Sept. 23, 1947. K. M. McLELLAN 2,427,993

PRODUCTION OF RAYON

Filed July 26, 1944

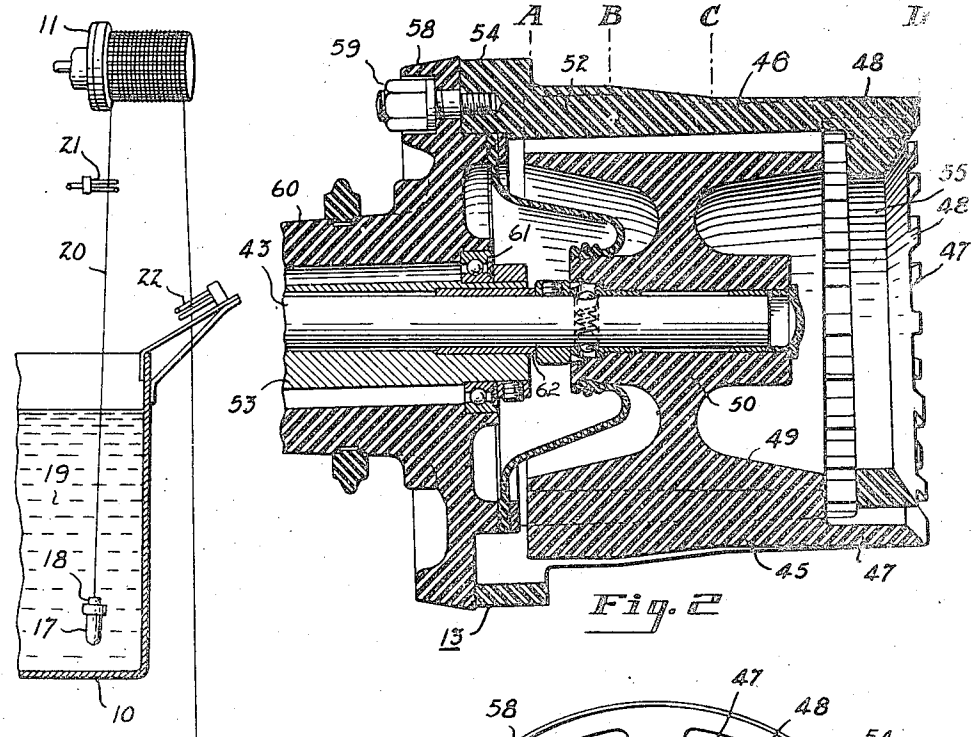


Fig. 2

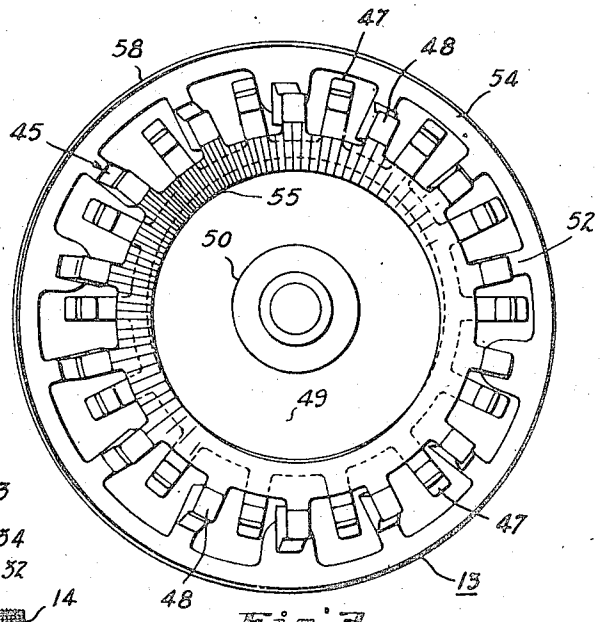


Fig. 3

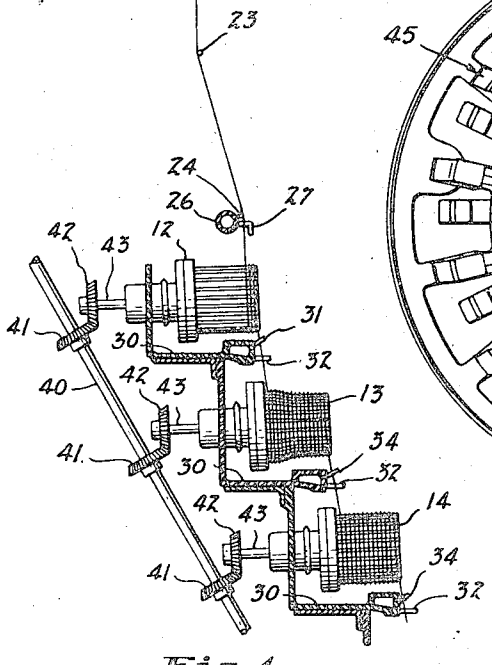


Fig. 4

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Patented Sept. 23, 1947 2,427,993

UNITED STATES PATENT OFFICE

2,427,993

PRODUCTION OF RAYON

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Application July 26, 1944, Serial No. 546,616

8 Claims. (Cl. 18—54)

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This invention relates to the production of rayon thread or yarn of high tensile strength and it provides a new and improved process by which such rayon may be advantageously produced.

High strength rayon yarns or threads may be produced by a variety of methods. In producing viscose rayon high strength yarns, it is common practice to extrude a viscose solution into a coagulating bath and thereafter subject the incompletely regenerated viscose rayon to one or more stretching operations. Prior to or during the stretching operations, the thread may be treated with various liquids in order to make it more plastic so that it may be stretched more readily. Nevertheless, in stretching the thread, tensions are built up which tend to resist the stretching forces. Such tensions manifest themselves by increased abrasive wear when the yarn is passed over guides in passing from one stretching device to another and by contractive force applied to the yarn stretching devices as a result of the shrinking tendency of the yarn passing over them.

Thus, for example, in producing viscose rayon by the continuous process, newly formed viscose thread is withdrawn from a coagulating bath by a thread-advancing, thread-storage reel on a continuous processing apparatus such as that shown and described, for example, in Torrence Patent No. 2,284,497. The thread is thereafter advanced to a series of thread-advancing, thread-storage devices upon which a variety of processing operations may be performed. In order to stretch the thread to increase its tensile strength, the reels may be operated at various peripheral speeds so that the thread in passing from one reel to the next succeeding reel is subjected to a desired amount of stretch. If desired, flared reels such as those shown in Torrence Patent No. 2,266,574 may be used to perform the stretching operation.

The tension built up in the thread as a result of the stretching operation causes the thread to tend to contract, and when the thread is wrapped around the thread-advancing reel it exerts substantial pressure on the operating members of the reel. The thread is advanced on the reel as a result of the inclined and offset relationship of the axes of its two interdigitating cage members. (See, for example, Knebusch Patent No. 2,210,914.) If the yarn is tightly wrapped around the cage members, increased abrasive wear of the filaments will be produced and the possibility of breakage of some of the filaments in the thread is increased. Where the amount of stretch imparted to the yarn is very considerable, e. g., 50% or more, the amount of force exerted by the yarn

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on the operating portions of the thread-advancing reels may be such as to impose unduly excessive strains on the bearing structures which support these portions of the reel. Similarly, when high stretch is imparted to the yarn, the pressure exerted by the yarn on the thread guides over which it passes in advancing from one reel to the other may become so great as to result in damage to the filaments.

This invention provides a method by which the tensions resulting from the stretching of the yarns or threads may be effectively minimized without reduction in tensile strength of the final yarn product. In general, this is accomplished by stretching the incompletely regenerated thread in at least two steps, the latter stretching step preceded by a treatment with an aqueous plasticizing medium, then permitting the stretched thread to shrink by an amount substantially less than it was stretched and thereafter completing the regeneration of the thread without permitting substantially any further shrinkage thereof. In the viscose process this may be accomplished particularly effectively by stretching the incompletely regenerated thread a total of at least 50%, and permitting the thread to shrink no more than about 5% after which the regeneration of the thread is completed.

In the further description of the invention, reference will be made to the production of rayon by the continuous process on an apparatus such as that shown and described, for example, in Torrence Patent No. 2,284,497. In this connection, reference will be made to the accompanying drawings in which:

Figure 1 shows a portion of a continuous rayon processing apparatus;

Figure 2 shows a sectional plan view of a particular type of thread-advancing, thread-storage reel which may be used in practicing the invention; and

Figure 3 shows an end view of the reel structure illustrated by Figure 2.

Referring now to Figure 1, a viscose solution is pumped through mass tube 17 and extruded through spinneret 18 into an acid coagulating bath 19 in trough 10. The newly formed and incompletely regenerated viscose filaments are then led in the form of a thread bundle upwardly through wiper guide 21 which removes excess coagulating bath from the thread and then onto a rotating thread-advancing, thread-storage reel 11 of uniform diameter. The thread advances in a plurality of helical turns from the supported to the unsupported end of the reel and then passes

downwardly through a second wiper guide 22 which also aids in removing processing liquid from the thread. The thread thereafter passes over guides 23 and 24 onto a second thread-advancing, thread-storage reel 12 of uniform diameter. This reel is rotated at a higher peripheral speed than the thread-advancing reel 11 by means of drive shaft 40 and bevel gears 41 and 42, the latter of which are mounted on reel shaft 43. As a result of the difference in peripheral speeds between reels 11 and 12, the incompletely regenerated thread is stretched. While the thread is on the reel 12 it is treated with a liquid, e. g., warm water or the like, which tends to plasticize the thread. This liquid is piped through conduit 26 and discharged through the outlet 27. The liquid which drips from reel 12 is collected in the trough 30 below the thread-advancing reel.

The plasticized thread after being discharged from the thread-advancing reel 12 passes over guide 31 and onto thread-advancing reel 13. The portion of reel 13 nearest the supported end is of uniform diameter and the portion of the reel nearest the unsupported end is also of uniform diameter but the diameter is less than that of the first portion. These two portions are joined by a tapered section which merges into the two portions of unequal diameter as shown more fully in Figure 2. The reel 13 is driven by means of drive shaft 40 and bevel gears 41 and 42, the latter of which is mounted on reel shaft 43. The speed of rotation of reel 13 is such that the peripheral speed of the portion of greatest diameter is greater than that of the preceding reel 12 so that a stretch imparted to the thread in passing from reel 12 to reel 13. The thread in advancing from the supported to the unsupported end of reel 13 is permitted to shrink when it passes over the tapered portion of the reel and the shrinkage is then checked when the thread reaches the portion of the reel of smallest diameter. While the thread is on the reel 13, it is treated with a suitable processing liquid to complete the regeneration of the thread. This liquid may advantageously be in the form of an acid solution which drips onto to reel through the pipe 32. The construction and operation of reel 13 is such that the peripheral speed of the portion of the reel of smallest diameter is greater than the peripheral speed of the preceding reel 12.

After being discharged from reel 13, the thread passes over guide 34 and onto a thread-advancing reel 14 of uniform diameter. This reel is operated by means of drive shaft 40 and bevel gears 41, 42 at the same peripheral speed as that prevailing on the portion of reel 13 which is of smallest diameter. Consequently, no streach will be imparted to the thread in its passage from reel 13 to reel 14. While the thread is on reel 14, it is treated with additional processing liquids to further complete the regeneration of the thread. These liquids are applied to the thread by being discharged through the pipe 32. Excess processing liquids are collected in the troughs 30 under the respective reels.

After leaving the reel 14, the thread is subjected to further processing operations such as, for example, desulfurizing, drying, and the like in order to make the final rayon product.

To further illustrate one form of apparatus which may be used with advantage in practicing the invention, reference will now be made to the thread-advancing, thread-storage reel shown in some detail in Figures 2 and 3. The reel consists of two rigid interdigitating corrosion-resistant

reel members of circular cross section, each having a periphery formed of a plurality of spaced, longitudinally extending bar members. The thread-supporting bars 47 of reel member 45 and thread-supporting bars 48 of reel member 46 are alternately disposed, the two reel members being mounted for rotation about axes which are offset from and inclined toward one another. The bars 47 of reel member 45 are fixed to a generally cylindrical body portion 49. Reel member 45 is concentrically mounted by means of hub 50 on reel drive shaft 43 journaled in the supporting member 53.

The other reel member 46, which may be termed the eccentric reel member, has its bars 48 formed as part of a rigid, cagelike member 52. The bars 48 are fixed at the unsupported end of the reel to an internal annular reinforcing rib 55 which serves to impart rigidity to the bars. At the other end of the member 52, the bars 48 merge into an external annular rib or flange 54 which also imparts rigidity to the bars and serves as a means by which the cagelike member 52 is fixed to the rotatable annular supporting flange 58.

The cagelike member 52 is rigidly fixed to flange 58 by means of a nut and bolt assembly 59. The flange 58 is part of the hub 60 which is mounted for rotation on antifriction bearings 61 positioned on the nonrotating eccentric sleeve 53. The eccentric sleeve, in turn, is mounted on a bushing type bearing 62 within which the reel shaft 43 rotates. The corresponding bearing members at the supported end of the reel structure are not shown.

Because of the offset and skew relation of the axes of the two reel members, a thread wound about the reel during rotation thereof is caused to advance in spaced, generally helical turns along the length of the reel.

As illustrated in Figure 2, the reel has a composite thread-bearing periphery comprising two generally cylindrical portions of uniform diameter A—B and C—D, the latter being of less diameter than the former and disposed at the discharge end of the reel. Merging with said cylindrical portions is an intermediate portion B—C having regularly diminishing diameters which decrease from the end of zone A—B to the beginning of zone C—D.

If the tensions built up in the thread as a result of the stretching operations become sufficiently great, they may interfere with the proper advancement of the thread on the thread-advancing reel. Thus, as a result of the tension, the offset and inclined relationship of the reel members may tend to be changed so that the thread is no longer properly advanced on the reel members. Similarly, the force applied to the reel members due to the tension of the thread may also impose substantial strains on the bearings supporting the reel members. Additionally, the bundle of filaments constituting the thread may be substantially flattened because of the tension in the thread with the result that overlapping of thread turns may occur causing filament damage. Furthermore, the processing liquids applied to the thread while it is on the reel may have greater difficulty in effectively penetrating the thread filaments. High tension in the thread also promotes abrasive wear or scuffing of the thread when it is advanced by the reel members. These conditions become especially serious in producing heavier denier threads which have been subjected to a considerable amount of stretching.

The use of a thread-advancing reel such as

that illustrated in Figures 1 and 2 in the position shown at 13 in Figure 1 effectively minimizes such difficulties. The tension built up in the thread as a result of the stretching operations between reels 11 and 12, and 12 and 13, respectively, is substantially reduced when the thread is advanced over the tapered portion B—C (Figure 2). The thread, consequently, is permitted to shrink somewhat and thereafter is advanced on the reel under reduced tension. Due to relaxed tension in the thread, the strains imposed on the reel members and their associated parts are substantially reduced and the processing liquids applied to complete the regeneration of the thread may act more effectively in accomplishing their intended purpose.

The invention will be more fully described by referring to the following example but it is understood that the invention is not limited thereto.

Example

1100 denier 480 filament viscose rayon is produced by extruding a viscose solution containing about 7–8% of cellulose and about 6–7% of caustic soda through a suitable spinneret into a coagulating bath containing about 8–9% of sulfuric acid, about 20% of sodium sulfate and about 3.4–3.8% of zinc sulfate. The newly coagulated but incompletely regenerated thread is withdrawn from the coagulating bath by means of a thread-advancing reel such as reel 11 in Figure 1 and advanced on this reel in a plurality of helical turns. The reel has a uniform diameter of about 5.75 inches and rotates at a peripheral speed of about 52.2 meters per minute. The thread is discharged from the reel and conducted to a second thread-advancing reel of the same diameter as reel 11 but operating at a peripheral speed of about 65.0 meters per minute. Sufficient turns of thread, e. g., two or three, are wrapped around reel 12 to prevent slippage of the thread on the reel. Due to the difference of peripheral speeds between reels 11 and 12, the thread will be stretched approximately 24.5%. Water at a temperature of about 58° C. drips through the pipe 27 onto the thread layer on reel 12 to plasticize the thread.

The thread is conducted from reel 12 to reel 13 which has a thread-bearing periphery of maximum diameter at its supported end of about 5.75 inches. The reel is rotated at a rate such that this portion of its periphery has a peripheral speed of approximately 80.8 meters per minute. As a consequence, the thread will be given additional stretch so that the total stretch imparted to the thread will be approximately 54.8%. The tapered portion of the reel is such that the thread is permitted to shrink about 4% and thereafter the thread is advanced on the portion of the reel of minimum but uniform diameter which is traveling at a peripheral speed of about 77.6 meters per minute. While the thread is on this reel, it is treated with a processing liquid containing about 2.5% of sulfuric acid and about 3.5% of sodium sulfate to complete regeneration of the thread. After completing its travel on reel 13, the thread is advanced to reel 14 which operates at the same peripheral speed as the discharge end of reel 13. Consequently, no further stretch is imparted to the thread. Thereafter, the thread is subjected to further processing operations to complete the transformation into a finished rayon product. The resulting thread has high tensile strength.

Instead of using a large number of turns of thread on the reel 11 as illustrated in Figure 1 and a small number of turns on reel 12, it may be desirable in certain instances to modify these conditions so that the number of turns on these reels may be more nearly equal. This will depend to some extent upon the composition of the viscose solution and the nature of the coagulating bath employed in the process. In general, the process may be carried out with particular effectiveness when using coagulating baths containing at least 0.25% of zinc advantageously in the form of zinc sulfate or other suitable zinc salts.

The plasticizing liquid applied to the yarn while it is on the reel 12 may consist of liquids other than water or may be in the form of aqueous solutions of suitable plasticizing agents. The processing liquids applied on reels 13 and 14 to complete the regeneration of the thread are advantageously such that they contain less acid than is contained in the coagulating bath and they may, if desired, be in the form of a diluted solution of the coagulating liquid.

Although the foregoing description of the invention has been chiefly concerned with the production of viscose rayon filaments, it is to be understood that the invention may also be applied to the production of other types of regenerated cellulosic products, whether made by the viscose or cuprammonium methods. Among such products may be mentioned threads, bands, ribbons and the like where similar problems of high tensions due to stretching operations may be encountered.

I claim:

1. A process for the manufacture of viscose rayon which comprises extruding a viscose solution into an acid coagulating bath, withdrawing the resulting viscose filaments from said coagulating bath before they are completely regenerated, stretching said incompletely regenerated filaments, treating said filaments with a dilute aqueous acid solution but maintaining said filaments in an incompletely regenerated state, stretching said treated filaments a second time during said dilute acid treatment, permitting a partial shrinkage of said stretched filaments and thereafter treating said partially shrunk filaments with an acid regenerating solution and completing the regeneration of said filaments without permitting substantially any further shrinkage.

2. A process for the manufacture of viscose rayon which comprises extruding a viscose solution into an acid coagulating bath; withdrawing the resulting viscose filaments from said bath before they are completely regenerated; stretching said incompletely regenerated filaments; treating said filaments with an aqueous plasticizing medium; stretching said treated filaments a second time; permitting a partial shrinkage of said filaments while they are in an incompletely regenerated state; and thereafter treating said partially shrunk filaments with an acid regenerating solution and completing the regeneration of said filaments without permitting substantially any further shrinkage.

3. A process for the manufacture of viscose rayon which comprises extruding a viscose solution into an acid coagulating bath; withdrawing the resulting viscose filaments from said bath before they are completely regenerated; stretching said incompletely regenerated filaments; treating said filaments with an aqueous plasticizing medium; stretching said treated filaments a second time; treating said stretched filaments

with dilute aqueous acid solution but maintaining said filaments in an incompletely regenerated state; permitting a partial shrinkage of said filaments; and thereafter treating said partially shrunk filaments with an acid regenerating solution and completing the regeneration of said filaments without permitting substantially any further shrinkage.

4. A process for the manufacture of viscose rayon which comprises extruding a viscose solution into an acid coagulating bath; withdrawing the resulting viscose filaments from said bath before they are completely regenerated; stretching said incompletely regenerated filaments; treating said filaments with an aqueous plasticizing medium while maintaining them in said stretched condition; stretching said treated filaments a second time; treating said stretched filaments with a dilute aqueous acid solution but maintaining said filaments in an incompletely regenerated state; permitting said incompletely regenerated filaments to shrink an amount less than the amount of said second stretch; and thereafter treating said partially shrunk filaments with an acid regenerating solution and completing the regeneration of said filaments without permitting substantially any further shrinkage.

5. The process as in claim 4 in which the total stretch imparted to said filaments as a result of said first and second stretching steps is at least 50% and in which said partial shrinkage of said filaments is no greater than about 5%.

6. The process as in claim 4 in which said aqueous plasticizing medium is water and in which at least 20% of the total stretch is imparted to said filaments by the first of said stretching steps.

7. A process for the manufacture of viscose rayon which comprises extruding a viscose solution into an acid coagulating bath; withdrawing the resulting viscose filaments from said bath before they are completely regenerated; stretching said incompletely regenerated filaments; treating said stretched filaments with an aqueous plasticizing medium while maintaining said filaments in said stretched condition; stretching said treated filaments a second time; transferring said stretched filaments to a thread-advancing, thread-storage device having a path of thread travel of progressively diminishing length in the direction of thread travel whereon said incompletely regenerated filaments are permitted to shrink an amount less than the amount of said second stretch; and thereafter treating said partrially shrunk filaments with an acid regenerating solution and completing the regeneration of said filaments without permitting substantially any further shrinkage.

8. The method of producing viscose rayon which comprises extruding a viscose solution into an acidic coagulating bath; withdrawing the resulting viscose filaments from said coagulating bath before they are completely regenerated; passing said filaments to a first thread-advancing, thread-storage reel having a thread-bearing periphery of substantially uniform diameter; passing said filaments to a second thread-advancing, thread-storage reel of substantially uniform diameter and operating at a greater peripheral speed than said first reel whereby said filaments will be stretched; treating said incompletely regenerated filaments stored on said second reel with an aqueous plasticizing medium; passing said treated filaments to a third thread-advancing, thread-storage reel having a thread-bearing periphery of progressively diminishing diameter in the direction of thread advance, the periphery of least diameter having a peripheral speed greater than said second reel whereby said filaments are stretched between said second and third reels and whereby said filaments are permitted to shrink an amount less than the amount of said first stretch; treating said filaments stored on said third reel with a dilute aqueous acid solution but maintaining said filaments in an incompletely regenerated state; passing said partially shrunk filaments to a fourth thread-advancing, thread-storage reel of substantially uniform diameter; treating said filaments stored thereon with an acid regenerating solution and completing the regeneration thereof without permitting substantially any further shrinkage.

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