, against the effects of subsequently encountered temperatures, and then twisting said heated yarn to an extent sufficient to produce said substantial wildness in the yarn and to cause substantial stitch distortion in the fabric produced from the yarn, and thereafter treating said yarn with an oily liquid to render the yarn temporarily limp.

27. A method as defined in claim 26, and in which the oily liquid is a light petroleum distillate product containing a small percentage of wax.

28. A method as defined in claim 26, and in which the oily liquid is a light petroleum distillate product containing a small percentage of degrass.

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