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ARTIFICIAL THREAD AND METHOD FOR PREPARING SAME

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This invention relates to sewing thread. More particularly, this invention relates to the production of sewing thread comprising synthetic linear polyamide filaments.

While it might be thought that any textile filament or yarn useful in the preparation of fabrics would also be valuable as a sewing thread, this is not the case. Of the many known natural and synthetic yarns only silk, cotton, and linen have proved at all useful as sewing threads. In spite of the tremendous expansion of the regenerated cellulose and cellulose acetate rayon arts, and the many attempts made to utilize the same in the production of sewing thread, it is still a fact that these are not useful as sewing threads. In other words, the state of the art is such as to indicate that synthetic yarns will not be useful for sewing threads.

Similarly, while it might be thought that the strength of a seam or joint would truly reflect the strength of the sewing thread, this is not the case.

The peculiar properties required in a sewing thread result from the fact that such a thread belongs to a class of materials used for joining articles together. These materials will have the requirement that they must produce a strong joint of attractive appearance irrespective of their own strength. The very fact that these materials are used to join articles together means that they are a part of a heterogeneous structure and the strength of the seam produced is dependent upon the interaction of various forces, coefficients of friction, etc., far different from those involved in fabric construction. Therefore, despite the advance of technical information and improved methods of testing textile products, the properties required for a sewing thread are so numerous and so unrelated or of such a complex relationship that it is impossible to predict from the known physical properties of a textile yarn, its utility as a sewing thread.

It has now been found, surprisingly, in view of the above facts, that sewing threads can be produced comprising synthetic linear polyamide filaments which are very useful and practical. This discovery has been particularly surprising in view of the known characteristics of synthetic linear polyamide filaments. It is known that they are of a crystalline character as evidenced by X-ray investigation and that they have definite melting points in the range of 180° to 275° C., temperatures greatly exceeded by the temperatures often reached by the needles of commercial sewing machines. Moreover, it is also known that these materials change their properties upon exposure to high temperatures and one would expect that the utility of these filaments would be affected by their travel through the hot needle. The very fact that these filaments melt within the range of temperature reached by the needle in sewing would preclude consideration of their use for this purpose particularly when it is realized that in forming a stitch the needle of a commercial sewing machine carries through the fabric a loop, some twenty times the size of the loop in the ultimate stitch. When the stitch is completed, this excess thread is drawn back through the fabric. As a result, each increment of thread passes back and forth through the fabric, the hot needle and some of the tension devices in the order of twenty times before it finally forms the stitch.

It is, therefore, an object of this invention to produce a new and novel sewing thread from artificial filaments which are exceedingly useful and practical.

A further object of this invention is the production of strong and attractive joints, seams, and the like between fabrics, leathers, furs, fasteners, and/or accessories, etc.

Other objects of this invention will hereinafter become apparent.

The objects of this invention are accomplished in general, by the production and use of a sewing thread comprising filaments of synthetic linear polyamides. These synthetic linear polyamides are of two types; those obtainable from monoamino monocarboxylic acids and those obtainable from the suitable aliphatic diamines and dibasic carboxylic acids. These synthetic polyamides, for example, may be prepared by a process of condensation polymerization such as is described in U. S. Patent No. 2,071,250. The diamine-dibasic acid types of synthetic linear polyamide are more fully described in the copending application of W. H. Carothers Serial No. 136,031, filed April 7, 1937.

These synthetic linear polyamide filaments are capable of being spun from melt. As spun, these filaments have an elongation of 400–500%. They are capable of being cold drawn (stretching in the solid state) whereupon they exhibit orientation along the fiber axis and their elongation is greatly reduced. For example, filaments prepared from polyhexamethylene adipamide, a synthetic linear polyamide having a melting point of about 265° C. which can be obtained by the reaction of hexamethylene diamine and adipic acid, can be cold drawn approximately

400% whereupon they exhibit an elongation of approximately 20%. It is possible, however, to obtain filaments having an elongation greater or less than 20%, for example, an elongation varying from 10% to 200%, by proper control of the drawing process. The synthetic polyamide filaments which have been cold drawn are referred to as oriented.

Another unique property of these synthetic polyamide filaments is their ability to be set in the condition or shape in which they are exposed to saturated steam or hot water having a temperature, preferably, above 85° C. Hot alcohols; e. g., methanol, ethanol, etc., hot aniline or other non-solvent swelling agents for the polyamides may also be used. This property may be employed to advantage in permanently setting the twist of the sewing threads produced. Advantage may be taken of this property in the production of balanced structure and making possible various constructions such as single ply sewing threads, high twists, etc., not previously possible. For this reason it will usually be preferable to employ filaments which have not previously been set since they can be reset only by a more rigorous treatment.

This invention will be more clearly understood by reference to the following examples although it is to be understood that it is not so limited.

Example I

A sewing thread was prepared by plying together three 100 denier, 40 filament 18 turn "S" twist Dull yarns, of oriented unshrunk polyhexamethylene adipamide, introducing 10 turn "Z" twist during the plying operation. The thread was then treated for 1 hour with air at 76.6° C., dry bulb; 71.2° C., wet bulb to reduce the liveliness of the twist in order to facilitate subsequent handling. The sewing thread was then wound to skeins and immersed in boiling water for 10 minutes to permanently set the twist. The skeins were then dyed, rinsed, the excess water removed by centrifuging, dried, and wound to spools. This thread was used in sewing worsted suiting with a commercial type sewing machine. A very strong seam of attractive appearance was produced.

Example II

A single end sewing thread was produced from from 300 denier, 90 filament, Bright yarn of oriented polyhexamethylene adipamide. Twenty turn "Z" twist was introduced into this yarn, the liveliness reduced as in Example I in order to permit skeining. The skeins were then immersed in boiling water for 20 minutes to permanently set the twist. This sewing thread was then used for sewing cotton fabrics. Satisfactory seams were produced.

Example III

A sewing thread was prepared as in Example I from three plies of 45 denier, 15 filament, 26 turn "S" twist, unshrunk, Dull, oriented polyhexamethylene adipamide yarn plied with 15 turns "Z" twist. After the dyeing operation, the skeins were rinsed, centrifuged and sized by immersion in an aqueous size bath containing:

Sodium salt of the product of the interpolymerization of methyl methacrylate and methacrylic acid	g./liter 15
25% solution of sodium cetyl sulfate	g./liter 25

The skeins were dried at 70° C., skutched lightly and wound to spools.

While some difficulty was encountered in getting an even application of this size, the yarn was somewhat softer and ran more readily on the sewing machine than the unsized yarn. Excellent seams were produced with various fabrics.

Example IV

A sewing thread was prepared as in Example III from 150 denier, 75 filament, 12 turn "S" twist, Dull, oriented polyhexamethylene adipamide yarn plied 8 turns "Z" twist. The yarn was sized in the same manner as in Example III. Excellent stitch formation and seams of great strength and attractive appearance were obtained for various fabrics and at high sewing speeds.

This yarn was also used for sewing a number of uppers of women's shoes. After sewing, these shoes were water lasted which subjects the sewing thread to a severe stress. Shoes sewed with this thread were compared with those sewed with silk sewing thread of comparable strength. Not only were the seams sewed with the synthetic linear polyamide much stronger, but upon lasting no failures were experienced, while with those shoes sewed with silk sewing thread, frequent failures were noted.

Example V

A sewing thread was prepared as described in Example IV using 120 denier, 50 filament, 16 turn "S" twist oriented polyhexamethylene adipamide yarn which had been partially drawn so that it had an elongation of 40%. The yarns were plied with 10 turns Z twist. This sewing thread was used for the preparation of elastic foundation garments. It was found that this high elongation yarn was far superior to previously known yarns for these purposes. The foundation garments showed greater elasticity, limits of stretch, and wearing qualities. The production of sewing threads from filaments of controlled elongations which may be adapted to each use offers many possibilities. It has not previously been possible to produce sewing thread from filaments, which, prior to the formation of the sewing thread, can be given any desirable elongation.

While, in some of the foregoing examples, a preference has been shown for the use of unshrunk yarns in the preparation of sewing threads, this invention is not so limited. This preference has been shown because most shrinking processes involve hot, wet treatments which have a setting action on these polyamide filaments, and it is preferable to use unset filaments for the reasons cited previously although satisfactory sewing thread may be produced from filaments which have been set. It is possible, however, to shrink these polyamide filaments by subjecting them to short exposure of dry heat at 180° C. without setting them. Such shrunk, unset filaments may be used to advantage in the preparation of sewing thread although in many cases it is still preferred to use the unshrunk filaments since the setting treatment, after plying, results in shrinking, thus giving a more compact structure. Likewise, it may be preferable to subject plied sewing threads produced from unset filaments to mild non-setting conditions such as the treatment disclosed in Example I to reduce the liveliness of the twist and to dye at temperatures below 90° C., subsequently setting the thread in its stitch formation in the finished seam or other joint.

It has also been found advantageous for some

types of sewing thread to ply a number of strands of partially drawn yarn and then subject the plied thread to further cold drawing. This further drawing results in a balanced structure which is unset. Such a thread may be set in any desired configuration, such as in the finished seam.

The foregoing examples illustrate that the sewing thread of this invention operates very successfully on the sewing machine and produces strong, attractive seams of great utility. By virtue of the setting treatment described in these examples, balanced constructions are produced which do not form knots or kinks during the sewing operation. This is very important because, as indicated above, during the formation of each stitch, enough thread is carried through the fabrics to be joined, to form a loop twenty times the size of that in the final stitch. The formation of this large loop through which the bobbin passes tends to form kinks and knots unless the thread is perfectly balanced. In fact, by virtue of this setting treatment, an unplied sewing thread from a single yarn which operated successfully and which produced satisfactory seams has been produced. This, as far as is known, is the first time such a thread has been produced. This is a great advance over multiple ply sewing threads since it reduces very materially the cost of the sewing thread and permits much wider application of these sewing threads.

Abrasion is a serious problem, since when the stitch is actually formed, the loop is drawn back through the fabrics and again projected through to form the next loop. As a result, the single length of thread passes back and forth through the tension device, needle and fabrics some twenty times. That the sewing thread of this invention did not undergo undue abrasion is apparent from the examples. This high resistance to abrasion may be partially due to the high twist which it is possible to introduce in threads comprising these synthetic polyamides. This is especially effective in the unplied sewing thread. Similarly, the finishes described serve to increase the resistance to abrasion.

Another very surprising and unexpected result obtained from the use of the sewing thread of the present invention is that, regardless of the high elasticity thereof, the seams will not pucker the fabric even when sewing with a high tension. One would expect that the thread would extend under the stress of the needle, but that when the seam was formed in the fabric and the tension relieved, the thread would tend to return to its original length and cause an unsightly puckering of the fabric. As a matter of fact, no satisfactory explanation is known as to why the thread does not pucker the fabric. By virtue of the fact that this thread does become extended under the tension of the needle, it is possible in certain cases to use much finer sewing thread than it has heretofore been possible. It has been the practice to use thread sufficiently strong and, therefore, sufficiently large to resist the tensions of the sewing machine. It is obvious, of course, that this elastic yarn having been put into the fabric without puckering, will have added utility in the fabric. Likewise, the seam can be sewed more tightly, with the result that there are a greater number of seams per unit length of sewing thread since no free thread need be left for purposes of mechanical elasticity of the fabric.

As indicated above, these are the first synthetic filaments to find practical application as a sewing thread. Because natural fibers, the properties of which are subject to variation have heretofore been used exclusively, it has not been possible to produce sewing threads of standard sizes which would have uniform strengths. This has necessitated an arbitrary standard of classification based upon standard strength. Thus, the denier of the sewing thread of a single classification varies considerably necessitating sewing machine adjustments and makes it impossible to calculate the length of yarn obtained in each pound of thread produced. The sewing thread of this invention can be produced continually which will have a uniform strength, thus overcoming this disadvantage. Similarly, the control of the elongation makes it possible not only to produce sewing threads from the same material useful for sewing a variety of materials, but also makes it possible for the first time to produce a sewing thread having the optimum elongation for each purpose.

The most surprising thing of this whole invention is, however, the fact that these polyamide filaments can be used as a sewing thread in view of the high temperature reached by the needle of commercial sewing machines. The needle passes back and forth through the fabrics at rates of 2,000 to 4,000 times per minute. In all types of sewing, the needle becomes very hot and in sewing heavy, dense fabrics it often reaches a dull red heat. This heat so seriously affects the strength of the seams produced from silk sewing thread with dense, heavy fabrics that it cannot be used. Likewise, it is known for seams produced from cotton to be as much as 50% weaker than expected due to this heat. It is therefore amazing that these polyamide filaments which are crystalline and have melting points far below the temperature of the needle should operate so successfully and produce such strong seams. This behavior could not be predicted in any way, for it would be expected that the filaments would melt, in the plurality of passages through the needle.

An interesting alternative of this invention is that, if desired, advantage can be taken of the fact that these polyamide filaments are capable of melting sharply, as is true of all crystalline materials, and in contrast to the slow degradation of other materials, such as cotton. By the use of the sewing thread of the invention, the sewing operation can be carried out under such conditions, for example, at maximum speed and efficiency, so that if the sewing machine is running properly, the seam strength will be definitely uniform and if running improperly, the sewing thread will be melted and the seam broken, giving visual indication to the operator that the machine needs adjustment. This is a tremendous advantage when it is realized that seams produced using cotton sewing thread may be weakened as much as 50% by this excessive heat without any appreciable change in appearance. As a result, inferior seams are produced and the articles comprising them placed upon the market without any indication of this weakness, whereupon they fail, causing dissatisfaction.

While this invention has been discussed with particular reference to polyhexamethylene adipamide filaments, it is apparent that other synthetic linear polyamide filaments may also be used. Similarly, other synthetic linear polymer filaments, e. g., the polyesters, polyethers, polyacetals, etc. may be used. For example, these may be produced by the process of condensation

polymerization described in U. S. Patent No. 2,071,250.

Since it is obvious that many changes and modifications of the invention may be made without departing from the nature and spirit of the invention, it is to be understood that the invention is not to be limited except as set forth in the appended claims.

I claim:

1. The method of constructing a sewing thread which comprises twisting a single bundle of synthetic linear polymer filaments, and permanently setting the said twist by subjecting the twisted bundle to a hot non-solvent swelling agent for said polymer.

2. The method of constructing a sewing thread which comprises twisting a single bundle of synthetic linear polyamide filaments, and permanently setting the said twist by subjecting the twisted bundle to a hot non-solvent swelling agent for said polyamide.

3. The method of constructing a sewing thread which comprises twisting a single bundle of synthetic linear polymer filaments, and permanently setting the said twist by subjecting the same to treatment with hot water.

4. The method of constructing a sewing thread which comprises twisting a single bundle of synthetic linear polyamide filaments, and permanently setting the said twist by subjecting the same to treatment with hot water.

5. A sewing thread comprising at least one bundle of synthetic linear polyamide filaments, said bundle of filaments twisted together and permanently set.

6. A sewing thread comprising a plurality of bundles of synthetic linear polyamide filaments plied together, the filaments of each of said bundles being twister together and permanently set.

7. A sewing thread consisting essentially of a single bundle of synthetic linear polyamide filaments twisted together and permanently set.

ALEXIS SOMMARIPA.