PROCESS OF AND APPARATUS FOR DRYING THREAD OR THE LIKE

Hayden B. Kline, Cleveland, Ohio, assignor to
Industrial Rayon Corporation, Cleveland, Ohio,
a corporation of Delaware

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This invention relates to apparatus for uninterruptedly drying thread-like materials such as filaments, cords, bands, tapes and tubes, hereinafter referred to as “thread”. Such apparatus is of importance, inter alia, in the manufacture of continuously processed artificial silk thread. In the manufacture of thread of this type, apparatus capable of uninterruptedly drying the thread as rapidly as it is processed is of particular value for the reason that its use makes it practicable to collect the thread in final package form concurrently with its production.

The apparatus of the present invention, which effects drying of thread as it is produced, lends itself to advantageous employment in known types of continuous processing apparatus. One of the features of the invention which helps make this possible is the division of the thread-drying operation into two separate stages. This the invention does by providing for the removal of external moisture on an element which efficiently accomplishes this particular end and the removal of internal moisture by means of an element especially adapted therefore. Dividing the operation of drying into these two stages results in a considerable saving of the amount of energy required in drying the thread.

For the purpose of disclosing the invention, it will be described in connection with a machine for continuously producing viscose artificial silk thread; however, it may, if desired, be employed to advantage in various other processes such as cuprammonium, cellulose nitrate and cellulose acetate processes.

A preferred embodiment of the invention is illustrated in the drawings, in which Figure 1 is a front elevation of the lower portion of a continuous thread-processing machine in which the thread-drying apparatus of the invention is employed. Figure 2 is a sectional elevation on line 2—2 of Figure 1. Figure 3 is a section on an enlarged scale on line 3—3 of Figure 1, parts being shown in elevation. Figure 4 is a front elevation of the device of Figure 3. Figure 5 is a section on line 5—5 of the device of Figure 3. Figure 6 is a side elevation, partly in section, of one of the thread-processing reels. Figure 7 is a front-end elevation of the reel of Figure 6. Figure 8 is a side elevation, partly in section of the reel used in the second drying stage.

Referring now to Figures 1 and 2, the thread 10 from which moisture is to be removed passes from wash reel 11 to drip reel 12 and then to the drying apparatus of the invention; i.e., tubular member 13 and reel 14. The reels 11 and 12 are the last two of the several processing reels ordinarily present in a machine for the performance of the steps necessary to the processing of the thread. Reels 11 and 12, together with the reels disposed thereabove, form a single descending series, of which in a complete thread-processing machine a great many are arranged side by side. Preferably, in each such descending series the thread-receiving portion of each reel is disposed directly below the thread-discharge portion of the preceding reel.

Reels 11, 12 and 14 are representative of any helix-forming device which functions automatically to advance the thread longitudinally thereof in a large number of closely spaced turns. The reels here shown are supported from one end only, a particularly convenient arrangement which leaves the other end free for access by the operator. In addition, the illustrated reels are of unitary construction, as will hereinafter appear, in order that they may be self-threading. It is not necessary to the practice of the invention that reels of this particular construction be employed, since other devices which will function in the intended manner may be used to advantage.

In certain details of construction, as will hereinafter appear, it is desirable that the reel 14 differ from the reels 11 and 12 and the reels thereabove, all of which may be of the same construction. The details of construction of reel 12 are illustrated in Figures 6 and 7. Reel 12 comprises two sets of interdigitating bar members 16 and 18. The bar members 16 are carried upon a body member 17 retained by cap nut 18 on a shaft 19. Shaft 19 is rotatably mounted in a bracket 21 carried by an inclined beam 22 of the thread-processing machine. A pin carried by shaft 19 and entering a slot in body 17 establishes a driving connection between the shaft 19 and the body 17.

Bar members 16 are supported by an annular member 25 at the free end of the reel and by an annular member 26 at the supported end of the reel. Annular member 26 is secured to a ring 27 which carries within a central opening thereof a bushing 28. Bushing 28 is rotatably mounted upon sleeve 29 carried on the exterior of bracket 21. Bar members 16 are driven by contact with bar members 15. Rotation of shaft 19 effects rotation of body 17 and bar members 16.

The axis of the exterior surface of bracket 21 is eccentric with respect to the axis of the bearing through which shaft 19 passes, due to which fact the axes of the sets of bar members 15 and 55
16 are offset from each other. The axis of the exterior surface of sleeve 29 is at an angle with respect to the axis of the interior surface of this sleeve; as a result, the axes of the respective sets of bar members 15 and 16 are inclined to each other. Due to the offset and askew relation existing between the axes of the respective sets of bar members 15 and 16, the thread is advanced lengthwise of the reel. The reel is rotated in a direction serving to advance the thread from the supported to the unsupported end thereof.

To rotate reels 11 and 12, their shafts are respectively connected to a shaft 33 by gearing 34 and gearing 32. Shaft 33 extends upward beyond reels 11 and 12 to drive the other reels in the same descending series. The several shafts 33 are driven by a common drive shaft 34. The several beams 22 necessary to support the various descending series of reels are carried by the longitudinally extending rail 35. Beams 22 are supported as shown from a standard which also serves to support the tubular member 13.

Tubular member 13 is formed of an internal metal sheet 43 having a hingly polished inner surface. This sheet is shaped to form a partial cylinder, the ends 44 of the sheet being flared outward to provide a lateral entrance 45 for thread. On the exterior of the sheet 43 and opposite the opening 45 is a longitudinally extending channel 46. To retain heat within the tubular member, the exterior surface of the sheet 43 may be covered with a thick layer of heat-insulating material 47 extending between the flared ends 44 and the channel 46.

To close the upper and lower open ends of the tubular member, plates 48 and 49 are provided. Plates 48 and 49 have therein slots 50 and 51, respectively, which extend inward from the periphery to the center of the plates. These plates are so located upon the tubular member that the openings to the slots 50 and 51 register with the opening 45 between the flared ends 44. The plates 48 and 49 may be held in position by any desired means, as by brazing at 52.

Within the tubular member and seated against the end plates 48 and 49 are ring members 54 and 55 preferably of some electric insulating material such as porcelain. Seated within recesses 56 in the ring members 54 and 55 and extending between them are rods 57 and 57', preferably of the same material. Rods 57 and 57' are circumferentially disposed about the axis of the tubular member. The rod 57' near the entrance 45 to the tubular member are preferably formed with projections 59 at spaced intervals therealong.

An electrical resistance wire 59 is wound in circular fashion about the rods along their entire lengths. This wire is hooked upon the uppermost of the two projections 58 upon one of the rods 57 and then is brought away from opening 45 and laid around the several rods 57 until the other rod 57' is reached. The wire is then hooked over the uppermost two of projections 58 upon the rod 57' which has just been reached, so that nearly complete circle has been formed. Thereafter the wire is brought toward the rear of the tubular member in a reverse direction and to the next lower two projections 58 on the first set of the rods 57'. The ends 60 and 61 of the resistance wire 59 are led into the channel 46 and out through an opening 62 in the reverse side thereof.

By carrying the wire back and forth in the described manner throughout the length of rods 57 and 57', the entrance 45 and the slots 50 and 51 in the end plates are not obstructed and the thread may readily be introduced into the tubular member. Also, due to the winding of the wire about the axis of the tubular member, the thread which is passing axially through the tubular member will be exposed upon nearly its entire periphery to the radiant heat emitted by the resistance element. Projections 58 not only enable the wire to be wound about the interior of the tubular member in the reverse manner noted, but also serve to maintain the spacing between the turns of the wire.

In assembling the tubular member, the rings 54 and 55 are located upon opposite ends of rods 57 and 57' and the resistance wire is wound about the rods in the formation described. This assembly is then inserted in one of the ends of the cylindrically formed metal sheet 43 and is held in proper position therein by securing the plates 48 and 49 upon the ends of the metal sheet 43. The lead wires 60 and 61 are now brought through the opening 62 and the channel 46 is then positioned against the exterior of the metal sheet 43. Wire ends 60 and 61 are connected to line 63 which supplies all the tubular elements 8 with 25-volt electric energy.

To retain the tubular member 13 upon the frame of the apparatus it may be secured to bracket 64 which in turn is fastened to rail 35, forming part of the standard from which are supported beams 22. Tubular member 13 is secured to bracket 64 by screws 67. Since the screws pass through the channel 46, the channel will be clamped in position between the tubular member and the bracket 64. Bracket 64, in addition to supporting tubular member 13, provides a convenient support for line wire 62.

Reel 14, to which the thread 16 passes from tubular member 13, is illustrated in detail in Figure 8.

In this reel, bar members 70 correspond to bar members 15 of reel 12; bar members 71, to bar members 16. Bar members 71 are supported and driven in a manner similar to bar members 15 of reel 12, while bar members 70 are carried upon a hollow cylindrical body 72 which is mounted upon a hollow drive shaft 73. Body 72 is retained upon the shaft by means of a bolt 74 which also serves as a closure member for the front end of the hollow shaft 73.

Hollow shaft 73 is rotatable within a bracket 75 supported upon a longitudinally extending channel member 76. To rotate hollow shaft 73 in fixed relation with respect to shaft 15 of reel 12, a vertical shaft 77 is provided. At its upper end, shaft 77 engages with shaft 33 through gears 78; at its lower end, shaft 77 drives hollow shaft 73 through gears 79. Hollow shaft 73 extends back into a packing joint 80 carried by a conduit 81 which packing joint permits rotation of hollow shaft 73. Conduit 81 is connected to and delivers a heated drying fluid to all of the various drying reels 14.

Openings 83 through hollow shaft 73 communicate with a chamber 84 at approximately the center of body 72. Through the wall of body 72 extend a plurality of passageways 85 which provide a means of escape for the drying fluid from chamber 84 to the exterior of the reel. The drying fluid supplied from conduit 85 passes through hollow shaft 73, through openings 83 into chamber 84, and through passageways 85 into the spaces between bars 70 and 71. Conveniently, such drying fluid may be heated air, but any...
other suitable drying fluid may be employed instead.

As shown in Figure 1, the axis of reel 14 lies substantially in the same vertical plane as the axes of reels 11 and 12. As shown in Figure 2, reel 14 projects endwise beyond reel 12 so that the thread-receiving portion of reel 14 is directly below the thread-discharging portion of reel 12. Tubular member 13 is so located between reels 12 and 14 that the thread passing between these reels will pass through the axis of the tubular member 13. Due to this arrangement, the thread will not come into contact with any portion of the tubular member and the thread will consequently be uniformly exposed to heat within the tubular member.

In operation, the thread on advancing over reel 11 is subjected to a washing operation by water dripped upon the reel from a distributor 86 supplied from a pipe 87. In passing over reel 12, a considerable amount of the water upon the thread is removed by dripping therefrom, but upon leaving this reel the water content of the thread may still be as high as 300%. The water-drying apparatus comprising tubular member 13 and reel 14 serves to remove all or as much as desired of this moisture, so that the thread may be collected in finished form upon cap-twistor 88.

Tests have shown that approximately half the moisture remaining in the thread after leaving reel 12 is upon the exterior of the thread, while the other half is largely internal. External thread moisture may be rapidly removed by the application of intense heat without causing injury to the thread. However, internal moisture is removable only at a much lower rate, inasmuch as its removal from the thread is accomplished largely by diffusion. Removal of internal moisture consequently must be accomplished with a lower supply of heat in order not to damage the thread.

Moreover, in the course of removal of external thread moisture, little or any shrinkage of the thread tends to occur. During removal of internal thread moisture, a marked shrinkage of the thread tends to occur. In order to produce thread of high quality, the shrinkage which tends to take place in the course of the removal of the internal thread moisture must be permitted to occur substantially without restraint. As hereinafter pointed out, the invention contemplates permitting such shrinkage to occur.

External thread moisture is removed from the thread by tubular member 13, which should preferably be of such length that all of the exterior moisture of the thread is removed by the time the thread issues therefrom. Inasmuch as a considerable amount of heat may be supplied to the thread without causing injury, tubular member 13 may be relatively short, dependence for drying being placed on high heat emission from the heating element 89. Since during the removal of external thread moisture during passage of the thread through tubular member 13, only slight shrinkage of the thread tends to occur, it is not necessary that any provision be made to correct this shrinkage; consequently, reel 14 may take up the thread at the same speed at which it is being delivered from reel 12.

In passing over reel 14, as much of the internal moisture of the thread as is desired may be removed, the thread being reduced, if desired, to a bone-dry condition. The time required for the passage of the thread over reel 14 will be considerably longer than the time required for the thread to pass through tubular member 13. The long period of time that the thread is upon reel 14 thus makes it possible to heat the reel to a moderate temperature and yet accomplish removal of the desired amount of internal thread moisture. The thread will not be injured while upon reel 14, as would be the case if reel 14 were heated as highly as is tubular member 13.

During the removal of internal moisture from the thread while upon reel 14, the shrinkage of the thread which tends to occur is permitted to take place by the tapered formation of reel 14 at its thread-receiving portion 90. The taper should be of such amount that the shrinkage which tends to occur in the thread will not be substantially restrained. Shrinkage of the thread should be permitted until nearly complete shrinkage has occurred, since this results in a thread of higher quality. By arresting shrinkage before it has completely occurred, the thread will be left with a small residual capacity to shrink. The cylindrical portion 91 at the free end of the reel should be of such dimensions that it will arrest shrinkage of the thread after the desired amount of shrinkage has occurred.

Drying of the thread is thus divided as between tubular member 13 and reel 14.

By removing the external moisture and the internal moisture through the use of separate elements, it is possible to permit each of these elements to operate at maximum efficiency. In this manner, advantage is taken of the fact that the external moisture may be removed by the application of an amount of heat so large that it would cause injury to the thread if it were applied to remove internal moisture. Furthermore, it makes possible the removal of internal moisture by the application of an amount of heat so moderate that an undesirably long length of time would be required to remove external moisture if this small amount of heat were utilized for that purpose. It is thus possible to deliver the maximum permissible amount of heat to the thread during each of the two drying stages in order to accomplish complete thread-drying in a minimum time.

In some instances it may be desirable to remove the external and a considerable part, if not all, of the internal moisture of the thread in the course of its passage through tubular member 13. In such case, a considerably longer tubular member is required and reel 14 serves merely to draw the thread through the tubular member and to fix the desired residual capacity to shrink in the thread. To allow for the shrinkage which occurs in the thread during its passage between reels 12 and 14 it is necessary with such an arrangement that the peripheral speed of the surface of reel 14 be less than the peripheral speed of reel 12. This may be accomplished either by making reel 14 of smaller size than reel 12 or by changing the gear ratio of either gearing 78 or gearing 18.

It will be understood that the invention is not limited to the precise details of the construction illustrated in the accompanying drawings. For example, the drying reel may be heated by electricity or some other means rather than by means of hot air. The tubular element may take some other form than that shown; e.g., it may be elliptical or parabolic in cross-section as disclosed in an application of even date herewith filed in the names of Laven J. Jordan and Clarence C. Walters, identified as application Serial
No. 162,701. It is intended that the patent shall cover, by suitable expression in the appended claims, whatever features of patentable novelty reside in the invention.

What is claimed is:

1. The process of continuously drying wet thread comprising advancing the thread endwise while applying heat to the thread, the application of heat being continued until such time as marked shrinkage of the thread begins to take place, and thereafter applying heat to the thread while advancing it in the form of a traveling helix, meanwhile permitting shrinkage of the thread to occur.

2. In the drying of multiple filament viscose artificial silk thread, the steps of continuously but temporarily storing the thread in succession in a plurality of traveling helices and heating the thread as it passes from one helix to another.

3. In the drying of multiple filament viscose artificial silk thread, the steps of continuously but temporarily storing the thread in succession in a plurality of traveling helices and heating the thread by radiant energy as it passes from one helix to another.

4. Apparatus for continuously drying wet thread comprising an elongated chamber through which the thread passes in a generally axial direction; a helix-forming device to which the thread proceeds from said elongated chamber by means of which the thread is continuously but temporarily stored in a series of generally helical turns; and means for subjecting the thread to drying treatment both within said elongated chamber and on said helix-forming device.

5. Apparatus for continuously drying wet thread comprising an elongated chamber through which the thread passes in a generally axial direction; a helix-forming device to which the thread proceeds from said elongated chamber by means of which the thread is continuously but temporarily stored in a series of generally helical turns; and means for subjecting the thread to drying treatment both in said elongated chamber and on said helix-forming device.

6. Apparatus for continuously drying wet thread comprising an elongated chamber through which the thread passes in a generally axial direction; a helix-forming device to which the thread proceeds from said elongated chamber by means of which the thread is continuously but temporarily stored in a series of generally helical turns; and means for heating the thread both in said elongated chamber and on the said helix-forming device, the heating means associated with said elongated chamber serving to deliver more energy to the thread than the heating means associated with said helix-forming device.

7. Apparatus for continuously drying wet thread comprising an elongated chamber through which the thread passes in a generally axial direction; means associated with said elongated chamber for subjecting the thread to a drying operation, said means cooperating with said elongated chamber to reduce the moisture content of the thread to the point at which marked shrinkage of the thread begins to take place; and an internally heated helix-forming device to which the thread proceeds from said elongated chamber by means of which helix-forming device the thread is continuously but temporarily stored in a series of generally helical turns, said helix-forming device including a tapered portion on which marked shrinkage of the thread is enabled to take place.

8. Thread-drying apparatus comprising an elongated chamber through which thread to be dried is passed and, associated therewith, a helix-forming device to which the thread proceeds from said elongated chamber, said elongated chamber including an electrical resistance element for subjecting the thread to intense heat and said helix-forming device including means for subjecting the thread to moderate heat.

9. Thread-drying apparatus comprising an elongated chamber through which thread to be dried is passed and, associated therewith, a helix-forming device to which the thread proceeds from said elongated chamber, said elongated chamber including an electrical resistance element for subjecting the thread to radiant heat and said helix-forming device including means for applying a heated fluid for subjecting the thread to moderate heat.

10. Thread-drying apparatus comprising two helix-forming devices for handling a thread in sequence; means for heating the thread on that one of said helix-forming devices to which the thread is delivered from the other; and, surrounding at least a portion of the length of thread between said helix-forming devices, an elongated chamber including means for applying heat to the thread.

11. Thread-drying apparatus comprising two helix-forming devices for handling a thread in sequence; means for subjecting the thread to moderate heat on that one of said helix-forming devices to which the thread is delivered from the other; and, surrounding at least a portion of the length of thread between said helix-forming devices, an elongated chamber including means for subjecting the thread to intense heat.

12. Thread-drying apparatus comprising two helix-forming devices for handling a thread in sequence; means for internally heating the one of said helix-forming devices to which the thread is delivered from the other; and, surrounding at least a portion of the length of thread between said helix-forming devices, an elongated chamber including means for heating the thread by radiant energy.

13. The process of continuously drying wet thread which comprises applying heat to the thread while advancing it endwise and thereafter applying heat to the thread while advancing it in the form of a traveling helix.

14. The process of continuously drying wet thread comprising applying intense heat to the thread while advancing it endwise and thereafter applying moderate heat to the thread while advancing it in the form of a traveling helix.

HAYDEN B. KLINE.