July 31, 1951 K. M. McLELLAN ET AL 2,562,199

LIQUID TREATMENT OF THREAD ON A THREAD-ADVANCING, THREAD-STORAGE DEVICE

Filed Dec. 23, 1948 2 Sheets-Sheet 1

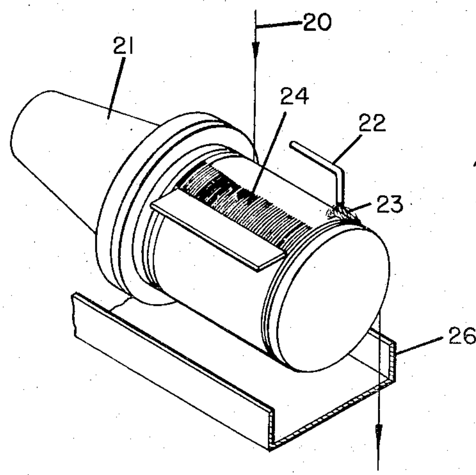

FIG. 1

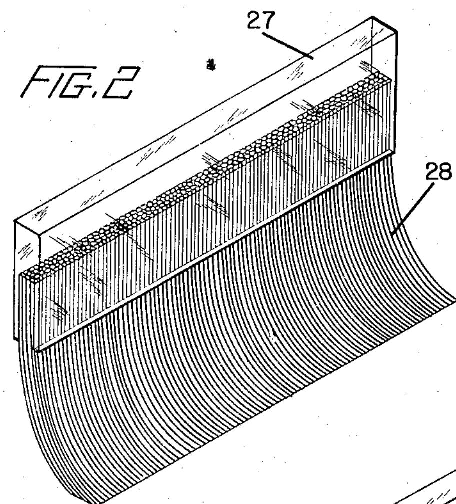

FIG. 2

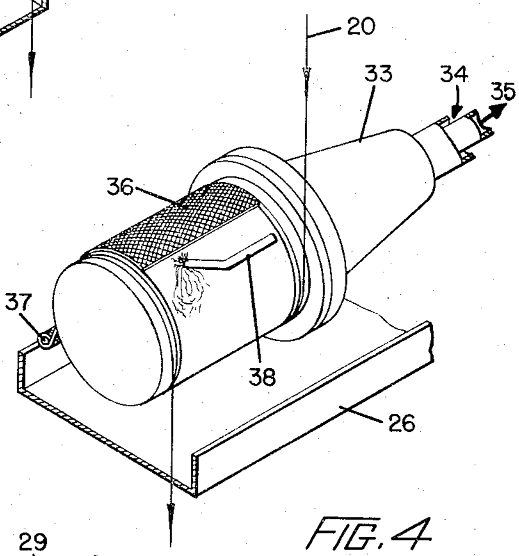

FIG. 4

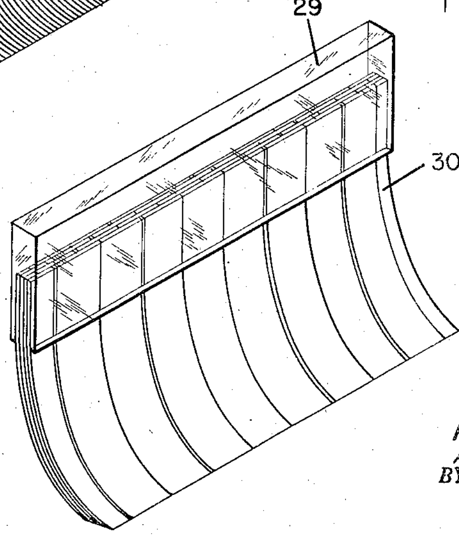

FIG. 3

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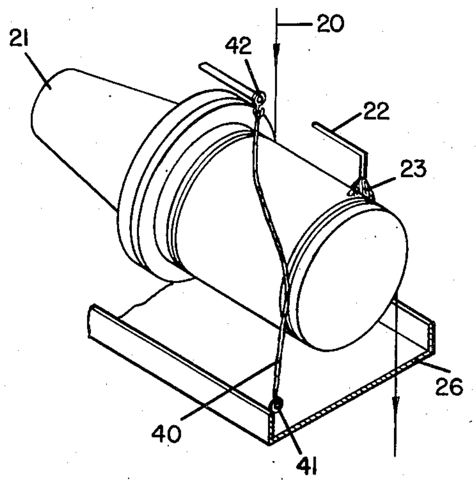

FIG. 5

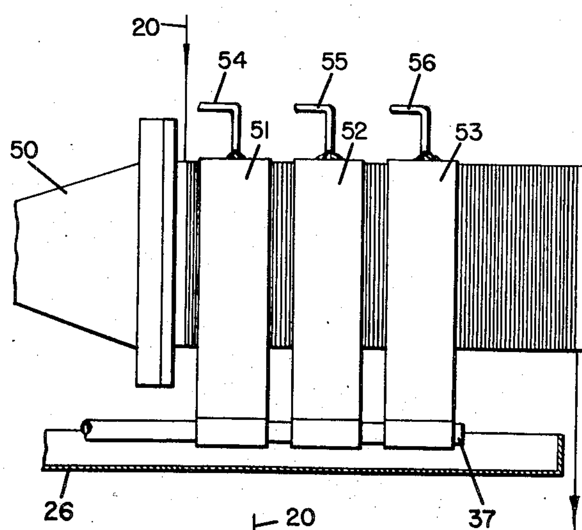

FIG. 7

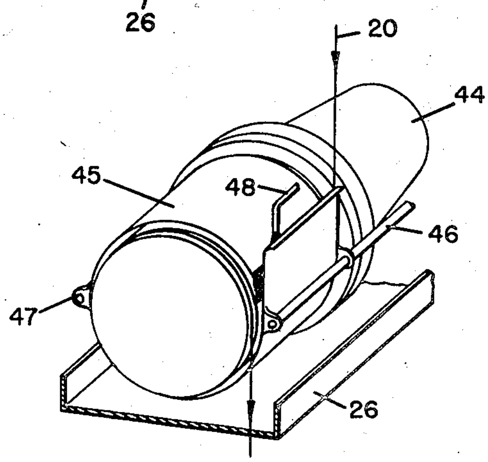

FIG. 6

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2,562,199

LIQUID TREATMENT OF THREAD ON A THREAD-ADVANCING, THREAD-STORAGE DEVICE

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Application December 23, 1948, Serial No. 67,018

12 Claims. (Cl. 117—66)

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This invention relates to the liquid treatment of multiple filament yarn, thread and the like (hereinafter referred to as thread) while such thread is continuously advanced and stored on a thread-advancing, thread-storage device as a single layer in a plurality of generally helical turns. More particularly, the invention relates to a new and improved method for the distribution of treating liquid applied to a thread helix.

In the liquid treatment of a thread helix, it is desirable for reasons of efficiency and uniformity of treatment to form a layer or film of treating liquid extending both across a number of adjacent helical turns of thread, and also at least partially around the thread helix.

However, under certain operating conditions it is difficult to achieve sufficient, uniform and yet efficient distribution of applied treating liquid. Such is the situation, for example, at higher thread speeds where increased centrifugal forces are imposed on an applied treating liquid. Difficulties are also encountered in certain situations when a thread is stored on a thread-advancing device at low thread tensions. Low tension conditions may be caused, for example, by the relaxation of the thread during treatment at elevated temperatures.

The present invention provides a process whereby proper and very desirable liquid distribution may be achieved and maintained under a wide variety of the thread treatment conditions. It provides a process in which the adverse effects of high thread speed and low thread tension are considerably minimized if not substantially completely eliminated. In addition, the new process provides efficient and uniform liquid treatment of thread when operating under one of more of the following conditions; wider spacings between adjacent turns of a thread helix; lower and more economical rates of delivery of treating liquids; and higher liquid treatment temperatures on a thread helix. The process of the present invention is particularly adaptable to the treatment of viscose rayon thread.

In accordance with the process of the present invention this is accomplished as follows: Thread is advanced in a plurality of generally helical turns and a treating liquid is applied to the advancing thread while maintaining a substantially stationary contour-following means in contact with a plurality of consecutive turns of liquid-containing thread.

In general, the present invention may be practiced on rotatable devices that advance and temporarily store thread in the form of a plurality of generally helical turns. A number of such thread advancing devices are known to the art. They include devices having as thread bearing members a plurality of drums, rollers, rods, bars and the like on which the advancing thread may form either a substantially true helix or a somewhat distorted helical configuration.

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Particular advantages are, however, derived with devices which form helices that are only slightly distorted from a true helix. Helices of this type are usually formed on unitary, generally cylindrical, thread-advancing devices and are referred to herein as thread-advancing reels. An advancing device of this type is described in the Knebusch Patent No. 2,210,914 and consists in general of a number of spaced bar members arranged in a generally cylindrical manner.

In general, the thread-advancing device may be positioned so that its axis is in a vertical or horizontal plane or at any angle thereto. However, greater advantages are derived by positioning the device in a generally horizontal manner. Advantageously, it may be positioned slightly off horizontal so that one end of the thread helix is higher than the other. In this manner the treating liquid may advantageously be delivered toward the higher end of the thread helix thereby permitting it to flow to the lower end of the helix. Especial advantages are derived when the applied liquid flows counter to the direction of thread advance. If desired, the liquid may be delivered to the top, the ascending or the descending side of a horizontal helix.

Although a wide variety of treating liquids may be employed, it is advantageous to use aqueous media, such as for example, water alone or aqueous alkaline or acid media. Especial benefits are derived, for example, in the processing of viscose rayon thread where a variety of aqueous treating media are usually employed.

The adjacent turns of thread in a thread helix may be spaced relatively wide apart from each other, or if desired, they may be rather closely spaced. By the term "closely spaced" turns, is meant that they are sufficiently close to each other to permit a liquid to form a film extending across two or more thread turns. Advantageous results are derived by the employment of widely spaced turns particularly when a reel type of thread-advancing device is used. Advantageously, such turn spacing may be between about 30% and 50% of the theoretical maximum turns per inch that can be wound on a thread advancing device without overlapping. The theoretical maximum turns per inch for a given thread-advancing device may be determined by measuring the spread of a multifilament strand of thread when it is wound on the device at the particular tension, temperature and treating liquid conditions to be employed and thereafter computing the number of separate adjacent turns that could occupy the distance of one inch. For example, a strand of freshly extruded, 150 denier, 40 filament, viscose rayon thread, wound at a tension of about 0.2 gram per filament and treated with a 3% aqueous sulfuric acid solution at about 60° C., will spread a distance of about 0.02 inch on a bar member of a thread-advancing reel. Therefore, the theoretical maximum number of turns per inch that can be wound under such conditions, without overlapping, is about 50.

The treating liquid which is applied to the thread helix is caused to form a substantially continuous liquid contact between the thread helix and a means positioned in close proximity to the outer periphery of the helix. Advantageously, this may be accomplished by contacting the applied liquid with a means positioned adjacent to and sufficiently close to the thread helix so as to form a substantially continuous liquid film between the helix and the external means.

The area of liquid contact between the helix and the external means may be small or large as desired. Thus, for example, the area of liquid contact may extend across a large number of adjacent turns of across only a few turns. Likewise, the area of liquid contact may extend only partially around the periphery of the thread helix or, if desired, completely around the helix.

The external means may be resilient or pliable in character. The resilient type of means may be made, for example, from materials such as metals or shaped plastics, resins, etc. The pliable means may be made from materials such as rubber, leather, fibrous materials or light-weight plastic materials. Advantageously, the external means may be made from materials that are chemically resistant, or are rendered chemically resistant, to the treating liquids employed.

Among the pliable materials that may be used may be mentioned for example fibrous mats; webs; threads, cords, ribbons, or strips assembled as brushes; woven or knit cloth etc. Particularly advantageous are light weight, sheet-like materials such as, for example, glass fiber cloth; sheets or films made from polymeric materials such as, for example, polymers or copolymers of acrylonitrile, vinyl or vinylidene chloride, nylon and the like.

In general the closer the distance between the thread helix and the external means the greater are the advantages derived from the process. The manner of positioning the external means adjacent and in close proximity to the thread helix depends, among other things, upon the type of means employed, the speed of the thread undergoing treatment and the extent of treatment desired. In general, the means are supported or anchored independently of the helix. Advantageously, the external means may be in actual contact with the thread helix under certain conditions without damage to the thread. The pliable means advantageously may be partially supported by the applied liquid present upon the thread helix. Because of their pliable nature they automatically adjust themselves to the periphery of the thread helix while permitting the desired continuous liquid contact between the means and the helix. The manner of positioning and employing various types of external means will be described in greater detail in connection with the drawings.

The thread undergoing liquid treatment may be advanced at a speed of about 60 to 90 meters per minute if desired. However, greater advantages are derived at the higher speeds particularly above about 100 meters per minute. Such higher speeds may include speeds which would cause applied liquids to be partially or completely thrown off the thread helix because of centrifugal forces. Particularly advantageous results are derived at thread speeds between about 100 and 300 meters per minute.

The quantity of treating liquid delivered to a thread helix may, if desired, be between 200 cc. and 600 cc. per minute. However, particular advantages are derived by delivering less than about 200 cc. per minute and especially between about 10 cc. and 150 cc. per minute. Even greater advantages are derived at deliveries between about 15 cc. and 100 cc. per minute. If desired, the treating liquid may be applied at several points around the periphery of a thread helix.

The temperatures of liquid treatment may, if desired, be normal room temperatures or with advantage more elevated temperatures such as, for example, temperatures causing the rapid evaporation of the treating liquid. Particular advantages are however derived at temperatures above about 70° C. and especially between about 80° C. and the boiling point of the treating media in contact with the thread. Elevated temperatures may be obtained by delivering hot treating liquids to the helix or with advantage by employing internally heated thread-advancing devices. Under the latter treatment conditions the temperature of the thread supporting members of the device are usually higher than the temperature of the treating liquid in contact with the advancing thread. Especial advantages are derived for example in the treatment of viscose rayon thread at elevated temperatures with aqueous acid media.

The thread tensions that may be employed on a thread-advancing device may, if desired, be between about 0.2 and 0.9 gram per filament or with advantage they may be below this range. Although it is desirable to maintain, where possible, higher thread tension conditions, it is difficult to do so under certain processing conditions, such as for example, at elevated treatment temperatures where threads tend to relax. It is therefore at low thread tension conditions where the greater advantages are derived from the process of this invention. Particular advantages are derived at thread tensions between about 0.07 and 0.16 gram per filament when employing a thread-advancing reel.

Although the process of this invention may be employed for the treatment of many types of filamentary material, it is particularly effective in the processing of freshly extruded viscose rayon thread. The present process is especially adaptable to the processing of viscose rayon by the continuous processing method in which a number of aqueous chemical treatments and washing treatments are performed on a single strand of viscose thread as it travels continuously over a series of thread-advancing devices.

The accompanying drawings will serve to illustrate several forms of apparatus by which the invention may be practiced.

Figure 1 shows an arrangement employing an external means associated with a thread-advancing reel. The means used is illustrated in greater detail in Figure 2 and consists of a number of thread segments assembled and bound by a plastic block to resemble a brush. Figure 3 illustrates another brush-like external means in which a number of strips or ribbons are also assembled and bound together in a plastic block.

Figure 4 illustrates the employment of an internally heated reel associated with a pliable sheet-like means which is partially supported by and riding on the applied liquid on the reel while anchored along one edge near the ascending side of the helix.

Figure 5 illustrates the use of a single strand of cord as an external means.

Figure 6 illustrates the employment of a resilient, annular, plastic band positioned in close proximity to the thread helix and extending substantially completely around the helix.

Figure 7 illustrates schematically an arrangement providing a series of independent liquid treatment zones on a single thread-advancing reel by the employment of a corresponding number of spaced external means.

In Figure 1 the yarn **20** is advanced and stored as a helical package on the thread-advancing reel **21** disposed with its axis at an angle to the horizontal so as to cause applied liquid to flow toward the beginning of the helix. The reel **21** is rotated in a clockwise direction and the treating liquid **23** delivered by the tube **22** is directed to the top side of the helical package. The brush-like means **24** with its threads **25** is positioned adjacent to the ascending side of the helix so that liquid contact is made with the helix over an arc of about 45°. The treating liquid which is discharged from the thread helix is collected in the tray **26**.

The brush-like means **27** and **29** shown in detail by Figures 2 and 3 respectively may be made by assembling suitable lengths, from 1 to 10 inches or longer, of the threads **28** or the ribbons **30** into a thin layer and sealing the ends along one edge between pairs of plastic blocks made from suitable polymeric, thermoplastic material. The threads or cords **28** may have deniers between about 200 and up to 1000 or over. The ribbons **30** may range from one-sixteenth to one-half inch in width.

In Figure 4 the reel **33** is inclined about 5° from the horizontal, the higher end being the thread-discharge end of the reel. The tube **38** delivers treating liquid to the top side of the reel near the thread-discharge end thereof. The reel **33** is of the type described in the Knebusch Patent 2,210,914 and in the Bergmann Patent 2,294,866. The reel may be internally heated by introducing steam or hot water through the shaft **34** and exhausting the same through the concentric shaft **35**. The heat from the steam or hot water is conducted to the advancing thread through the thread supporting bar members of the reel **33**.

The external means **36** consists of a relatively thin, light-weight cloth made of chemically resistant fibers. One edge of the cloth **36** is anchored to one side of the tray **26** by the pin **37** while a portion of the cloth opposite the anchored edge is supported by the applied liquid present on the rotating thread helix forming a liquid contact over an arc of about 95°. The cloth **36** positioned in this manner is effective in confining the spray of the treating liquid which may be thrown off the reel **33** and also, with advantage, in returning part of such discharged liquid to the thread helix.

The arrangement in Figure 5 is the same as Figure 1 with the exception that the external means consists of the cord **40** having a denier of about 2000. One end of the cord **40** is tied to the left forward corner **41** of the tray **26**, the cord then contacting the ascending side of the thread helix from the front to the back of the reel **21**. The other end of the cord **40** is attached to the hook **42** positioned above and level with top of the reel at a point to the right and behind the reel.

In Figure 6 the external annular means **45** consists of a thin, light-weight, resilient band made from transparent methyl methacrylate resin. The band is supported by the shafts **46** and **47** on either side of the reel **44** and encircles the reel almost completely. One end of the band **45** overlaps the other so as to provide a funnel-like opening on the top side of the helix for the delivery of treating liquid by the tube **48**.

In general an external means such as the band **45** may be resilient in character and is positioned so that it is in actual contact with the thread helix. Further, if desired, the annular band may extend only partially around the periphery of the helix.

In Figure 7 the series of axially spaced external means **51**, **52** and **53** adjacent the reel may consist of pliable cloth means positioned as shown in Figure 4 or resilient means similar to those shown in Figure 6. To each of the treatment zones formed by the spaced means is delivered the treating liquids supplied by the tubes **54**, **55** and **56**, respectively. By the employment of the separate spaced means **51**, **52** and **53** the advancing thread leaving each zone of treatment tends to shed the applied treating liquid as it advances through the space between each of the means. In this manner the extent of intermingling by the various treating liquids present on the same helix is minimized.

This modification of the present invention may be practiced with considerable advantage at the higher thread speeds where the increased centrifugal forces may be utilized to remove applied treating liquid from the advancing thread as such thread leaves each treating zone. If desired a single means may be substituted for the spaced means and the various liquids permitted to intermingle and flow to the thread discharge end of the reel. Further, if desired, the complete processing of a thread such as viscose rayon may be performed on a plurality of multi-zone reels of the types above described.

The following examples will serve to further describe the invention. Although reference is made to the accompanying drawings it will be understood that the invention is not intended to be limited to the specific details set forth.

Example 1

A freshly coagulated 150 denier 40 filament viscose rayon thread which has been stretched about 10 per cent is treated as follows on the reel **33** described in connection with Figure 4 of the drawings. The reel **33** is about five inches in diameter and about six inches long and is driven at a peripheral speed of about 77 meters per minute. It is internally heated as previously described so as to maintain a treatment temperature of about 72° C. The thread is advanced and stored on the reel in a helical package about four inches long containing about 25 turns per inch which is about 50 per cent of the theoretical maximum turns per inch. About 30 cc. per minute of a 2 per cent, by weight, aqueous sulfuric acid solution is delivered at about room temperature to the top of the heated helix by the delivery tube 38 positioned at about four inches from the beginning of the helix. The cloth means 36, made from a polyacrylonitrile yarn, is positioned adjacent the ascending side of the helix so that it extends across about three inches of the helical package and around the helix over an arc of about 20°. The applied treating solution which is discharged from the helix is collected into the tray 26.

The first few turns of thread on the heated reel 33 have a tension of about 0.3 gram per filament. As the thread advances over the reel, however, the elevated temperature relaxes the thread and lowers the thread tension to about 0.16 gram per filament toward the discharge end of the helix. The thread 20 discharged from the reel 33 may be processed to completion by the employment of a series of similarly adapted thread-advancing reels or by any other method.

Example 2

A 150 denier 40 filament thread is processed in the manner and under the conditions described in Example 1 except for the following. The thread treatment temperature on the reel 33 is maintained at about 80° C. The reel 33 is driven at a peripheral speed of about 120 meters per minute and the rate of liquid delivery is increased to about 50 cc. per minute. The arc of liquid contact between the cloth 36 and the helix is increased to about 45° and the tension of the stored thread toward the discharge end of the helix is about 0.1 gram per filament.

Example 3

In this example the conditions are the same as Example 2 except for the following. The reel 33 is driven at a peripheral speed of 160 meters per minute and the cloth means 36 consists of a relatively thin piece of glass fiber cloth impregnated with a vinyl chloride polymer. The cloth means extends around the helix over an arc of about 60°. The rate of liquid delivery is increased to about 70 cc. per minute.

Example 4

The conditions of this example are the same as Example 2 except for the following. The treatment temperature of the thread stored on the heated reel 33 is maintained at about 90° C. and the tension of the stored thread toward the discharge end of the helix is about 0.08 gram per filament.

Example 5

The conditions of this example are the same as Example 2 except for the following. The treatlike means 27 of Figure 2 is substituted for the cloth means 36. The thread on the heated reel 33 is stored at about 15 turns per inch and the aqueous acid solution delivered to the reel 33 contains about 0.2%, by weight, of a dispersed sulfonated vegetable oil.

Example 6

A 150 denier, 40 filament viscose rayon thread containing an aqueous sulfuric acid treating solution is washed with water by the following method in which reference is made to Figure 6 of the drawings. The thread 20 is advanced and stored at about 15 turns per inch over the reel 44 which has the same dimensions as, and is positioned similarly to, the reel 33 employed in Example 1. The annular band 45 is about 3 inches in width and is positioned so as to press against the thread helix. About 150 cc. per minute of water containing about 0.2%, by weight, of a surface active material is delivered to the helix by the tube 48 through the opening provided by the overlapping ends of the annular band 45. The stored thread 20 is maintained at a tension of about 0.2 gram per filament. The reel 44 is operated at a peripheral speed of about 300 meters per minute.

Example 7

A freshly coagulated, 150 denier 40 filament viscose rayon thread which has been stretched about 10% is processed on the reel 50 by the following method in which reference is made to Figure 7 of the drawings. The reel 50 is about 5 inches in diameter and about 6 inches long and is driven at a peripheral speed of about 150 meters per minute. The thread 20 is advanced and stored on the reel 50 in a helical package about 5 inches long, containing about 20 turns per inch which is about 40% of the theoretical maximum turns per inch. The external means 51, 52 and 53 consists of glass fiber cloths impregnated with a vinyl chloride polymer. Each of the cloths is about 1¼ inches wide and each is spaced about ½ inch apart. The cloths are in liquid contact with the helical thread package over an arc of about 90°. The manner of attaching and positioning the cloth means adjacent to the reel 50 is similar to the manner described with respect to Figure 4.

The delivery tubes 54, 55 and 56 are each set to deliver about 50 cc. per minute of the following treating liquids respectively: 2%, by weight, aqueous sulfuric acid solution at 55° C., water at room temperature, and an 0.35%, by weight, aqueous sodium sulfide desulfurizing solution at room temperature. The thread 20 stored on the reel 50 has a tension of about 0.2 gram per filament. The treated thread discharged from the reel may be processed to completion by any desired method.

Example 8

The conditions of this example are the same as Example 7 with the following exceptions. Instead of the cloth means resilient annular bands, such as the band 45 described in connection with Figure 6, are used as the external means 51, 52 and 53. The annular bands are about 1¾ inches wide, are spaced about ¼ inch apart and are pressed against the thread helix. The bands encircle the helix as described and shown in Figure 6. About 200 cc. per minute of the aqueous treating liquids are delivered and the reel 50 is rotated at a peripheral speed of about 300 meters per minute.

Example 9

The treated thread discharged from the reel 50 in Example 7 is transferred to another multizone reel which is the same as reel 50 and the thread treated under the same conditions described in Example 7 with the exception that the following aqueous liquids at room temperature are applied in sequence; water, an 0.05%, by weight, aqueous sodium hypochlorite solution having a pH of about 8.0, and water containing about 0.5%, by weight, of a sulfonated vegetable oil. The resulting thread may then be dried and packaged as a completely processed rayon thread.

In practicing the present invention the manner of employing a pliable external means may be adapted with advantage to the particular operating conditions present. For example, when operating with low thread tensions and permitting the pliable means to be supported in part by the helix, it is advisable to minimize the amount of pressure exerted by the means on the advancing thread. This may be accomplished for example by employing a pliable means of relatively low weight, such as a light-weight, thin piece of cloth or sheet-like material; or by forming a liquid contact with a smaller arc of the thread helix. Accordingly where a greater arc of contact is desired it is advantageous to employ a pliable means of proportionately lower weight. However, when greater thread tensions are available both greater areas of liquid contact and relatively heavier weights of the pliable means may be employed if desired. Advantageously the arc of liquid contact with the helix may be between about 10° and 165° when employing a pliable, sheet-like means. Particular advantages are derived however between about 20° and 90°.

In the processing of viscose rayon thread with various aqueous alkaline, acid or neutral media, advantageous results are derived by incorporating surface-active materials in such aqueous media. Under these conditions the surface tension of the water is reduced thereby assisting the proper distribution of the applied aqueous media on a thread helix. In addition, such aqueous media may with advantage contain various oleaginous materials, emulsified or dispersed therein, comprising for example, oils, waxes, etc., of both natural and artificial origin. Particularly advantageous results are derived when such lubricant-containing media are employed for the treatment of thread at elevated temperatures.

We claim:

1. A process for the liquid treatment of thread comprising, storing and advancing a single layer of thread as a rotating helix having a plurality of consecutive generally helical turns; applying a liquid to said rotating thread helix; bringing a substantially stationary, contour-following means into contact with said rotating liquid-containing helix; said means contacting a substantial arcuate portion of said rotating liquid-containing helix.

2. A process for the liquid treatment of thread comprising, storing and advancing a single layer of thread as a rotating helix having a plurality of consecutive generally helical turns; delivering a stream of an aqueous treating liquid to said rotating thread helix; bringing a substantially stationary, flexible, contour-following means into contact with said rotating liquid-containing helix; said means contacting a substantial arcuate portion of said rotating liquid-containing helix.

3. A process for the liquid treatment of thread comprising, storing and advancing a single layer of thread as a rotating helix having a plurality of consecutive generally helical turns; delivering a stream of an aqueous treating liquid to said rotating thread helix; bringing a substantially stationary, contour-following sheet-like means into contact with said rotating liquid-containing helix; said sheet-like means contacting a substantial arcuate portion of said rotating liquid-containing helix.

4. A process for the liquid treatment of thread comprising, storing and advancing a single layer of thread as a rotating helix having a plurality of consecutive generally helical turns; delivering a stream of an aqueous treating liquid to said rotating thread helix; bringing a substantially stationary, relatively lightweight, sheet-like, flexible material into contact with said liquid-containing helix; said sheet-like material contacting a substantial arcuate portion of said rotating liquid-containing helix, thereby resulting in said sheet-like material clinging to said liquid-containing helix.

5. A process for the liquid treatment of thread comprising, storing and advancing a single layer of thread as a rotating helix having a plurality of consecutive generally helical turns; delivering a stream of an aqueous treating liquid to said rotating thread helix; bringing a substantially stationary, relatively lightweight, sheet-like, flexible material into contact with said liquid-containing helix; said sheet-like material contacting and clinging to an arcuate portion of between about 10° and 165° of said rotating liquid-containing helix; rotating said helix at a peripheral speed that would cause a portion of said applied liquid to be discharged from the advancing thread due to centrifugal forces.

6. A process according to claim 4 in which the thread undergoing treatment is viscose rayon and the aqueous treating liquid is an aqueous viscose rayon regenerating liquid.

7. A process according to claim 5 in which the thread undergoing treatment is viscose rayon and the aqueous treating liquid is an aqueous viscose rayon regenerating liquid.

8. A process according to claim 5 in which the thread undergoing treatment is viscose rayon and the aqueous treating liquid is an aqueous acid viscose rayon regenerating liquid.

9. A process for the liquid treatment of thread comprising, storing and advancing a single layer of thread as a rotating helix having a plurality of closely spaced consecutive generally helical turns; the axis of said helix being in a generally horizontal position; delivering a stream of an aqueous treating liquid to said rotating thread helix; bringing a substantially stationary cloth into contact with said liquid-containing helix, said cloth contacting and clinging to an arcuate portion of between about 10° and 165° of said rotating liquid-containing helix; rotating said helix at a peripheral speed that would cause a portion of the applied liquid to be discharged from the advancing thread due to centrifugal forces.

10. A process for the liquid treatment of thread according to claim 9 in which the thread undergoing treatment is viscose rayon; in which the plurality of consecutive turns are spaced at between about 30% and 50% of the theoretical maximum turns per inch that could be wound separately to form said helix; in which the aqueous treating liquid comprises an aqueous viscose rayon regenerating liquid; and in which said applied aqueous treating liquid is maintained at an elevated temperature.

11. A process for the liquid treatment of thread according to claim 10 in which said helix is formed on an internally heated thread-storing, thread-advancing reel; and in which the aqueous regenerating liquid is an aqueous acid liquid.

12. A process for the liquid treatment of thread according to claim 5 in which between about 10 and 150 cc. per minute of the aqueous treating liquid is applied to the rotating helix; in which a plurality of consecutive turns are spaced at between about 30% and 50% of the theoretical maximum turns per inch that could be wound separately to form said helix; in which the plurality of consecutive turns have a tension of between about 0.07 and 0.16 gram per filament; and

in which a plurality of said sheet-like materials is brought into contact with the rotating liquid-containing helix.

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The following references are of record in the file of this patent:

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Certificate of Correction

Patent No. 2,562,199

July 31, 1951

KENNETH M. McLELLAN ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 1, line 20, for "centifugal" read *centrifugal*; line 38, for "one of" read *one or*; column 7, line 58, for "Example 2" read *Example 1*; same line, for "treat-" read *brush-*;

and that the said Letters Patent should be read as corrected above, so that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 16th day of October, A. D. 1951.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.