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PROCESS OF MANUFACTURING TEXTILE
YARN

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The invention relates in general to the manufacture of textile yarns and in particular to an improved thrown yarn and to correlated improvements in the process of producing the same.

During the past many years the hosiery knitting trade has been using yarns composed of two or more threads of silk in which the twist ranged from 10 to 30 turns per inch. The process of imparting a twist to yarns is commonly known to the knitting trade as the throwing of the yarn. This particular type of throwing has produced in the past a yarn that has given a merchandisable type of stocking, notwithstanding its low snag resistance.

Recently, however, the throwsters in collaboration with the knitting trade have attempted to work out many ideas whereby they believed the increase in degree of the twist of the thread might produce a yarn which when knitted would give a better clearness of stitch, greater snag resistance in the finished stocking and greater sheerness of the stocking itself. With these thoughts in mind they attempted to raise the conventional degree of twist in the yarn from 20, 25 and 30 up as high as 40 to 50 or 60 turns per inch. However, in attempting to increase the twist of the yarn they found that this type of yarn had a tendency to curl, snag and kink when the yarn, which was in cone form, was used on the knitting machine.

Many special soaking and sizing treatments were devised in an effort to offset this kinking of the yarn, which, incidentally produced press-offs, which in the knitting phraseology means the breaking of the stitch formation. In several instances, however, such soaking and sizing treatments produced a deadening effect on the yarn whereby the knitter was able to properly knit the stocking. However, it was found that when the stockings were boiled off and the size or soaking agent originally applied to the yarn was lost through the scouring, that distortion took place immediately in the stocking as there was nothing to hold the stitch formation therein. Moreover finished stockings produced from silk yarns treated in this manner were found to develop a roll which materially detracted from their commercial and sales values.

In the production of hosiery from rayon yarns thrown as aforementioned similar difficulties have been encountered both with the yarn itself and the handling thereof as well as in the finished stockings.

The general object of the present invention is

to alleviate the foregoing and other disadvantages prevalent in the art.

A specific object of the invention is to provide a new and improved thrown yarn having a high tensile strength and a high degree of sheerness and which is particularly adapted for the manufacture of full-fashioned and seamless hosiery.

Another object of the invention is to provide a new and improved process of throwing knitting yarns.

A further object of the invention is to produce an improved knitting yarn which is adapted for the knitting of hosiery of high snag resistance and sheerness.

An additional object is to provide a novel and improved high strength knitting yarn which is substantially free from kinking and which may be knitted with ease.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The foregoing and other objects of this invention are achieved by the process of this invention, which in its broader aspect comprises twisting one or more natural or synthetic silk threads and subsequently twisting this thread or combined threads in the opposite direction, the number of turns per inch in the second twisting operation exceeding twice that of the first twisting operation and the second twisting operation being effected without setting the twist imparted to the yarn in the first twisting operation. Subsequent to the second twisting operation the final twist is set by any appropriate setting operation, such as steaming under a suitable pressure, whether it be atmospheric, sub-atmospheric or super-atmospheric pressure. The first twisting operation in the process may be effected in a high speed doubler such as the so-called 5 b doubler or in a spinning machine. The relative number of turns per inch in each of the twisting operations may be varied within rather wide limits, the only governing factor being that the number of turns per inch in the second twisting operation be greater than twice that of the first twisting operation. Another important factor is that the second or final twist be put in the yarn without setting the first twist.

From the foregoing description it may be seen that the novel yarn of the invention is characterized by having a reverse twist therein, the net number of turns per inch in the final twist exceeding that of the original twist in the opposite direction.

The invention accordingly comprises the several steps and relation of one or more of such

steps with respect to each of the others, and the article possessing the features, properties and the relation of elements, which are exemplified in the following detailed disclosure, and the scope of the invention will be indicated in the claims.

In carrying out the process of the invention, any suitable thread such as natural silk or continuous synthetic thread may be employed; thus, for example, natural silk, rayon (produced by either the viscose or cuprammonium processes) "Nylon," "Vinyon," "Tenasco," "Cordura," cellulose esters and ethers, casein and like threads may be used. For example the ordinary 13-15 denier natural silk threads may be used; likewise various cellulose hydrate threads of various denier sizes may be employed, such, for example, as 50, 55, 65, 75, 100 and 150 denier rayon (cellulose hydrate) threads which are composed of about 20 to 60 or more filaments. In other words, any of the usual natural or artificial silk threads may be used, the selection thereof being dependent upon the denier required in making up the final yarn.

In the first step of the process of the invention the yarn to be thrown is twisted in a given direction. This operation is varied somewhat depending upon whether natural silk or synthetic yarns are to be thrown. In order that the present invention may be described in full detail the practice of the process as applied to synthetic yarns and natural silk will be separately set forth hereinafter.

Synthetic yarns

It is known that the synthetic yarns such as regenerated cellulose, cellulose esters, cellulose ethers, "Nylon," "Vinyon," etc., are commercially produced by extruding and combining a plurality of individual fine filaments, the denier size of which may be varied by the number of filaments combined to form the finished yarn. In the case of regenerated cellulose (rayon), yarns now available on the market are composed of about 20 to 60 or more individual filaments, which, for the most part, are combined with a slight twist varying from about one to five turns per inch. Inasmuch as the present invention is particularly concerned with the manufacture of hosiery knitting yarns, it is preferred to employ yarns having a denier ranging from about 150 down to 50 or less, the smaller sizes being preferred when sheerness is an important factor. The other well known synthetic yarns have a construction similar to that of rayon; consequently the process will be described in detail as applied to rayon, it being understood that any of the aforementioned and other similar synthetic yarns may be thrown in the same manner according to the process of the invention.

Before proceeding with the first twisting operation the yarn should be examined to ascertain whether or not it possesses any twist, and if it does, the number of turns per inch should be determined. Inasmuch as the twist usually imparted to rayon yarn by the original manufacturer thereof is in the right hand direction, it is advantageous to have the spinning mechanism set for twisting the yarn in this same direction in the first twisting operation. Rayon now available on the market usually contains a twist in the order of about 1 to 5 turns per inch. In determining the degree of twist to be imparted to the yarn in the first operation, two factors are to be considered, i. e. the degree of twist desired in the completed yarn and the degree of twist in the original yarn. It has been found that the

number of turns per inch in the yarn after the first twisting operation should be about 33% to 80% of that in the yarn upon completion of the throwing process; or otherwise stated the number of turns per inch imparted to the yarn in the second twisting operation should be $2\frac{1}{4}$ to 4 times the number of turns in the yarn prior to the second or final twist. For example, if it is desired to produce a yarn having 40 turns per inch left twist, the number of turns per inch to the right in the yarn after the first operation should lie within the range of 14 to 32; if the original yarn contained 3 turns per inch to the right, then 11 to 29 turns per inch should be put into the yarn in the first twisting operation. The first twisting operation may be carried out in either a spinning machine or a so-called high speed 5 b doubler. In the event that the original rayon yarn is received by the throwster in cone form, it is then to advantage to effect the first twisting step in a high speed doubler, as this machine is equipped to accommodate a cone as well as a spool, whereas the yarn should be on a spool when a spinning machine is used. By using a high speed doubler the cost of rewinding from the original cone may be eliminated. There are new spinners now available, however, that will accommodate a cone, but they are not prevalent in the industry as yet.

Upon completion of the first twisting operation and without setting the twist in the yarn, it is run through a spinning machine to impart thereto a twist in a direction opposite to that put into the yarn in the first twisting operation. Before running the yarn through the spinner in the second twisting operation, the yarn must be redrawn to a spinning spool so that the opposite twist may be imparted thereto as most spinners are set for operation in one direction only. It is obvious, of course, if the spinner is equipped with reversing gears that this rewinding operation may be dispensed with. As aforementioned, the number of turns per inch which is put into the yarn in this second twisting operation is greater than twice that imparted thereto in the first operation, i. e. the number of turns after having reached the theoretical zero point in the second twist is greater than the number of turns in the yarn after the first twisting operation. Completing the example started above (wherein a 40 turn yarn was in the making and wherein this yarn after the first twisting operation contains 14 to 32 right turns per inch) this yarn is twisted to the left an equal number of turns per inch plus 40. In other words, if the yarn possessed 16 turns to the right per inch after the first twisting operation, 16 plus 40, or 56 turns per inch to the left, would be imparted to the yarn in the second twisting operation. The yarn after the second twisting operation is now ready for steaming to set the final twist therein. The setting operation is usually effected by subjecting the resulting yarn package to the action of steam in the usual manner, this operation being well known in the art.

While a specific example of the preparation of a thrown yarn having 40 turns per inch has been given, it is within the purview of the invention to produce a yarn having any desired number of turns per inch. Thus, for example, the number of turns per inch in the final yarn may vary from about 20 to 50 or more. It has been found that the finer the yarn, i. e. the lower the denier, the greater is the degree of twist that may be imparted thereto. Another observation that has

been made is that the coarser the original yarn, i. e. the higher the denier, the greater should be the number of turns per inch in the first operation with respect to the reverse twist. In other words, when throwing a 50 denier yarn according to the process, the number of turns in the first twist should preferably be about 40% of the number of turns in the final yarn, i. e. if a 40 turn yarn is to be produced, the total number of turns per inch after the first twist should be 16, whereas in producing a 40 turn yarn from 100 denier yarn, the number of turns after the first operation should preferably be about 50% of the final twist or about 20 turns per inch. The foregoing values with respect to the relative twist have been found to be particularly efficacious in the production of seamless stockings, whereas in the knitting of full-fashioned hosiery, it is preferable to increase somewhat the percentage of twist up to 55% to 60% in the first operation.

It has been found that yarns thrown according to the present process have an unusually high tensile strength, and in view thereof, delustered yarns which have a lower tensile strength than bright yarns may be thrown according to the process of this invention and still provide a hosiery knitting yarn of the desired high tensile strength.

Natural silk yarns

In throwing natural silk according to the process of the invention, substantially the same procedure is followed as in the case of synthetic yarns. The only real difference resides in the fact that natural silk as it is imported comes in threads ranging between 13 to 15 denier and 20 to 22 denier. Inasmuch as such threads are too fine and of insufficient strength to knit individually two or more and preferably 2, 3 or 4 of such threads are combined and twisted together. Thus in applying the present process to silk throwing 2 or more silk threads are combined in a doubler such as the well known 5 b doubler. If a high speed doubler is used, the silk threads may be doubled and twisted in the same operation. However, if the ordinary doubler is used and which cannot be geared up, the silk threads are first combined (doubled) during which operation only few turns per inch are imparted to the yarn and whereby the first twisting operation will have to be completed in a spinner.

The relationship between the number of turns per inch in the two stages of twist as far as silk is concerned is substantially the same except it has been found that the number of turns per inch imparted to silk yarn in the first operation may be slightly less than in the case of the synthetic yarns. For example, good results are obtained if the turns per inch after the first twist in a three thread silk yarn constitutes about 33% of the final twist in the completed yarn. As in the case of the synthetic yarns, this value may range up to about 80%. The fact that the number of turns in the first twist may be slightly lower than that in rayon may be due to the lower denier size of three thread silk yarn with respect to the rayon of 50 denier or more and also due in part to the natural gums which are normally associated with silk.

Upon completion of the aforementioned twisting operation and without setting the twist imparted thereby, the yarn is twisted in the reverse direction in a spinning machine in the same manner as described in the process of

throwing the synthetic yarns. After this second twisting operation the yarn is subjected to a steaming or like operation to set the twist in the yarn. Before throwing the silk yarn in accordance with this process it is soaked in the usual manner to soften the natural gums associated therewith.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following examples which are given merely to further illustrate the invention and are not to be construed in a limiting sense.

Example I

A 50 denier regenerated cellulose yarn ("Tenasco" produced by viscose) and which possessed 4 turns per inch to the right was given an additional twist of $6\frac{1}{2}$ turns per inch to the right, making a total of $10\frac{1}{2}$ turns to the right. The yarn was then twisted to the left $40\frac{1}{2}$ turns per inch, giving to the yarn a final twist of 30 turns per inch to the left. The packages resulting from the second twisting operation were subjected to the usual steaming operation to set the twist in the yarn.

This yarn was knitted into full-fashioned hose and dyed in the usual manner. The resulting hosiery was found to be evenly dyed and no difficulty was encountered in the knitting from kinking. The hosiery thus produced was characterized by a high degree of sheerness, flexibility and resiliency and a high degree of snag-resistance.

Example II

The yarn of Example I was thrown in the same manner except 16 turns per inch were put into the yarn in the first operation, making a total of 20 turns to the right. In the second twisting operation 60 turns per inch to the left were imparted to the yarn giving a net of 40 turns per inch to the left. This yarn was more sheer than that produced in Example I and hosiery produced therefrom was excellent in all respects.

Example III

The same yarn and procedure of Example I was followed except that $23\frac{1}{2}$ turns per inch to the right were put into the yarn, making a total of $27\frac{1}{2}$ turns per inch. In the second operation $77\frac{1}{2}$ turns per inch to the left were put into the yarn, giving a net of 50 turns per inch to the left. This yarn possessed all the aforementioned desirable characteristics.

Example IV

A 100 denier regenerated cellulose yarn was twisted to the right to give a total of 17 turns per inch. The yarn was then twisted to the left 52 turns per inch giving a net of 35 turns per inch to the left. While this yarn was not as sheer as those produced according to Examples I to III, hosiery produced therefrom was highly satisfactory and by far the best rayon stockings produced prior to my invention.

Example V

Three 13-15 denier silk threads were soaked, wound and doubled and given a twist of 15 turns per inch to the right in a high speed doubler. The yarn was then twisted to the left at the rate of $57\frac{1}{2}$ turns per inch, giving a net of $42\frac{1}{2}$ turns per inch to the left. The twist was set by steaming and the yarn was knitted into full-fashioned hosiery. The resulting hosiery dis-

played a marked improvement over prior known hosiery in its sheerness, flexibility, strength and snag-resistance.

The thrown yarns of the present invention are characterized by their high degree of sheerness and flexibility. One of the valuable features of the novel yarn resides in its unusually high tensile strength which is attributed directly to the manner in which the yarn is twisted. In view of the high tensile strength of the yarn, delustered synthetic yarns may be employed, thus enhancing the appearance of hosiery produced therefrom. The tensile strength of yarn produced in accordance with this invention from delustered rayon has been found to exceed that of yarn produced from bright yarns according to the prior art throwing processes. The salient feature of the invention resides in the fact that stockings produced from the yarns of the invention are substantially snag-resistant; moreover, such hosiery is substantially free of roll, curl and distortion, and the number of press-offs in the manufacture thereof is substantially nil. While the yarns of the invention are primarily designed and adapted for hosiery knitting, they may be employed in the fabrication of other textile fabrics or knit goods.

Since certain changes in carrying out the above process, and certain modifications in the article which embody the invention may be made without departing from its scope, it is intended that all matter contained in the above description shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all the generic and specific features of the invention herein described, and all statements of the scope of the invention, which as a matter of language might be said to fall therebetween.

Having described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. A novel process of throwing a continuous filament yarn which comprises twisting the yarn in one direction and subsequently twisting the yarn in the opposite direction without setting the first twist, the number of turns per inch imparted to the yarn in the second twist exceeding twice the number of turns per inch in the yarn prior to the second twist.

2. A novel process of throwing a regenerated cellulose yarn which comprises twisting the yarn in one direction and subsequently twisting the yarn in the opposite direction without setting

the first twist, the number of turns per inch imparted to the yarn in the second twist exceeding twice the number of turns per inch in the yarn prior to the second twist.

3. A novel process of throwing silk which comprises twisting the yarn in one direction and subsequently twisting the yarn in the opposite direction without setting the first twist, the number of turns per inch imparted to the yarn in the second twist exceeding twice the number of turns per inch in the yarn prior to the second twist.

4. A novel process of throwing silk which comprises combining at least two threads and twisting the same in one direction and subsequently twisting the resulting yarn in the opposite direction without setting the first twist, the number of turns per inch imparted to the yarn in the second twist exceeding twice the number of turns per inch in the yarn prior to the second twist.

5. A novel process of throwing a continuous filament yarn which comprises twisting the yarn in one direction and subsequently twisting the yarn in the opposite direction without setting the first twist, the number of turns per inch imparted to the yarn in the second twist being from $2\frac{1}{4}$ to 4 times the number of turns per inch in the yarn prior to the second twist.

6. A novel process of throwing a regenerated cellulose yarn which comprises twisting the yarn in one direction and subsequently twisting the yarn in the opposite direction without setting the first twist, the number of turns per inch imparted to the yarn in the second twist being $2\frac{1}{4}$ to 4 times the number of turns per inch in the yarn prior to the second twist.

7. A novel process of throwing silk which comprises twisting the yarn in one direction and subsequently twisting the yarn in the opposite direction without setting the first twist, the number of turns per inch imparted to the yarn in the second twist being from $2\frac{1}{4}$ to 4 times the number of turns per inch in the yarn prior to the second twist.

8. A novel process of throwing silk which comprises combining at least two threads and twisting the same in one direction and subsequently twisting the resulting yarn in the opposite direction without setting the first twist, the number of turns per inch imparted to the yarn in the second twist being from $2\frac{1}{4}$ to 4 times the number of turns per inch in the yarn prior to the second twist.

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