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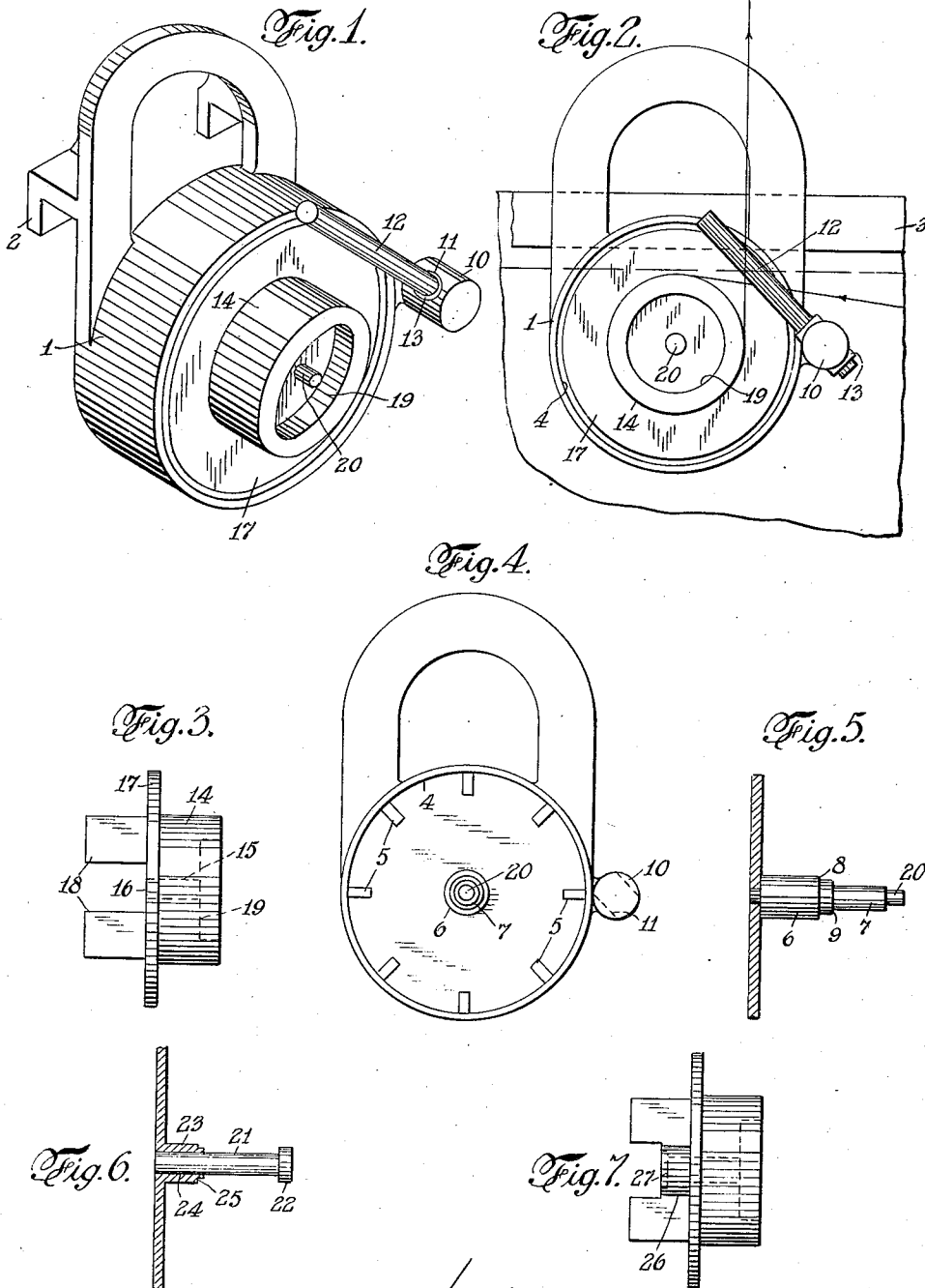
W. H. BRADSHAW ET AL

2,083,252

METHOD OF PRODUCING ARTIFICIAL THREAD

Filed Feb. 8, 1933

2 Sheets-Sheet 1



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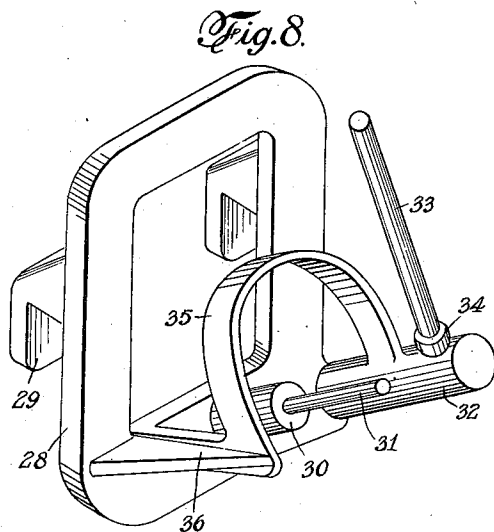
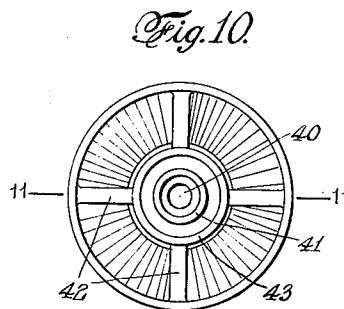
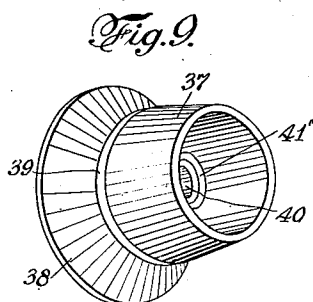
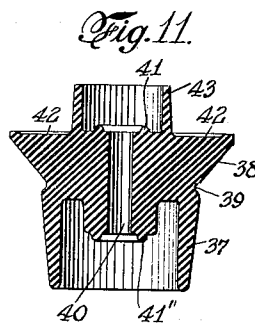
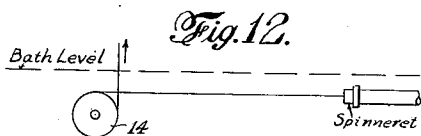
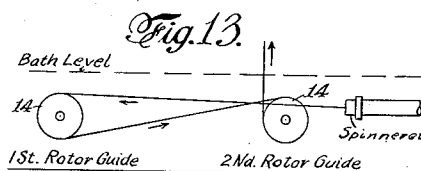
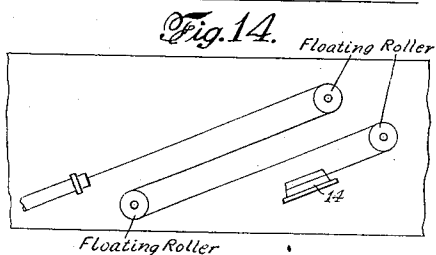
W. H. BRADSHAW ET AL

2,083,252

METHOD OF PRODUCING ARTIFICIAL THREAD

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2 Sheets-Sheet 2



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## UNITED STATES PATENT OFFICE

2,083,252

METHOD OF PRODUCING ARTIFICIAL  
THREAD

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Application February 8, 1933, Serial No. 655,738

26 Claims. (Cl. 18—54)

This invention relates to the manufacture of artificial threads, filaments, horsehair, straw, ribbons and the like and is a division in part of copending application Serial No. 303,574, filed September 1, 1928.

The tensile strength, hereinafter called tenacity, of finished artificial threads can be increased by stretching the thread when it is in the freshly coagulated and partially regenerated state. Prior to this invention, this was accomplished by causing the thread to drag around one or more stationary guides placed between the spinneret and the take-up device. This practice had many disadvantages. When the tension on the thread was increased by increasing the number of guides, by increasing the acuteness of angles around the guides, by increasing their diameters or by other means to a point where the tenacity was materially increased, the excessive friction of the thread on the guides broke some of the filaments and greatly reduced the elongation, the uniformity of dyeing and the dye index of the finished artificial thread.

We have found that we can overcome the above mentioned disadvantages by applying or developing a uniform or constant tension in a thread without subjecting it to a severe sliding friction, such as that developed when a thread is dragged under tension around a rod or other guide, and thereby produce a thread having a higher elongation with a given tenacity and a more uniform and deeper dyeing than a thread previously obtained in processes wherein sliding friction is employed and also, if desired, can produce a thread relatively free from broken filaments and characterized by unusual strength and endurance in both the wet and dry states to a degree heretofore never obtained in prior art procedures mentioned above.

It is therefore an object of this invention to provide a thread having a higher elongation with a given tenacity and a more uniform and deeper dyeing than a thread previously produced by methods, wherein sliding friction is present and wherein enough tension is used to yield equivalent strength and whereby the yarn is admirably suited for general textile operations.

Another object of this invention is to produce a thread having unusual strength, elasticity and endurance, both in the wet and dry states, whereby the yarn is admirably suited for the manufacture of cords or fabrics for use in vehicle tires, steam hose and belts, of balloon cloth, reinforcing fabrics, brake linings, filter cloths for hydraulic presses, parachute cloth, electrical insulation, aeroplane cloth, fabric for use in highway construction, etc.

An additional object of this invention is to provide methods of producing yarn having the characteristics and properties aforementioned.

A further object of this invention is to impose a substantial, uniform and constant tension on a freshly coagulated and partially regenerated thread without any undue or substantial sliding friction at one or more points in its path of travel from the spinneret to the take-up device.

Other objects will become apparent from the following description, appended claims and the accompanying drawings illustrating tension applying or developing means and in which:

Figure 1 is a perspective view of a guide adapted to be used with a take-up mechanism and constitutes one embodiment or modification for carrying out the invention;

Figure 2 illustrates the guide positioned in a coagulating or precipitating bath;

Figure 3 is a side elevation of the rotor removed from its casing;

Figure 4 is a front elevation of the casing or frame with the rotor removed;

Figure 5 illustrates the manner of mounting the rotor in the casing;

Figure 6 illustrates another manner of mounting the rotor in the casing;

Figure 7 is a side elevation of a modified form of the rotor;

Figure 8 is a perspective view of a modified form of the frame;

Figure 9 is a perspective view of a modified form of the rotor;

Figure 10 is a rear view of the rotor shown in Figure 9;

Figure 11 is a section taken on line 11—11 of Figure 10;

Figures 12—14 inclusive show diagrammatically illustrative set-ups for carrying out the method.

In one of the preferred embodiments, the artificial thread constituting the instant invention is characterized by unusually high wet and dry tenacities and unusually high wet and dry elongations relative to said tenacities. Such a thread is produced by applying to or developing a tension in the thread during the process of making the same, said tension being substantially constant and obtained substantially without any sliding friction. In this preferred embodiment of the invention, the thread is given a long bath travel, for example in excess of 20" and preferably 45, 60, 70, 80 or up to 100 or even more inches. Optimum results are secured when in conjunction with the long bath travel a relatively high tension, such as a total tension in excess of 0.4 gram per denier and preferably 0.5, 0.6, 0.7, 0.8 or more grams per denier, is progressively developed in the thread.

In another preferred embodiment of the invention wherein a thread having unusual strength, elasticity and endurance, both in the wet and dry states, is not desired, the thread is given a bath travel from 6" to 20", 25", 30", 60

more or less, and a total tension of less than 0.4, such as 0.05, 0.075, 0.10, 0.13, 0.15 gram per denier, is developed by passing the thread around a single guide of the type more fully hereinafter described.

5 It is to be understood that, when we speak of total tension, we mean the tension on the thread between the last tension-applying device in the bath and the traverse guide (in the case of bobbin spinning) which lays the thread on the 10 bobbin or (in the case of bucket spinning) the feed wheel.

Several illustrative means for imposing or developing the tension hereinbefore mentioned are shown in the drawings.

15 Referring now to Figures 1 to 5 of the drawings, wherein one modification for imposing or developing the tension in the thread is illustrated and wherein like reference numerals designate like parts, the reference numeral 1 designates a 20 frame or casing having a bracket 2 whereby it may be mounted on the edge of the bath or a rail 3 positioned over or in the bath. The casing 1, though it may be made of any shape, is preferably cylindrical in shape and has an open front 25 face and is provided on its inner periphery 4 with a plurality of vanes or flanges 5.

Securely fastened in the center of the casing 1 or formed therewith is a boss 6 in which a pin shaft 7 is rigidly mounted. The boss 6 is larger 30 in diameter than the shaft 7 and its end forms a shoulder 8 which limits the movement of a rotor mounted on the shaft 7, as hereafter explained. A washer 9 is positioned adjacent the shoulder 8 and is held in position by any suitable 35 means. Formed integrally with one side of the casing 1 is an arm 10 having a bore 11 there-through which is disposed at an angle to the vertical axis of the arm and adapted to carry a guide 12. Preferably, a resilient sleeve 13 is 40 disposed in the bore whereby the guide 12 may yield to a small degree upon the application of pressure.

The guide illustrated in Figures 1, 2 and 3 comprises a cylindrical body or rotor 14 having a bore 45 15 therethrough whereby it is freely mounted on the shaft 7 and is adapted to be engaged and rotated by a thread moving around its periphery. The rear face 16 of the rotor 14 is formed with a circular outwardly extending flange 17 which is 50 adapted to loosely close and fit in the open front face of the casing 1. Disposed on the rear face 16 of the rotor 14 is a plurality of vanes 18 which during operation rotate within the casing 1. The vanes may be made of divers shapes. Instead of 55 the form illustrated in this modification, the vanes may be curved in the direction of rotation, resulting in an increased resistance. They may also be cupped or channeled longitudinally. Though in this exemplification we have shown only two vanes, it is obvious that any number 60 thereof may be used. In the rotor illustrated in Figures 1, 2 and 3, its front face is provided with a circular depression 19, the depth of which is equal to the length of the extension 20 of the 65 pin shaft. Though the rotor is illustrated as cylindrical in shape, it is, however, to be understood that it may be made of any shape.

The tension on the thread may be varied within wide limits by varying alone or in combination 70 the diameter of the thread-bearing surface of the rotor, the specific gravity of the bath, the size, number and location of the vanes on the rotor, and the size, number and spacing of the stationary vanes in the casing.

75 The casing, guide shaft and rotor may be

made of any material which is resistant to the solutions and acids used in the coagulating and precipitating baths. Various materials, such as metals, alloys, glass, phenol-condensation products, hard rubber, etc. may be used. We have 5 found that the rotor, when made of a phenol-condensation product, produces satisfactory results. The casing 1 and bracket 2 we prefer to make from a metal or alloy whereby, due to its weight, the guide may be mounted and submerged 10 without any difficulty or inconvenience. The guide shaft is preferably made of tantalum, lithium or other resistant nickel alloys. A fine-grained, unglazed porcelain, such as sold under the trade name "Isolantite" is an admirably suitable material for the post guide 12. 15

In Figure 6, a modified form of mounting the rotor is illustrated. It differs from that previously described in that the shaft 21 is of constant diameter and provided with a collar 22 on its 20 front end. The hole 24 in the boss 23 is slightly tapered and the shaft press-fitted therein. For reasons which will become apparent, the boss 23 is provided with a shoulder 25.

In Figure 7, a modified form of the rotor (illustrated in Figure 3) is shown. This rotor differs from that previously described in that it is provided with a boss 26 on the rear face thereof to provide a larger bearing surface. A recess 27 is 25 formed therein to cooperate and receive the shoulder 25 above mentioned. When the construction described in Figures 6 and 7 is employed, the mode of operation is similar to that above explained. 30

The specific embodiment described in the foregoing included the casing 1 and its flanges 5, but these are not essential for the successful operation of the apparatus and they may be omitted. As an exemplification illustrating this phase of the invention, reference is directed to Figures 8 35 to 11 inclusive of the drawings.

Referring now to Figure 8, the reference numeral 28 designates a hollow rectangular frame provided with a bracket 29 on the rear face of each of the longitudinal legs thereof, whereby the 40 device may be mounted on the edge of a bath or on a rail positioned over or in the bath in the manner previously described. On the lower horizontal member, the frame is provided with a boss 30 in which a pin shaft 31 is rigidly mounted. 50 The boss 30 and the shaft 31 may be similar to that illustrated in the previously described modifications. At some convenient place, such as adjacent one of the lower corners of the frame, there is provided an arm 32 having a bore in which 55 a post guide 33 is mounted. Preferably, a resilient sleeve 34 is disposed in the bore of the arm 32 in which the guide 33 is mounted, whereby the guide 33 may yield a small degree upon the application of pressure thereto. If desired, a bridge 60 35 of any suitable form, such as that illustrated, extending from the arm 33 to a projection 36 formed integrally with or mounted on, for example, the lower horizontal member of the frame, may be provided. 65

Referring now to Figures 9, 10 and 11 wherein a form of tension-imposing means adapted to cooperate with the support shown in Figure 8 is illustrated, the reference numeral 37 designates the rotor which, as shown in the drawings, has 70 a slight taper and is provided at the rear end thereof with a flange 38 disposed at an angle relative to said rotor. At the junction between the flange 38 and the surface 37, there is provided an annular groove 39 in which the thread travels 75

in its passage around the guide. The guide is provided with a bearing portion 40 whereby it may be mounted on the shaft, for example shaft 31. If desired, the portion adjacent the termini of the bearing may be provided with small annular flanges 41 and 41'. By virtue of the flange 41 the area of surface contact between the bearing portion 40 and the boss 30 is small, thereby reducing the friction therebetween. The rear face of the guide is provided with an annular flange 43 which is designed to loosely fit over the boss 30 so as to prevent the thread from wrapping around the boss 30 and pin 31. A plurality of vanes 42 is also provided on the rear face of the guide, whereby resistance may be developed. It should be noted that the portion 37 of the rotor is in the nature of a flange which extends beyond the end of the element by means of which the guide is mounted in position. This is similar to the portion of the rotor which extends beyond the depression 19 as illustrated in the previous modifications.

In practice, when a device such as illustrated in Figures 1 to 7 is employed, the rotor 14 is mounted on the shaft 7, and its vanes 18 are enclosed within the casing and in cooperative relation with the flanges 5. The assembled guide may be mounted on the rail 3 at the edge of the coagulating bath and completely or partially submerged therein, as illustrated in Figure 2. Due to the loose fit of the flange 17 of the rotor 14, the interior of the casing is filled with the liquid comprising the bath. The thread, after it issues from the spinneret, passes behind the guide 12, around the rotor 14, and thence in front of the guide 12. After leaving the guide, the thread as shown in Figure 12 may pass directly on to a bobbin or around a godet wheel and then in a rotating bucket, the last three elements not being shown. Alternatively, a plurality of rotor guides may be used in combination with each other. For example, the thread after leaving the rotor guide 14 may be led through the bath to a second rotor guide 14 as shown in Figure 13.

It is to be understood that the thread may cooperate with other suitable guides prior to passing around the rotor guide 14. For example, the thread may pass around one or more floating rollers of the type described in United States Patent 1,873,455 and located in the bath in predetermined spaced relationship before passing around the rotor guide. Figure 14 illustrates the thread first passing around three floating rollers and then around the rotor 14.

It is further to be understood that the method constituting one phase of this invention is not restricted to any particular set-up or number of guides. Any suitable and desired number of rotor guides and/or appropriate guides and/or floating rollers may be employed. Also, when the development of greater tension is desired, the floating rollers may be slotted, or provided with projections on the under side thereof.

The thread, as it passes around the periphery of the rotor 14 on its way to another guide or to the take-up device, causes the rotor 14 to rotate. The rotor 14 is maintained in position on the shaft 7 by the shoulder 8 of the boss 6 and a collar at the end 20 of the shaft 7. The vanes 18 on the rear of the rotor 14 are thus rotated and, as they whirl through the bath within the casing in cooperation with the flanges 5 in the casing 1, retard the speed of rotation, whereby a tension is set up or developed in the thread between the guide and the next element in the

path of travel of the thread which may be as described, another guide or the take-up device.

It is apparent that the take-up device constitutes means for applying stress to the filaments to cause them to rotate the rotor, and the vanes 18 constitute means for applying to said rotor a drag resisting such rotation independent of the stress in the filaments.

The modifications illustrated in Figures 8 to 11 operate in a similar manner.

The time of travel of the thread in the bath, the location of the various guides, the composition and temperature of the bath and the character of the spinning solution spun must be carefully balanced to obtain optimum results.

By means of this invention there can be secured a thread having much more uniform characteristics than has been possible to produce heretofore. When a freshly coagulated or gel-thread is stretched a definite amount between two rollers having different peripheral speeds, the tension developed in the thread between these rollers varies considerably from time to time. This is not due to varying degrees of slippage but is due to the practical impossibility of maintaining the threads in exactly the same state of regeneration at a given point in its travel. In the manufacture of artificial threads of regenerated cellulose or of cellulose derivatives, it is impossible to control conditions so that the spinning solution is extruded under the same identical set of conditions at all times. For instance, in the spinning of regenerated cellulose threads from viscose, when the coagulating bath changes slightly in concentration, or when the viscose varies perhaps only a very slight amount in its degree of ripeness, the rate of coagulation and regeneration changes sufficiently to cause a considerable change in tension between the two positively driven wheels.

In this invention the percentage of stretch between the rotor guide and the next element in the path of travel such as, for example, the draw-off device, is not fixed as is the case when both the rotor and the draw-off device are positively driven, but as hereinafter described, may vary depending upon the R. P. M. of the rotor. Under any given set of conditions an equilibrium exists between the R. P. M. of the thread-driven rotating device or rotor and the degree of coagulation and regeneration of the freshly formed thread, which is in turn influenced by the composition and temperature of the coagulating bath, the degree of ripeness of the viscose, etc. By virtue of the principles involved in this thread-driven rotor device, any change in the degree of coagulation and regeneration of the thread is immediately followed by a shifting to a new state of equilibrium at an R. P. M. slightly different from the previous value. For example, when the viscose is extruded from the spinneret at a slightly greater degree of ripeness, its rate of coagulation and regeneration is faster. The more completely coagulated and regenerated thread between the rotor and the take-up device offers greater resistance to stretching. A greater portion of the total stretch, therefore, takes place between the spinneret and the rotor. This additional length of thread passes over the rotor causing it to turn slightly faster which produces a slight increase in tension on the thread between the rotor and the take-up device. This slight increase in tension is small in comparison to that which would be required were the thread stretched a constant amount between the rotor

and the take-up device. If this were not true, the R. P. M. of the rotor would not increase slightly as we find it does under the conditions stated. Thus the thread is always subjected to a more uniform tension than can be maintained in practice using positively driven thread devices.

The tension imparted to the freshly coagulated thread also depends inter alia on the resistance offered to the rotating vanes. This resistance is a function of the size and number of the vanes, specific gravity of the bath, and, when the form illustrated in Figures 1 to 5 is used, also their position relative to the flanges 5 in the casing 1 and the circumference of the latter.

When the method of tension spinning above described is used in the bucket spinning process, as the tension increases, the tendency of the resulting yarn to shrink in the bucket or to recover also increases, and a point may be reached where poor cake formation develops and the process becomes impractical. By the use of high speed buckets or buckets having large diameters, the centrifugal force may be made great enough to resist the tendency of the yarn to shrink and overcome the above defect. The invention, therefore, contemplates utilizing high speed buckets or buckets having large diameters, whereby the cake formation is controlled. The high centrifugal force obtained by high speed buckets or large diameter buckets not only prevents the formation of a soft cake but also by applying greater tension to the thread on the bucket side of the take-up wheel reduces the possibility of feed wheel slippage.

Instead of mounting the rotor illustrated in Figures 1 to 5 in the bath and having the coagulating bath offer the resistance, various other solutions may be used for this purpose. For instance, the vanes may be caused to rotate in a bath of oil retained in the casing. If desired, the vanes may be omitted and a resistance imparted to the rotor by any suitable means.

The rotor guide, as previously described, is supported completely or partially submerged in the bath. It, however, may be disposed at any point between the spinneret and the take-up device.

The illustrative set-ups shown in Figures 12 to 14 inclusive and above described may be employed to produce the thread constituting one phase of the invention and which is characterized by high wet and dry tenacities and high wet and dry elongations relative to said tenacities. In this preferred embodiment of the invention, the thread is given a long bath travel, for example, in excess of 20", and preferably 45", 60", 70", 80" or up to 100" or even more inches. Optimum results are secured when in conjunction with the long bath travel a relatively high tension, such as a total tension in excess of 0.4 gram per denier, and preferably 0.5, 0.6, 0.7, 0.8 gram per denier, or more, is progressively developed in the thread such as secured by employing the set-ups shown in Figures 13 and 14.

When a thread having unusual strength, elasticity and endurance, both in the wet and dry state, is not desired, the thread is given a bath travel of from 6" to 20", 25", 30", more or less, and a total tension of less than 0.4 gram per denier, such as 0.05, 0.075, 0.10, 0.13, 0.15 gram per denier is developed by passing the thread around a single rotor type in a set-up such as illustrated in Figure 12.

Optimum physical characteristics of the

thread are secured when a viscose having a salt index of between 3.0 and 4.9 is employed.

Attempts have been made in the past to greatly increase the tenacity of viscose rayon by developing tension in the thread in successive increments. When it was attempted to produce thread with unusual strength, the result was very unsatisfactory due to the fact that, as the tension was increased, the destructive action of the sliding friction over the fixed guides used became so pronounced that the yarn could not be sold commercially and, when still higher tenacities were attempted, the yarn actually broke during the spinning operation. Other conditions being constant, it is a well known fact that the tenacity developed in the yarn is nearly a direct function of the tension applied to the thread during the spinning process. By eliminating the destructive action of the sliding friction, which prevented previous experiments from making use of very high tensions to develop the tenacity, we have been able to apply much higher tensions to the thread and therefore produce a yarn which has a much greater tenacity and at the same time is relatively free from broken filaments, irregular dyeing, etc. which characterized the products heretofore produced.

As is apparent from the foregoing, the thread constituting one phase of the invention in one embodiment is characterized by having uniform dyeing characteristics and a high elongation relative to its tenacity. By a thread having relatively high elongation for a given tenacity, we mean a thread which possesses at least 10%, and usually 20%, or even 30% or more, higher elongation than the elongation of a thread having the same tenacity but which in spinning has been tensioned through the application of substantial sliding friction. In another embodiment the thread, in addition to the high elongation, also possesses unusual strength, elasticity and endurance. The thread is, moreover, highly crenulated and, because of this, it possesses greater covering power and filling power and is less apt to slip in the fabric when the yarn is used in the customary textile operations. In the case of high tenacity yarn, the highly crenulated surface of the filament makes it admirably suitable for reinforcing rubber tires, rubber steam hose, and the like.

The high tenacity yarn is further characterized by an outer wall structure of substantial thickness when viewed in cross-section under a microscope under the conditions hereafter set forth. This characteristic is not found in high tenacity yarn spun in plasticizing baths, such as those containing 50% or more of sulphuric acid and, in this respect, plasticized regenerated cellulose threads prepared from viscose are more like cuprammonium cellulose threads which are also without this characteristic wall structure. This phenomenon is indicative of difference in physical properties between the regenerated cellulose constituting the surface of the filaments and the regenerated cellulose constituting the interior or core of the filaments.

In order to view this characteristic structure, filament cross-sections are prepared as follows—The cross-sections of thread are cut from the customary paraffin block wherein it is mounted in the usual manner and the paraffin is removed from the cut filaments by means of a suitable solvent. The filament cross-sections are mounted on a slide, wet with a drop of water and then covered with the usual cover glass. Under the

microscope the characteristic wall structure just mentioned is readily discernible.

The thread may be in the desulphured or non-desulphured state.

When the samples of yarn, for example a few loose threads, are immersed for 10 minutes in a solution containing 0.1 gram of iodine and 2.0 grams of potassium iodide in 100 cc. of water, they acquire a reddish brown coloration.

In order to more fully explain the nature of the invention, several illustrative procedures for producing the thread are hereinafter set forth. It is to be understood that the invention is not restricted to the precise procedures hereinafter set forth. The floating roller guides used according to the examples may be replaced by slotted floating rollers or floating rollers having projections on the under side of them, if it is desired to develop a greater tension.

**Example I.**—Viscose ripened to a salt point of 3.2 is spun through a 24-hole spinneret at a rate of delivery to produce 150 denier thread. The bath contains 9% sulphuric acid, 19% sodium sulphate, 4% glucose and 0.85% zinc sulphate, and is heated to about 45° C. The thread is led through the bath 15" to a rotor guide as shown in Figures 8 to 11, therearound and thence to a godet wheel and finally collected in a bucket rotating at 6,000 R. P. M. The total travel of the thread in the bath is about 20" and the tension developed is about 9 grams. The finished yarn, that is after it has been washed, desulphured, bleached and dried, has the following physical properties:

|                |          |      |
|----------------|----------|------|
| Dry tenacity   | g. p. d. | 1.60 |
| Wet tenacity   | do       | 0.78 |
| Dry elongation | percent  | 21.8 |
| Wet elongation | do       | 30.7 |

**Example II.**—A viscose solution having a salt index of 3.2 is spun through a spinneret having 60 orifices into a coagulating bath containing 11.5% sulphuric acid and 27% sodium sulphate. The viscose delivery is such that the final denier of the thread is 150. The thread, upon extrusion from the spinneret, is given a bath travel of 20" to a guide having 2 vanes as hereinabove described. After passing around this rotor guide, the thread is caused to travel 8½" through the bath to a second guide similar to the first. From the second guide the thread then passes to a feed wheel and thence to the collecting device.

The total bath travel is 35" and the tension developed is 79.5 grams. The feed wheel peripheral speed is 2,760" per minute. The physical properties of the washed, desulphured and dried yarn are as follows:

|                          | Min. | Max.  | Avg.  |
|--------------------------|------|-------|-------|
| Denier                   | 142  | 146   | 145   |
| Tenacity, dry (g. p. d.) | 2.36 | 2.56  | 2.48  |
| Tenacity, wet (g. p. d.) | 1.04 | 1.37  | 1.28  |
| Elongation, dry          | 9.9% | 12.3% | 10.9% |
| Elongation, wet          | 7.5% | 14.3% | 11.0% |

**Example III.**—A viscose prepared from cotton linters and having a salt index of 4.0 is spun through a spinneret of 60 holes so as to yield a 150 denier yarn, into a coagulating bath containing 11.5% sulphuric acid and 27% sodium sulphate. After the thread issues from the spinneret, it is given a bath travel of 25" and then passed around a rotor guide without vanes. After leaving the guide just mentioned, the thread is

given a bath travel of 10" and passed around a rotor guide of the type described in this application. Then it is conducted to the feed wheel, the peripheral speed of which is 3,000" per minute. Finally, the thread is wound in a bucket of normal size rotating at 9,300 R. P. M.

The total bath travel of the thread is 41" and the tension developed is 86 grams.

The physical properties as measured on the desulphured and dried yarn are as follows:

|                          | Min.  | Max.  | Avg.  |
|--------------------------|-------|-------|-------|
| Denier                   | 146   | 152   | 149   |
| Tenacity, dry (g. p. d.) | 2.40  | 2.63  | 2.43  |
| Tenacity, wet (g. p. d.) | 1.05  | 1.31  | 1.16  |
| Elongation, dry          | 13.3% | 16.3% | 14.6% |
| Elongation, wet          | 18.0% | 23.8% | 20.2% |

**Example IV.**—Viscose prepared in the usual manner and having a salt index of 3.5 to 4.0 is spun into a coagulating bath containing 10.2% sulphuric acid, 22.4% sodium sulphate, 4% glucose and 0.8% zinc sulphate. The thread, as it issues from the spinneret, is led through the bath 21" to a floating roller guide and, after passing therearound, is led through the bath an additional 23" to a rotor guide of the type previously described. After leaving the rotor guide, it passes upward to a traverse guide and on to a bobbin. The total bath travel is about 50" and the tension developed is 0.44 gram per denier. The yarn, after desulphuring and drying, has the following characteristics:

|                |          |      |
|----------------|----------|------|
| Dry tenacity   | g. p. d. | 2.52 |
| Wet tenacity   | do       | 1.42 |
| Dry elongation | percent  | 15.4 |
| Wet elongation | do       | 16.2 |

**Example V.**—Viscose ripened to a salt index of approximately 3.2 is brought to the spinneret through the usual pumps, candle filters and lead necks. The thread is spun at 2,500" per minute into a bath containing 11% sulphuric acid, 19% sodium sulphate, 4% glucose and 0.6% zinc sulphate, at a temperature of 50° C. The total bath travel is 74.5", the thread passing around 3 floating roller guides and then around a rotor guide of the type herein described, the distance to the first floating roller being about 20" from the spinneret, and between the floating rollers about 20". There is an 8" travel from the last floating roller to the rotor guide and a 6½" travel around the rotor guide. The total tension developed is 70 grams (this is on 100 denier 40 filament thread), and the physical properties of the yarn are as follows:

|                         | Min. | Max.  | Avg. |
|-------------------------|------|-------|------|
| Denier                  | 93   | 102   | 96   |
| Dry tenacity (g. p. d.) | 2.55 | 2.93  | 2.75 |
| Wet tenacity (g. p. d.) | 1.50 | 1.71  | 1.60 |
| Dry elongation          | 7.7% | 12.0% | 9.7% |
| Wet elongation          | 6.0% | 12.0% | 9.6% |

**Example VI.**—The same viscose as in Example V is spun through a spinneret having 60 holes to form a finished thread of 100 denier. The bath and salt index are the same as in Example V. The total bath travel is 55", which is made up of 21" to a first floating roller guide, 17" between this guide and the next floating roller guide, 6" from the second floating roller guide to a rotor guide, and then about 7" around the rotor guide and out of the bath. The total tension on the thread, that is between the bath and the

traversing guide at the bobbin, is 68 grams. The yarn is handled in the same way as in Example V and the physical properties of bleached skeins are as follows:

|                              | Min. | Max.  | Avg. |
|------------------------------|------|-------|------|
| Denier.....                  | 96   | 98    | 97   |
| Dry tenacity (g. p. d.)..... | 2.42 | 2.98  | 2.75 |
| Wet tenacity (g. p. d.)..... | 1.44 | 1.72  | 1.61 |
| Dry elongation.....          | 5.8% | 10.8% | 8.1% |
| Wet elongation.....          | 5.8% | 11.0% | 8.7% |

The yarn produced in accordance with the principles of this invention may be desulphured and bleached or undesulphured and not bleached. Usually, the yarn produced in those procedures wherein the desulphuring and bleaching operations are omitted has physicals which are somewhat higher than that resulting from methods employing these steps. To illustrate this phase, the following example is given:

*Example VII.*—A yarn produced by the method set forth above in Example V which has not been subjected to the desulphuring and bleaching operations but has been washed and dried only has the following characteristics:

|                              | Min. | Max.  | Avg. |
|------------------------------|------|-------|------|
| Denier.....                  | 92   | 92    | 92   |
| Dry tenacity (g. p. d.)..... | 2.81 | 3.00  | 2.90 |
| Wet tenacity (g. p. d.)..... | 1.47 | 1.70  | 1.60 |
| Dry elongation.....          | 6.3% | 8.8%  | 7.5% |
| Wet elongation.....          | 6.0% | 12.3% | 9.4% |

For certain uses it is desirable to have a yarn possessing a reasonably high elongation with a high tenacity, for instance, a yarn possessing a dry strength of 2.50 grams per denier, with a dry elongation of 16% or more. Such a yarn can be obtained according to this invention if the thread is finally wound up under a very slight tension or no tension at all. If the yarn is collected in a bucket revolving at not too high a speed, the reduction in tension applied to the thread after it leaves the godet wheel is sufficient to produce the desired result. In the bobbin process, however, it is necessary to provide a draw-off wheel, that is, the yarn is stretched between the draw-off wheel and the bath so that the thread is under a very high tension, such as 0.5, 0.6, 0.7, 0.8 or more grams per denier, and then the thread is led to a collecting device such as the usual bobbin rotating at a speed somewhat lower than that of the draw-off wheel, or so that the tension on the thread between the draw-off wheel and the bobbin is not more than about 0.05 gram per denier and preferably not more than about 0.02 gram per denier. The thread is then washed, purified and dried upon the bobbin, or it may be wet reeled and purified as a skein, without any resistance whatsoever to its tendency to shrink during drying.

Throughout the specification reference to the viscose salt index refers to those values determined by the process discussed on page 68, paragraph 2, of "Artificial Silk", by Reinthaler & Rowe, published in 1928.

Since it is obvious that various mechanisms may be employed in the above-described method, this invention is not limited to the device above described except as defined in the appended claims.

We claim:

1. A method of preparing artificial thread which comprises extruding a viscose solution in

a spinning bath, conducting the thread through said bath and applying a substantially uniform tension without any substantial sliding friction to the freshly produced thread in its path of travel from the spinneret to the collection device to stretch the freshly produced thread and improve the physical properties of the final thread, the stretch of the thread varying with the normal changes of the conditions during spinning.

2. A method of preparing artificial thread which comprises extruding a viscose solution in a spinning bath, conducting the thread through said bath and applying a plurality of substantially uniform tensions without any substantial sliding friction to the freshly produced thread at different points in the path of travel of the thread from the spinneret to the collection device to stretch the freshly produced thread and improve the physical properties of the final thread, the stretch of the thread varying with the normal changes of the conditions during spinning.

3. A method of preparing artificial thread which comprises extruding a viscose solution in a spinning bath, conducting the thread through said bath for at least a distance between 6" and 20" and developing a tension of at least 0.4 gram per denier without any substantial sliding friction in the freshly produced thread in its path of travel from the spinneret to the collection device to stretch the freshly produced thread and improve the physical properties of the final thread, the stretch of the thread varying with the normal changes of the conditions during spinning.

4. A method of preparing artificial thread which comprises extruding a viscose solution in a spinning bath, conducting the thread through said bath for at least 20" and applying a plurality of substantially uniform tensions without any substantial sliding friction to the freshly produced thread at different points in the path of travel of the thread from the spinneret to the collection device to stretch the freshly produced thread and improve the physical properties of the final thread, the stretch of the thread varying with the normal changes of the conditions during spinning, the total tension developed in the thread being at least 0.4 gram per denier.

5. A method of preparing artificial thread which comprises extruding a viscose solution in a spinning bath, conducting the thread through said bath for at least 20", developing a tension of at least 0.4 gram per denier without any substantial sliding friction in the freshly produced thread in its path of travel from the spinneret to the collection device to stretch the freshly produced thread and improve the physical properties of the final thread, the stretch of the thread varying with the normal changes of the conditions during spinning, and winding the thread at a tension which does not exceed 0.05 gram per denier.

6. A method of preparing artificial thread which comprises extruding a viscose solution in a spinning bath, conducting the thread through said bath for at least 20", applying a plurality of substantially uniform tensions without any substantial sliding friction to the freshly produced thread at different points in the path of travel of the thread from the spinneret to the collection device to stretch the freshly produced thread and improve the physical properties of the final thread, the stretch of the thread varying with the normal changes of the conditions during

spinning, the total tension developed in the thread being at least 0.4 gram per denier, and winding the thread at a tension which does not exceed 0.05 gram per denier.

5 7. A method of preparing artificial thread which comprises extruding a viscose solution in a spinning bath, developing a substantial tension without any substantial sliding friction in the thread by passing the thread around a thread-driven rotor device disposed in said bath to stretch the freshly produced thread and improve the physical properties of the final thread, and subsequently conducting the thread to a take-up device, the rotation of said thread-driven rotor device varying slightly with the variations that take place in the degree of regeneration of the thread as it passes between said rotor device and said take-up device.

10 8. A method of preparing artificial thread which comprises extruding a viscose solution in a spinning bath, developing a tension of at least 0.4 gram per denier without any substantial sliding friction in the thread by passing the thread around a thread-driven rotor device disposed in said bath to stretch the freshly produced thread and improve the physical properties of the final thread, and subsequently conducting the thread to a take-up device, the rotation of said thread-driven rotor device varying slightly with the variations that take place in the degree of regeneration of the thread as it passes between said rotor device and said take-up device.

15 9. A method of preparing artificial thread which comprises extruding a viscose solution in a spinning bath, passing the thread in said bath for a distance not less than 6", developing a substantial tension without any substantial sliding friction in the thread by passing the thread around a thread-driven rotor device disposed in said bath to stretch the freshly produced thread and improve the physical properties of the final thread, and subsequently conducting the thread to a take-up device, the rotation of said thread-driven rotor device varying slightly with the variations that take place in the degree of regeneration of the thread as it passes between said rotor device and said take-up device.

20 10. A method of preparing artificial thread which comprises extruding a viscose solution in a spinning bath, passing the thread in said bath for a distance at least between 6" and 20", developing a tension of at least 0.4 gram per denier without any substantial sliding friction in the thread by passing the thread around a thread-driven rotor device disposed in said bath to stretch the freshly produced thread and improve the physical properties of the final thread, and subsequently conducting the thread to a take-up device, the rotation of said thread-driven rotor device varying slightly with the variations that take place in the degree of regeneration of the thread as it passes between said rotor device and said take-up device.

25 11. A method of preparing artificial thread which comprises extruding a cellulosic solution into a spinning bath, causing the freshly produced thread to pass through said bath and imposing a substantially uniform tension without any substantial sliding friction on the freshly produced thread during its passage through said bath to stretch the freshly produced thread and improve the physical properties of the final thread, the stretch of the thread varying with

the normal changes of conditions during the spinning cycle.

12. A method of preparing artificial thread which comprises extruding a cellulosic solution into a spinning bath, causing the freshly produced thread to pass through said bath and developing a tension without any substantial sliding friction of at least 0.4 gram per denier on the freshly produced thread during its travel through said bath to stretch the thread and improve the physical properties of the final thread, the stretch of the thread varying with the normal changes of conditions during the spinning cycle.

13. The method of preparing artificial thread which comprises spinning a cellulosic solution, imposing a substantially uniform and constant tension without any substantial sliding friction on the freshly produced thread in the bath, said tension being of a magnitude to stretch the thread and improve the physical properties of the final thread, the stretch of the thread varying with the normal changes of the conditions during the spinning cycle, and winding the thread at a high speed to form a package or cake thereof.

14. A method of preparing artificial thread which comprises spinning a cellulosic solution, imposing a substantially uniform and constant tension without any substantial sliding friction on the freshly produced thread in the bath, said tension being of a magnitude to stretch the thread and improve the physical properties of the final thread, the stretch of the thread varying with the normal changes of the conditions during the spinning cycle, and winding the thread in a bucket having a high peripheral speed.

15. A method of preparing artificial thread which comprises spinning a cellulosic solution, imposing a substantially uniform and constant tension without any substantial sliding friction on the freshly produced thread in the bath, said tension being of a magnitude to stretch the thread and improve the physical properties of the final thread, the stretch of the thread varying with the normal changes of the conditions during the spinning cycle, and winding the thread in a bucket under conditions preventing the formation of a soft cake.

16. A method of preparing artificial thread which comprises spinning a cellulosic solution, imposing a substantially uniform and constant tension without any substantial sliding friction on the freshly produced thread in the bath, said tension being of a magnitude to stretch the thread and improve the physical properties of the final thread, the stretch of the thread varying with the normal changes of the conditions during the spinning cycle, and winding the thread in a bucket under conditions whereby the tension on the thread on the bucket side of the take-up device is increased.

17. A method of preparing artificial thread which comprises spinning a cellulosic solution, imposing a substantially uniform and constant tension without any substantial sliding friction on the freshly produced thread between the spinneret and the take-up device, said tension being of a magnitude to stretch the thread and improve the physical properties of the final thread, the stretch of the thread varying with the normal changes of the conditions during the spinning cycle, and winding the thread at a high speed to form a package or cake thereof.

18. A method of preparing artificial thread

which comprises spinning a viscose solution in a spinning bath, imposing a substantially uniform and constant tension without any substantial sliding friction on the thread during its passage through said spinning bath, said tension being of a magnitude to stretch the thread and improve the physical properties of the final thread, the stretch of the thread varying with the normal changes of the conditions during the spinning cycle, and winding the thread at a high speed to form a package or cake thereof.

19. A method of preparing artificial thread which comprises spinning a cellulosic solution, imposing a substantially uniform and constant tension without any substantial sliding friction on the freshly produced thread between the spinneret and the take-up device, said tension being of a magnitude to stretch the thread and improve the physical properties of the final thread, the stretch of the thread varying with the normal changes of the conditions during the spinning cycle, and winding the thread in a bucket having a high peripheral speed.

20. A method of preparing artificial thread which comprises spinning a viscose solution in a spinning bath, imposing a substantially uniform and constant tension without any substantial sliding friction on the thread during its passage through said spinning bath, said tension being of a magnitude to stretch the thread and improve the physical properties of the final thread, the stretch of the thread varying with the normal changes of the conditions during the spinning cycle, and winding the thread in a bucket having a high peripheral speed.

21. A method of preparing artificial thread which comprises spinning a cellulosic solution, imposing a substantially uniform and constant tension without any substantial sliding friction on the freshly produced thread between the spinneret and the take-up device, said tension being of a magnitude to stretch the thread and improve the physical properties of the final thread, the stretch of the thread varying with the normal changes of the conditions during the spinning cycle, and winding the thread in a bucket under conditions preventing the formation of a soft cake.

22. A method of preparing artificial thread which comprises spinning a cellulosic solution, imposing a substantially uniform and constant tension without any substantial sliding friction on the freshly produced thread between the spinneret and the take-up device, said tension being of a magnitude to stretch the thread and improve the physical properties of the final thread, the stretch of the thread varying with the normal changes of the conditions during

the spinning cycle, and winding the thread in a bucket under conditions whereby the tension on the thread on the bucket side of the take-up device is increased.

23. A method of preparing artificial thread which comprises spinning a viscose solution in a spinning bath, imposing a substantially uniform and constant tension without any substantial sliding friction on the thread during its passage through said spinning bath, said tension being of a magnitude to stretch the thread and improve the physical properties of the final thread, the stretch of the thread varying with the normal changes of the conditions during the spinning cycle, and winding the thread in a bucket under conditions whereby the tension on the thread on the bucket side of the take-up device is increased.

24. A method of treating artificial filaments while they are travelling which comprises passing the filaments around a cylindrical surface rotatable about its axis, applying a stress to the filaments to cause them to rotate said surface, and resisting such rotation by the application to said surface of a drag which is independent of the stress in the filaments, whereby a tension of sufficient magnitude is imposed on the thread to permanently stretch the thread and thereby improve its physical properties.

25. A method of preparing artificial threads or filaments which comprises extruding a cellulosic solution, passing the freshly produced filaments around a substantially cylindrical surface rotatable about its axis, applying a stress to the filaments to cause them to rotate said surface, and resisting such rotation by the application to said surface of a drag which is independent of the stress in the filaments, whereby a tension of sufficient magnitude is imposed on the thread to permanently stretch the thread and improve its physical properties, and thereafter collecting the thread.

26. A method of preparing artificial threads or filaments which comprises extruding a cellulosic solution, passing the freshly produced filaments around a substantially cylindrical surface rotatable about its axis, applying a stress to the filaments to cause them to rotate said surface, and resisting such rotation by the application to said surface of a drag which varies with the normal changes of conditions during the spinning cycle and is independent of the stress in the filaments, whereby a tension of sufficient magnitude is imposed on the thread to permanently stretch the thread and improve its physical properties, and thereafter collecting the thread.

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