April 20, 1948. E. A. TIPPETTS 2,439,829

METHOD OF PRODUCING ARTIFICIAL YARN

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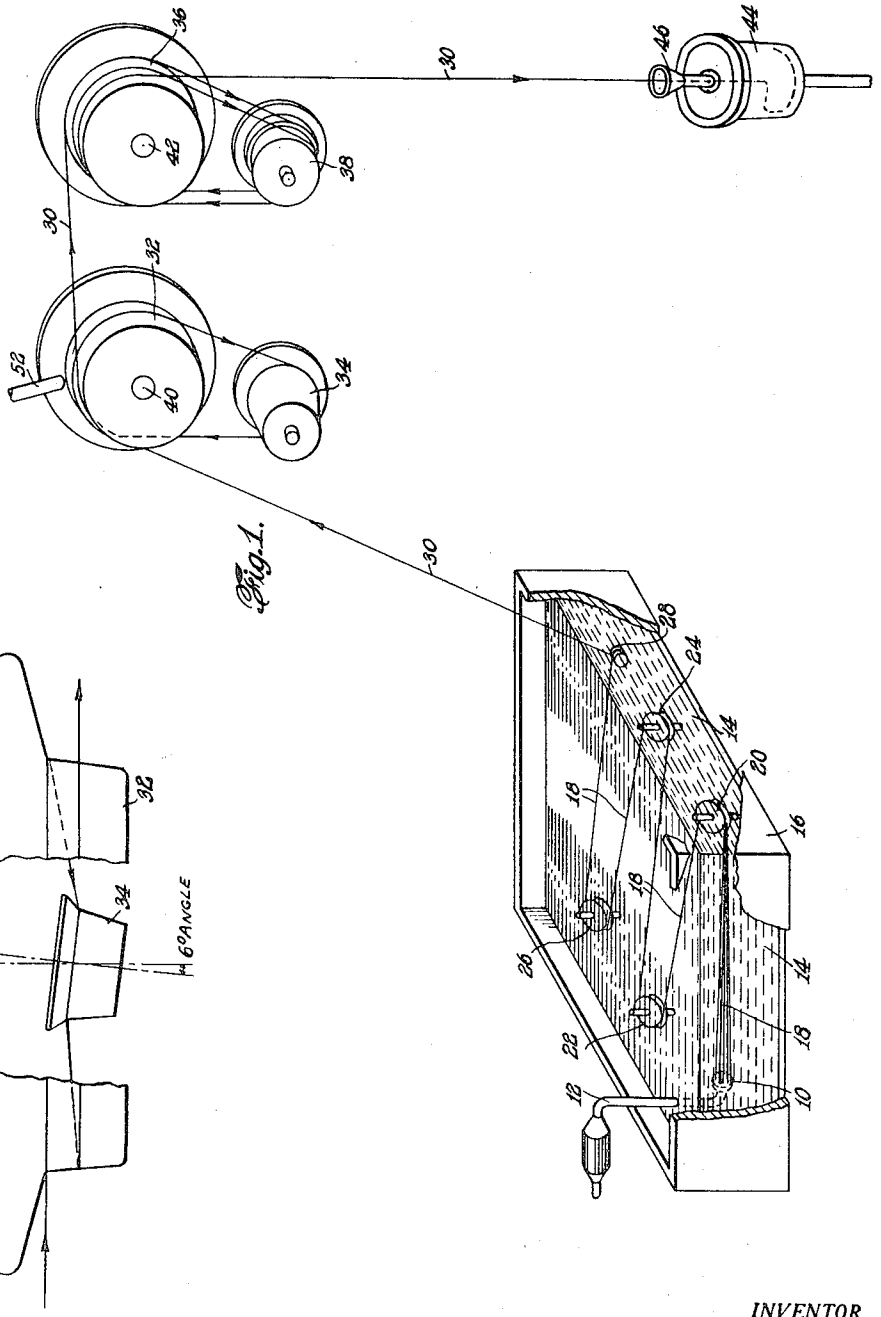


Fig. 1.

Fig. 5.

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Fig. 2.

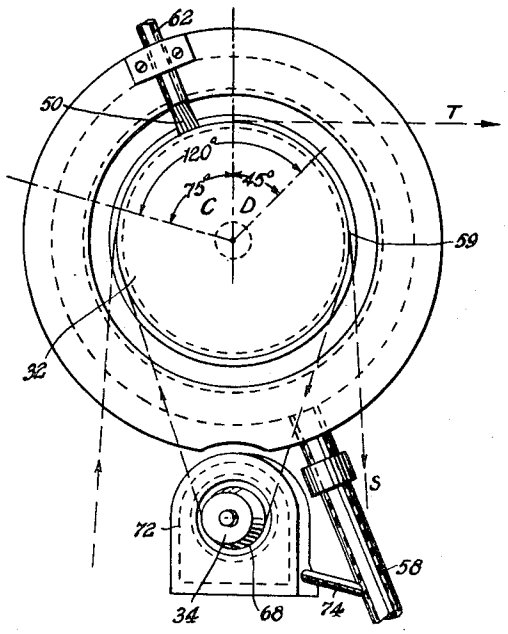


Fig. 3.

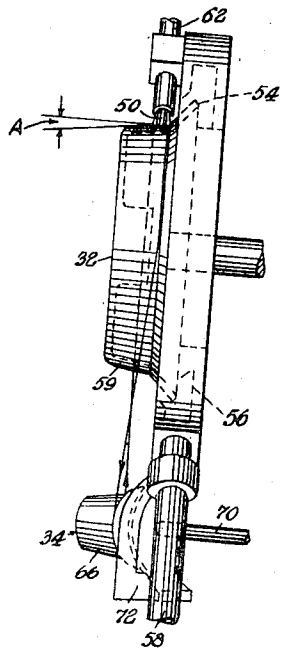
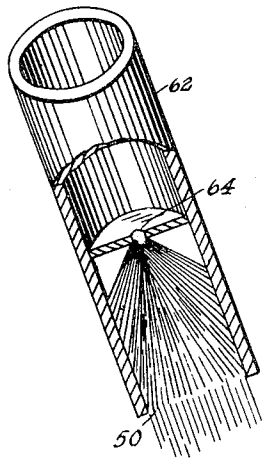


Fig. 4.



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Fig. 6.

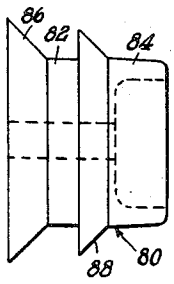


Fig. 7.

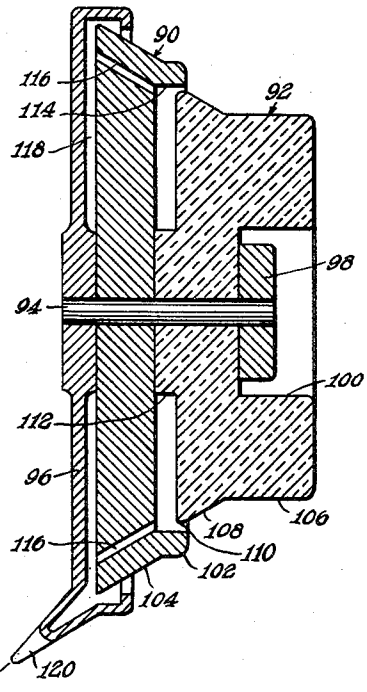
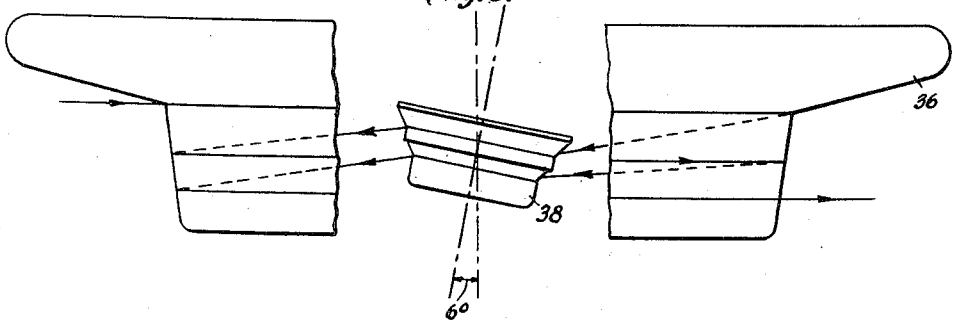


Fig. 8.



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UNITED STATES PATENT OFFICE

2,439,829

METHOD OF PRODUCING ARTIFICIAL YARN

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Application August 19, 1943, Serial No. 499,162

7 Claims. (Cl. 18—8)

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This invention relates to the manufacture of high tenacity regenerated cellulose yarn from viscose by the hot dip method. More particularly, this invention relates to a method for use in the hot dip method to produce high tenacity regenerated cellulose yarn of substantially uniform physical characteristics.

United States Patents No. 1,901,007 of March 14, 1933, and No. 1,996,989 of April 9, 1935, disclose procedures for producing viscose rayon of improved tenacity by passing the coagulated partially regenerated filaments through a hot aqueous bath heated to 70° C. to 100° C. and, while the filaments are in contact with such hot aqueous bath, subjecting them to substantal tension and/or stretching. In each of the procedures disclosed in the aforementioned patents, the amount of swelling or plasticizing of the yarn by the hot water treatment was not readily controllable and the application of stretch over substantial length of the yarn did not given consistent reproducible results so that a product of uniform characteristics could be obtained.

United States Patent No. 2,248,862 of July 8, 1941, discloses a hot bath stretching arrangement wherein the first feed wheel is partially immersed in the hot bath and whereby the hot bath is applied only at the bottom of the feed wheel. The application of the hot bath to the first feed wheel only at the bottom thereof limits the take-off point of the yarn to the side of the feed wheel and at a point not greater than 60° from the point where the feed wheel contacts the hot bath if the thread is to be at the maximum temperature (and this is necessary for optimum results) at the time of stretching. If the thread were taken off at some other point greater than 60° from the point of application of the hot bath, such as from the top of the first feed wheel in its passage to the second feed wheel, the temperature of the thread at the time of stretching would be less than the temperature of the bath due to cooling by evaporation from the feed wheel. Additionally, such arrangement is objectionable in that it prevents the imposition of the maximum possible tension, such as of the order of 1 gram per denier, between the two positively driven rollers. It is well recognized that the tenacity of yarn produced is dependent to a very large extent on the amount of tension imposed on the partially regenerated yarn, and it is therefore of paramount importance to impose on the yarn before wind-up as high a tension as possible without causing individual filaments of the yarn to become broken or seriously weakened. The

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inability of the arrangement in said Patent No. 2,248,862 to impose these extremely high spinning tensions on the freshly formed yarn is apparently due to the fact that stationary yarn directional guides are used and the frictional resistance to the travel of the yarn makes it necessary to spin at lower tensions than would be possible if the yarn came in contact with substantially no frictional resistance. Further, the application of hot bath to the yarn passing around the roller, as disclosed in said Patent No. 2,248,862, is not suited to the optimum control of stretching as will be more fully explained hereinafter.

Slippage of the freshly formed yarn on the feed wheels when yarn was being spun by the bucket spinning process was a major problem some years ago. The use of double wraps around the feed wheel and especially the use of a freely rotatable snubber guide roller, such as shown in United States Patent No. 1,977,611, was decidedly helpful in the development of yarn of more uniform properties. However, in the spinning of large denier yarns, such as 1100 denier, under high tension, and especially when the yarn is treated with a hot aqueous bath and stretched a substantial amount, a small number of the filaments are commonly broken. The hot bath does not act instantaneously on all the filaments comprising the bundle and, as soon as most of the filaments become plasticized, they stretch, releasing a large part of their load to the less plasticized filaments which bear or try to bear an unproportionally large load, and finally break. These broken filaments most frequently wrap around the snubber guide roller, continue to build up, and often cause other filaments to break, until the entire bundle breaks or until the wrap becomes so large as to prevent normal operation of the roller.

In addition, the advent of much higher spinning tensions (of the order of 1 gram per denier) made necessary, in order to maintain a high degree of uniformity, a plurality of complete wraps around the feed wheel and two or more wraps around the snubber roller guide. While slippage of the yarn on the stretching wheel was thus avoided, increased roller wraps were a barrier against any practical application. It is, of course, apparent that in spinning at tensions well below the yarn breaking tension many of these difficulties never arise. Nevertheless, when spinning at speeds 25% to 50% higher than commonly used and at maximum tensions on the filament bundle within 80% to 95% of the breaking tension, what would normally be considered

extremely minor irregularities become of extreme importance and the procurement of optimum benefits from this extremely high tension spinning are vitally dependent on every minute refinement.

It is an object of this invention to provide an improved process for the impregnation of freshly spun viscose rayon yarn with a hot aqueous liquid and stretching the same. Another object of this invention is to stretch the freshly spun viscose rayon yarn impregnated with a hot aqueous liquid between two feed wheels. Other objects will be apparent from the description hereinafter set forth.

The objects of the invention are generally accomplished by stretching freshly spun viscose rayon yarn between two positively driven feed wheels, the yarn passing one or more times around the first feed wheel and a plurality of times around the second feed wheel. While the yarn is on the first feed wheel, it is uniformly impregnated with a hot aqueous liquid. the peripheral speeds of the feed wheels are such as to impose in the yarn a total tension of the order of 1 gram per denier. As will become apparent hereinafter, the stretch is confined within a short distance in the path of travel of the yarn (as it comes onto the first feed wheel and as it leaves said feed wheel) and at a time when the yarn is uniformly impregnated with the hot aqueous bath.

This invention is directed to improvements in the process involving hot aqueous bath stretching wherein the bath may be water, acidulated water, or a viscose regenerating bath of the same or different composition as that into which the viscose is initially spun. It has been found that optimum results are obtained by applying to the yarn to be stretched a bath heated to a temperature of about 90° C. to 95° C. so that stretching will take place in yarn that is not below 85° C. at the region and time of stretching, although excellent results can often be obtained by impregnating the yarn to be stretched at much lower temperatures, such as at 75° C. or thereabouts.

For convenience, the invention will be described in connection with the method and apparatus forming the subject-matter of application Serial No. 673,446.

The details of the invention will become more apparent by reference to the accompanying drawings when taken in connection with the following detailed description.

In the drawings,

Figure 1 is a perspective view, partly in section, showing an apparatus suitable for carrying out the invention;

Figure 2 is a front elevation of the first stretching wheel and the snubber roller cooperating therewith, and also showing the zone of hot bath application;

Figure 3 is a side elevation of the set-up shown in Figure 2;

Figure 4 is an enlarged front elevation, partly in section, of the means for applying the hot aqueous bath;

Figure 5 is a top plan view, broken away for clarity, showing the arrangement of the snubber roller with respect to the feed wheel;

Figure 6 is a modified form of snubber roller suitable for use when two passes of the yarn are made about the snubber roller;

Figure 7 is a section of another modified form of snubber roller suitable for use when two passes of yarn are made about the snubber roller; and

Figure 8 is a top view, partly broken away for clarity, showing the arrangement of the snubber roller with respect to the feed wheel when two passes of the yarn are made about the snubber roller.

Referring now to the drawings wherein like reference numerals designate like parts, the reference numeral 10 designates a multi-hole spinneret through which the viscose solution, supplied thereto through a conduit 12, is extruded into a spinning bath 14 contained in a trough 16. The filaments 18 extruded within the bath through the spinneret 10 are passed around guides 20, 22, 24, 26 and 28 positioned beneath the level of the bath. The guide 28 is designed to impose a tension on the yarn and may be of the type shown in United States Patent No. 2,083,251. The yarn 30 is withdrawn from the bath 14 by a positively driven feed wheel 32 and passed once around said feed wheel 32. In its passage over and around the feed wheel 32, the yarn is passed under a freely rotatable snubber roller 34. From the wheel 32, the yarn is passed over and a plurality of times around a second positively driven feed wheel 36. The yarn 30, in its passage around the feed wheel 36, also passes under a freely rotatable snubber roller 38. The feed wheels 32 and 36 are mounted on shafts 40 and 42, which are driven by means (not shown) at such rates that the peripheral speed of the wheel 36 is greater than the peripheral speed of the wheel 32 whereby the yarn between said wheels is stretched. After leaving the feed wheel 36, the yarn is collected in a rotating bucket 44 into which it is guided by a reciprocating funnel 46.

While the yarn 30 is on the first feed wheel 32, it is impregnated with a jet of hot aqueous bath 50.

The feed wheel 32 is provided at the rear thereof with an upwardly inclined (slinger ring) flange 54, from which the hot bath liquid applied to the feed wheel is discharged into a collecting shroud 56 from which it is removed by a conduit 58. In order that the bath be discharged from the feed wheel 32 only at the flange 54, the jet of hot liquid 50 is applied to the upper portion of the feed wheel 32 within the range of 120°, as shown in Figure 2, and the thread-contacting portion 59 of the feed wheel is constructed with a slight taper, as indicated by the reference character A in Figure 3, to insure that centrifugal force will drive the liquid from the thread-contacting portion 59 of the feed wheel 32 to the point of the flange 54 before discharging it from the wheel. While this taper A may be no more than 1°, preferably it is greater than 3°, but in no case more than 6° or 8°.

The region of application of the jet 50 will vary with the contour of the feed wheel 32, the peripheral speed and radius thereof. When the yarn 30 leaves the wheel 32 at the top, as indicated in Figure 2 by the reference character T, the jet 50 is located preferably at an angle of 10° or anywhere within the 75° angle, designated as C in Figure 2. When the yarn leaves the wheel 32 from the side, referred to as "alternate route of thread" and designated by the reference character S, the jet 50 is directed onto the wheel 32, preferably at the top center or anywhere within the 45° angle marked D. In all cases, the jet of hot bath liquor 50 is applied to the yarn within a zone of an angle of about 90° from the point the yarn leaves the wheel, and it is preferably

also so directed as to have a component of its velocity in the direction of rotation of the wheel 32.

Part of the stretching of the yarn 30 takes place over the surface 59 of the feed wheel 32 just before the yarn loses contact with the wheel, resulting in slippage of the yarn on the wheel. It is, therefore, important that the yarn be in the most plastic condition possible to keep this slippage at a minimum, and to provide plenty of lubrication by means of a liquid so that this slippage will not damage the yarn. Some slippage also occurs in the region where the yarn 30 first contacts the wheel 32, since the surface 59 of the wheel is wet with the hot treating liquor. The tension device 28 located in the spinning bath 14 serves as a retarding force on the yarn, which stretches the partially heated yarn on the feed wheel before sufficient contact of the surface is present between the yarn and the feed wheel to prevent slippage. It is, therefore, very important that the point of application of the hot bath jet 50 be uniform on the wheel 32 from position to position and that the desired point of application of the jet be determined to control the amount of preliminary stretch to give the best results. By this process, the yarn that is stretched in the primary bath is then given a preliminary small amount of stretching before becoming positively engaged on the feed wheel and is then brought to a temperature of about 90° C. just prior to its final stretching between the feed wheels. The optimum location of the jet will vary somewhat, as previously indicated, depending on the peripheral speed and radius of the feed wheel.

Several factors are considered in the construction of the jet and the exact angle of impingement of the bath on the wheel. The temperature of the hot aqueous bath liquid drops from the time it first contacts the yarn until it is removed from the wheel. The absolute temperature drop across the wheel will be determined by the absolute magnitude of flow of the hot bath. Since it is desired to keep the temperature drop at a minimum, fairly large flows of hot bath are used. In the form shown in the drawings, the jet 50 is obtained through the use of a pipe 62, which is provided with an orifice 64 at a sufficient distance from the mouth of the pipe to permit the jet 50 to be supplied in a smooth large flow and to prevent splashing of the jet when it impinges on the wheel 32. The pipe 62 is secured to the shroud, as shown in Figures 2 and 3, and the hot bath liquid is supplied at a constant pressure to the top thereof from a source (not shown).

As previously mentioned, the jet is directed so as to have some component of its velocity in the direction of rotation of the wheel. The yarn lies on the feed wheel in the form of a ribbon, due to the extremely high tension imposed on the yarn and its normal tendency to hug the wheel, and the direction of the jet upon this ribbon of yarn with positive force achieves more rapid penetration of heating liquor into the yarn.

It is desirable to eliminate all sharp corners or edges from the feed wheel 32, thereby eliminating points and edges from which the bath may be discharged from the feed wheel rather than be pumped to the slinger ring flange 54 where it is discharged into the shroud 56. The proper contour of the feed wheel 32 is also partially determined by the angle between the plane of rotation of the feed wheel 32 and the horizontal. If the thread-contacting surface 59 slopes too steeply from the flange 54 to the front of the feed wheel 32, gravity partially overcomes centrifugal force and the treating liquor is discharged from the front of the feed wheel. The flow of hot bath along the upper surface of the wheel is aided by tilting the plane of rotation of the wheel from the vertical by an amount approximately equal to the degree of taper of the feed wheel.

In the set-up shown in Figures 1, 2 and 3, the yarn 30 is given one pass under the snubber roller 34. In such a set-up, the snubber roller 34 may be like that described in United States Patent No. 1,977,611. As described in said patent, the snubber roller 34 has a frusto-conical thread-contacting portion 66 and an upwardly inclined flange 68 at the rear thereof. The snubber roller 34 is freely rotatable on a stud 70, and the flange 68 is positioned within a shroud 72. A pipe 74 conducts any liquor, which passes from the snubber roller 34 to the shroud 72, to the conduit 58.

As disclosed in application Serial No. 673,446, the snubber roller 34 must be positioned and located as hereinafter described. As shown in Figures 3 and 5, the snubber roller 34 is mounted in front of the vertical line extending down from the tangent point of first contact of the thread with the feed wheel by a small amount, and the axis of the snubber guide is horizontally rotated out of the vertical plane passing through the axis of the feed wheel by a small angle of about 6° or 8°.

By locating the snubber guide 34 in this manner, the yarn 30 coming down from the feed wheel 32 first contacts the flange 68 of the snubber 34 and, due to the askew position thereof, rolls down the flange onto the (less tapered) frusto-conical body 66. Because the yarn rolls on itself in coming onto the snubber roller 34, it develops temporarily a certain amount of twist. The twist actually takes place between the point at which the yarn leaves the feed wheel 32 and the contact point with the snubber guide roller 34, so that the yarn contacting the snubber roller 34 is well bundled and broken filaments are not picked up and wrapped around the snubber roller 34 but are carried along as part of the continuous filament bundle. When the yarn leaves the snubber roller 34 and travels to the feed wheel 32, the twist is removed. However, due to the brief existence of the twist, the many filaments comprising the yarn are more closely bundled together than they would be otherwise, and the yarn is prevented from being spread out as a wide ribbon on the snubber roller 34. As previously stated, due to the high tension imparted in the thread, it is appreciably flattened as a ribbon on the wheel 32, but the filaments are still all sufficiently united that, when substantial stretching of the yarn takes place, each filament more uniformly assumes its share of the load.

The arrangement shown in Figures 2, 3 and 5 illustrates one wrap around the snubber roller, which is entirely satisfactory when the tension differential between the oncoming yarn and the yarn leaving is not too great. When this differential is large, then the yarn should be given two or more passes around the feed wheel and snubber roller.

If two passes of the yarn are to be made about the snubber guide roller, snubber guide rollers of the type shown in Figures 6 and 7 may be used, and the twist will be imparted to the yarn in its two successive passes therearound.

Referring now to Figure 6, the reference nu-

meral 80 designates a one-piece snubber roller which can be used when the yarn is given two passes about it. This snubber roller 80 is provided with two thread-contacting portions 82 and 84 having the same diameter and two flanges 86 and 88 of the same angularity. This snubber roller 80 is positioned in the same askew position as the snubber roller 34, and the yarn 30 is directed first onto the flange 86, from which it is rolled onto the thread-contacting surface 82 to impart the temporary twist. In its second pass, the yarn 30 is fed onto the flange 88 and is rolled onto the thread-contacting surface 84 whereby the temporary twist is imparted to the thread. When snubber roller 80 is used, any filament wraps which occur between the flanges 88 and 86 can be removed only with some difficulty.

The modified snubber roller designed to take two passes of the yarn therearound and to satisfactorily displace the yarn and impart the twist thereto, shown in Figure 7, comprises two elements 90 and 92 which are independently and freely rotatable on a stub shaft 94, one end of which is fixedly mounted in a shroud 96. The rotatable elements 90 and 92 are held on the shaft by means of a press-fit washer 98. The element 90 has a substantially cylindrical body 102 and an inclined flange 104 at the rear thereof. The element 92 also has a substantially cylindrical body 106 and an inclined flange 108 which terminates in a small cylindrical flange 110. The rotatable element 92 is smaller than the element 90 and it is so mounted that the substantially cylindrical body 102 of the element 90 overlaps and is spaced from the flange 110 of the element 92. As is shown in Figure 7, the element 92 is provided on the rear end thereof with a boss 112 which is positioned in a recess 114 and on the front face of the element 90. While the liquid discharged from the element 92 generally flows over the rounded shoulder of the element 90, due to the action of centrifugal force a certain amount may be discharged into the recess 114, in which case it is conducted by means of ducts 116 to a passage 118, from which it is removed by the conduits 120. The liquid from the element 90 is discharged in the passage 118. In operation, this snubber roller is positioned in the same askew manner beneath the feed wheel 32 as the snubber roller 34, and as diagrammatically shown in Figure 8.

In operation, the yarn 30, as it comes from the feed wheel, is led onto the flange 104, from which it rolls onto the thread-contacting cylindrical surface 102 and whereby the temporary twist is imparted to the yarn. In its second passage, the yarn 30 is led onto the flange 108, from which it rolls onto the thread-contacting cylindrical surface 106 whereby the temporary twist is imparted. By having both elements 90 and 92 independently rotatable, each of them seeks its own speed of rotation, when driven by the yarn passing therearound. In this way, any chance of frictional rubbing of the yarn on the surface is avoided because only one path of the yarn is in contact with each independent rotatable element of the guide. The slope of the flanges 104 and 108 is preferably about 40° to 50° with respect to the axis of rotation.

If more than two passes of yarn around the feed wheel are desired, the snubber roller hereinbefore described may be substituted by snubber rollers having three or more independently rotatable elements of the type shown in Figure 7, or, when a single roller is used, three or more

flanges and thread-contacting surfaces of the type shown in Figure 6.

The snubber roller 38 may be of any of the types herein described, depending of course on the number of passes the yarn makes therearound. Because of the high tension on the oncoming side and the relatively low tension on the yarn leaving the second wheel 36, it is preferred and more generally needed to use snubber rollers of the type shown in Figures 6 and 7 wherein a double pass of the yarn about the snubber roller is obtained.

The feed wheels and the snubber guides herein described are constructed of such surface material that sulfur and sludge from the spinning bath will not adhere in the yarn path, forming ridges from which the hot liquid will be discharged without flowing to the flange. A glass surface has given satisfactory results.

Instead of collecting the yarn in a bucket, it can be collected on a bobbin.

To further illustrate this invention, the following specific example, wherein proportions are by weight, is given:

Example

A viscose solution containing 7% cellulose, 6% NaOH ripened to a sodium chloride salt index of 5.2 is spun into a primary acid-salt bath and then is stretched 20% between two feed wheels, the hot bath consisting of 95° C. water acidulated by the primary bath carried along with the yarn being applied to the yarn on the first of the two wheels substantially as shown in Figure 1. The yarn, which will be finished in the form of 1100 denier, 480 filaments, comes from the primary bath under a tension of 660 grams and the 20% stretch applies additional tension, so that between the two feed wheels the tension is equal to 1060 grams. The yarn is collected in a centrifugal spinning bucket under an average tension of about 15 grams (measured between the second feed wheel and the bucket funnel), and in view of this great tension differential three passes of yarn are made over the second feed wheel, necessitating a double pass of yarn under the snubber roller guide, although but a single pass is needed under the snubber roller guide associated with the first of the stretching feed wheels since the tension differential here is relatively small.

During 5 hours of spinning, using the double roller guide shown in Figure 7 under the second feed wheel and so positioned that a temporary twist was produced in the yarn with each pass thereto, not a single wrap was formed and the yarn produced was of uniform high quality with the desired high tenacity. However, when this double roller snubber guide was replaced with a one-piece cylindrical roller under which the yarn passed without the benefit of temporary twist being applied thereto, eight wraps were formed during a 5 hour period, of which two wraps built up so large by entanglement of other filaments that the yarn was broken.

This invention enables the production of yarn of substantially uniform physical properties having a desirably high elongation as well as high tenacity, good knot strength, and excellent fatigue value. Such yarn is eminently suited for the manufacture of cord for use in the reinforcement of rubber structures, such as rubber tires, steam hose and the like, and is also useful in many other fields where high strength and reasonable good elongation are desired. This invention permits the production of yarns of higher

average dry tenacities than have been possible heretofore by the hot bath spinning method and greatly reduces spinning difficulties.

The snubber rollers, the method of imparting the twist and the removal thereof, and the combination method wherein the yarn is both treated with a jet of hot aqueous liquid on the first feed wheel and twisted and untwisted, form the subject-matter of divisional application Serial No. 673,446.

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

I claim:

1. In the process of stretching viscose yarn between two spaced positively driven feed wheels, the step which comprises applying a jet of hot aqueous liquid to the yarn on the first feed wheel and while the yarn is within a zone of 90° from the point it leaves said feed wheel to pass to the second feed wheel, the temperature of said aqueous liquid being such as to heat said yarn to a temperature of at least 75° C., said jet being so directed as to have a component of its velocity in the direction of rotation of said first feed wheel.

2. In the process of stretching viscose yarn between two spaced positively driven feed wheels, the steps which comprise leading the yarn from the top of the first wheel to the second wheel, and applying a jet of hot aqueous liquid to the yarn while it is on the first wheel and within a zone of 75° from the point it leaves said first wheel to pass to said second wheel, the temperature of said aqueous liquid being such as to heat said yarn to a temperature of at least 75° C., said jet being so directed as to have a component of its velocity in the direction of rotation of said first feed wheel.

3. In the process of stretching viscose yarn between two spaced positively driven feed wheels, the steps which comprise leading the yarn from the downrunning side of the first wheel to the second wheel, and applying a jet of hot aqueous liquid to the yarn while it is on the first wheel and within a zone of 45° to 90° from the point it leaves said first wheel to pass to the second wheel, the temperature of said aqueous liquid being such as to heat said yarn to a temperature of at least 75° C., said jet being so directed as to have a component of its velocity in the direction of rotation of said first feed wheel.

4. A method as set forth in claim 1, wherein the temperature of the aqueous bath is 90° C.

to 95° C. and the flow thereof from the jet is sufficiently large to keep the temperature drop across said first feed wheel at a minimum.

5. In the process of stretching viscose yarn between two spaced positively driven feed wheels, the step which comprises applying a jet of hot aqueous liquid directly to the yarn on the first feed wheel and while the yarn is within a zone of 90° from the point it leaves said feed wheel to pass to the second feed wheel, the temperature of such aqueous liquid being such as to heat said yarn to a temperature of at least 75° C.

6. In the process of stretching viscose yarn between two spaced positively driven feed wheels, the steps which comprise leading the yarn from the top of the first wheel to the second wheel, and applying a jet of hot aqueous liquid to the yarn while it is on the first wheel and within a zone of 75° from the point it leaves said first wheel to pass to said second wheel, the temperature of said aqueous liquid being such as to heat said yarn to a temperature of at least 75° C.

7. In the process of stretching viscose yarn between two spaced positively driven feed wheels, the steps which comprise leading the yarn from the downrunning side of the first wheel to the second wheel, and applying a jet of hot aqueous liquid to the yarn while it is on the first wheel and within a zone of 45° to 90° from the point it leaves said first wheel to pass to the second wheel, the temperature of said aqueous liquid being such as to heat said yarn to a temperature of at least 75° C.

EMERSON A. TIPPETTS.

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