Jan. 30, 1951 P. VAN DIJK 2,539,978

DRYING YARN

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Fig. 1.

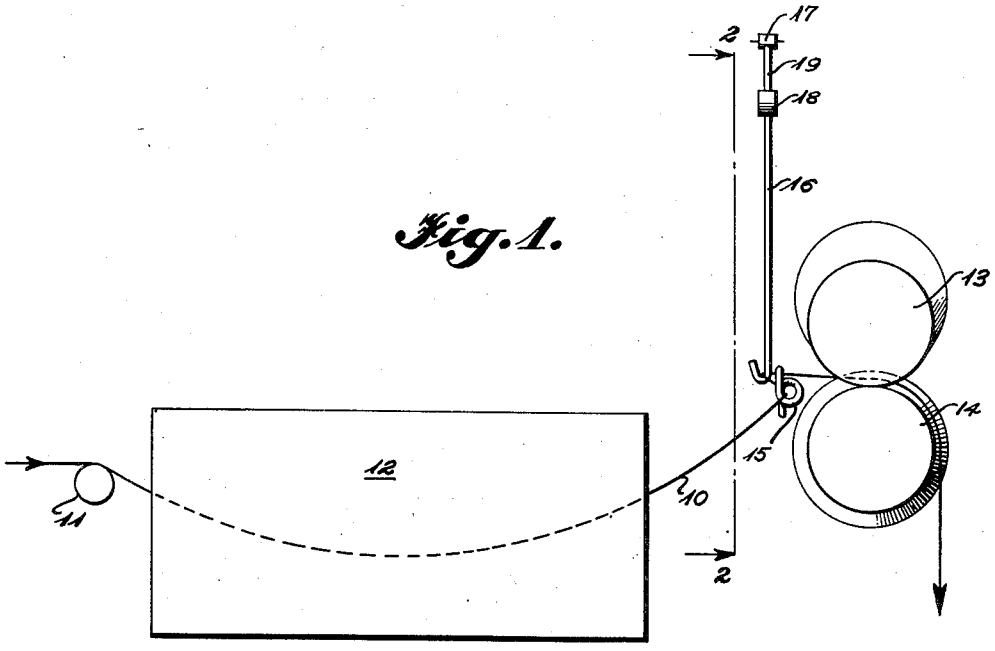


Fig. 2.

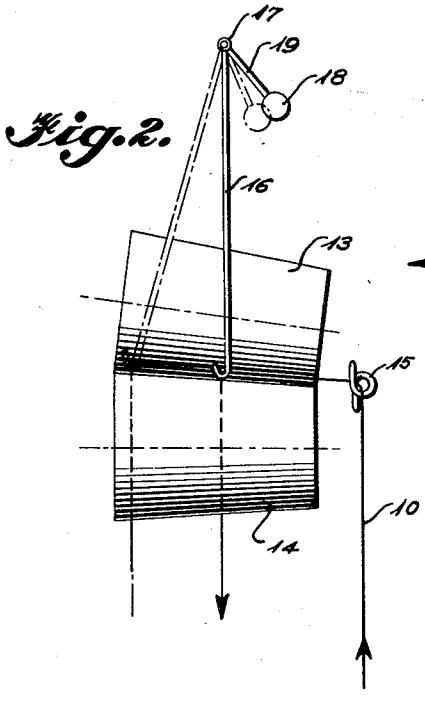
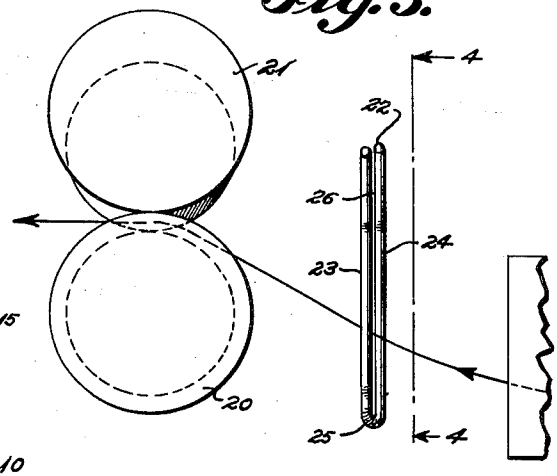


Fig. 3.



INVENTOR.
Pieter Van Dijk
BY
Albin F. Knight
ATTORNEY

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Fig. 4.

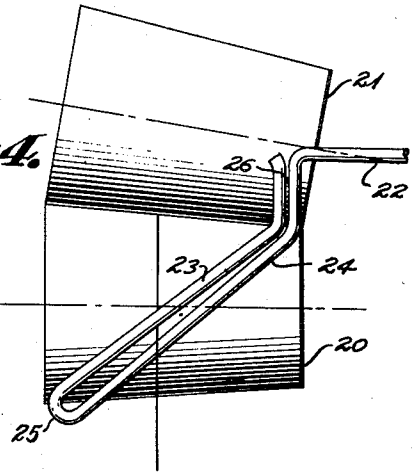


Fig. 5.

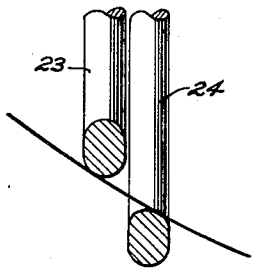


Fig. 7.

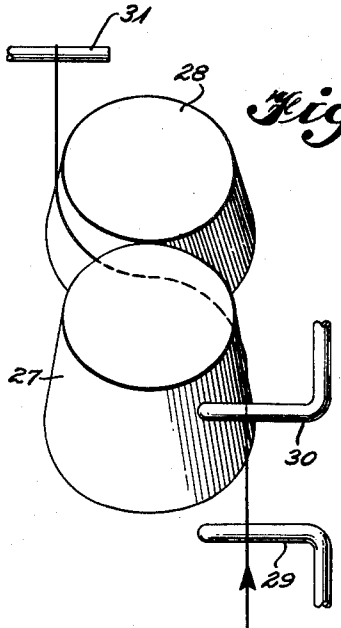
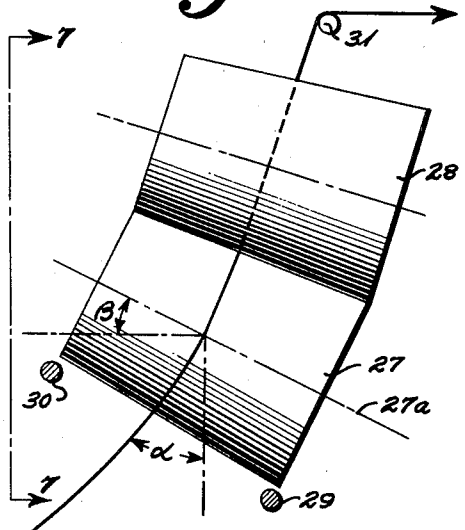
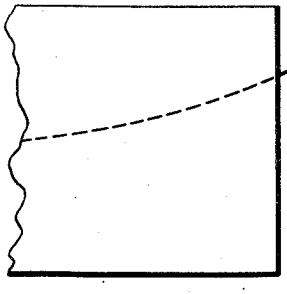


Fig. 6.





INVENTOR.
Pieter Van Dijk
BY
Albin F. Knight
ATTORNEY

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Fig. 8.

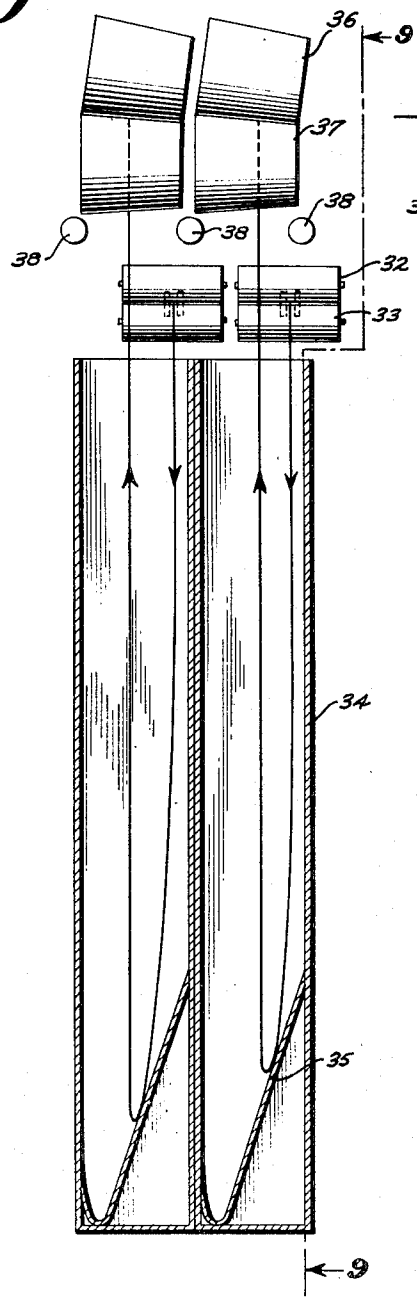
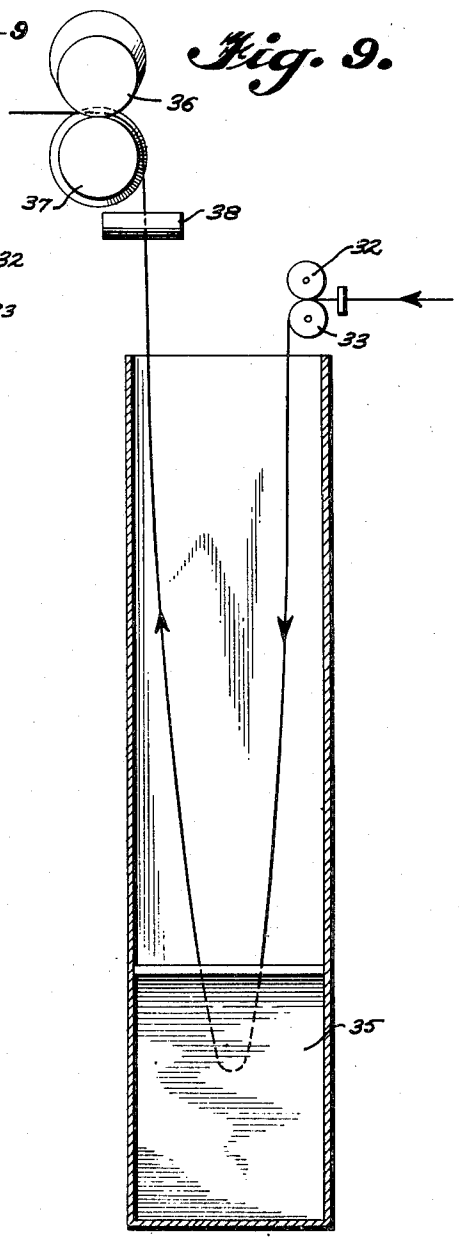


Fig. 9.



INVENTOR.
Pieter Van Dijk
BY
Albin F. Knight
ATTORNEY

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Fig. 10.

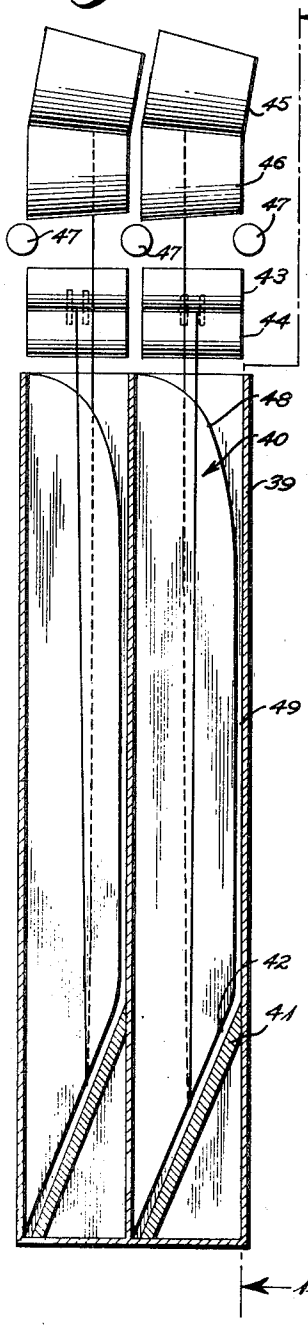
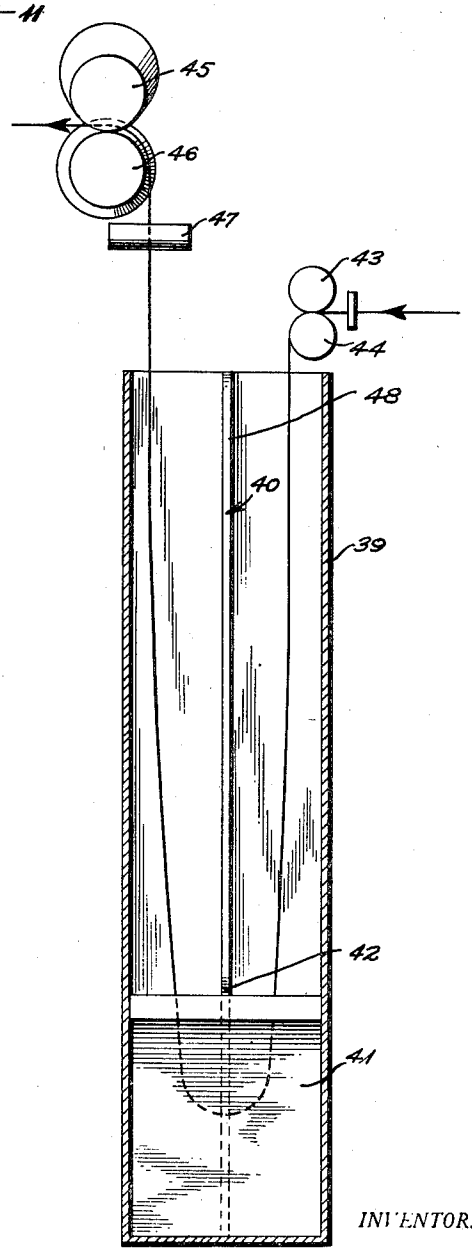


Fig. 11.



INVENTOR.

BY Pieter Van Dijk

Alvin F. Knight

ATTORNEY

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UNITED STATES PATENT OFFICE

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DRYING YARN

Pieter van Dijk, Velp, Netherlands, assignor to American Enka Corporation, Enka, N. C., a corporation of Delaware

Application April 25, 1949, Serial No. 89,449

15 Claims. (Cl. 34—23)

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This invention relates to a method of and apparatus for the continuous drying of synthetic threads in a manner to produce fully shrunk threads having uniformly low residual shrinkage characteristics. This application is a continuation-in-part of application, Serial No. 12,838 filed March 3, 1948, now abandoned.

Both the viscose and cuprammonium processes involve the wet spinning of threads and the use of liquid aftertreating agents with the result that threads so produced must be dried before they can be packaged for shipment. The drying of these threads presents a difficult problem because they possess a considerable capacity to shrink during drying and, if this tendency is inhibited to any considerable extent, the dried threads possess a residual capacity for shrinkage which deleteriously affects their marketability, particularly to weavers.

In an attempt to overcome the foregoing difficulties it has been proposed to dry wet spun synthetic threads on thread-storage-thread-advancing devices having tapering contours adapted to compensate for the shrinkage and hence to allow free shrinkage of the thread during drying. In practice, however, these devices have not proved satisfactory due to the fact that every fixed support, even when it is in direct contact with only a limited part of the thread, prevents the thread from shrinking in that localized zone, in consequence of which a residual shrinkage in that zone remains.

Another effort to produce fully shrunk, wet spun synthetic threads involves drawing the threads, in freely supported condition, through a drying zone by a take-up device having a take-up speed less than the delivery speed to the drying zone by an amount corresponding to average anticipated thread shrinkage during travel through the zone. This arrangement has also been disappointing in operation, and it appears that the defects result from the lack of uniformity in the shrinkage potential of wet thread. This difference in ability to shrink or capacity for shrinkage is presumably caused by small variations in the properties of the spinning solution. In any event, a thread which has a tendency to shrink more than average is subjected to some stretch in passage through the drying zone, and it therefore possesses an undesirably high capacity for residual shrinkage, while a thread having a tendency to shrink less than the average causes mechanical difficulties, the shrinkage being less than that for which the take-up is adjusted. The latter causes a thread sag of increasing magnitude which interferes with normal operation of the apparatus in the drying zone.

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When, however, there is a localized and unpredictable tendency to shrinkage in a portion of the thread, a tension is exerted on the thread in the drying zone, with the result that the material produced is not fully shrunk. Even if the thread should be homogeneous it is usually impossible to adapt a constant discharge to the constant supply speed, as the ratio of said two speeds often cannot be accomplished by mechanical (gear wheel) transmissions.

It is an object of this invention to overcome the foregoing difficulties and to provide a method and apparatus for drying threads under free shrinkage conditions whereby the tendency to shrink of each thread is continuously analyzed and this analysis is impressed upon the take-up mechanism in a manner to adjust the take-up from the drying zone to the feed to that zone so that free shrinkage occurs in every case and mechanical difficulties are avoided.

It is proposed according to the present invention to draw each thread to be dried through a drying zone while controlling the draw off rate as a function of the magnitude of thread sag between points of support located exteriorally of the drying zone.

A further and more specific object of this invention is to accomplish the control of the draw off rate by entirely stationary apparatus variously located with respect to the drying chamber and the draw off device in such a way as to permit drying in either a vertical or horizontal zone.

Other objects and advantages of this invention will be apparent upon consideration of the following detailed description of several embodiments thereof in conjunction with the annexed drawings wherein:

Figure 1 is a schematic view in side elevation of one embodiment of the present invention;

Figure 2 is a schematic view of a portion of the apparatus of Figure 1 taken from the line 2—2;

Figure 3 is a schematic view in side elevation of a modified draw-off device constructed in accordance with the principles of the present invention;

Figure 4 is a view of the apparatus of Figure 3 taken along the line 4—4;

Figure 5 is a fragmentary view showing in detail the manner of passage of the thread through the guiding device of Figures 3 and 4;

Figure 6 is a view in side elevation of still another modified form of the present invention.

Figure 7 is a view taken from the line 7—7 of Figure 6;

Figure 8 discloses in vertical section a form of the present invention particularly adapted to the drying of thread in a vertical drying chamber;

Figure 9 is a view in section taken along the line 9—9 of Figure 8;

Figure 10 is a view similar to Figure 8 but illustrating a further modified form of apparatus for controlled shrinkage drying in vertical drying chambers; and

Figure 11 is a view in section taken along the line 11—11 of Figure 10.

Now referring in greater detail to Figures 1 and 2 of the drawings, the thread to be dried bears reference numeral 10 and it is fed by a propelling device 11 into a drying tunnel 12 from which it is withdrawn by a pair of rollers 13 and 14. Between the rollers 13 and 14 and the egress mouth of the drying tunnel 12 there is located a fixed thread guide 15 and a movable hook guide 16 pivotally mounted at 17 in association with a counterweight 18. The counterweight 18 is mounted on an arm 19 which is really one arm of a bell crank, the other arm of which is the hook 16. As stated above, the point of pivotal connection of the bell crank is at 17.

Throughout the drying tunnel 12 the thread is entirely unsupported and it comes into contact with no structural parts of the drier. Consequently the thread, in its path between the propelling device 11 and the thread guide 15, forms a sagging curve somewhat similar to a catenary but not a true catenary in view of the fact that the weight of the thread per unit length changes as drying occurs. In general, the curve of the thread need not be described mathematically since it is apparent that the thread passes in a generally horizontal direction through the drying tunnel with the sag being adjusted to maintain the tension at a predetermined low value which will be sufficiently low so as not to resist materially the tendency of the thread to shrink during drying. For the purposes of this specification "substantially horizontal" may be construed to mean almost any direction of passage through the drying tunnel which provides a substantial horizontal component which, in turn, will produce a sag in the thread.

If detailed reference is made to the take-up rollers 13 and 14 it will be noted that they are frustoconical in shape. The roller 14 is driven at a constant rate of speed by any suitable means not shown, and the axis of this roller is horizontal. The upper roller 13 is driven from the roller 14 and is mounted in slotted standards, not shown, for vertical adjustment so that it can be raised to permit passage of a thread between rollers 13 and 14 during threading up of the machine. The speed at which the take-up members 13 and 14 are driven is so adjusted that when the thread contacts those members at or near the mid-point between their ends, thread will be drawn from the drying chamber or tunnel 12 at a rate correlated with the feeding rate of device 11 in such a way as to permit complete shrinkage.

In view of the fact that threads are non-uniform and will not all have the same shrinkage potential or capacity for shrinkage, the hook guide 16 is provided to move the thread lengthwise of the rollers 13 and 14 to adjust the take-up to make it more or less rapid depending upon whether the thread has a greater or a lesser tendency to shrink. This adjustment is effected

entirely automatically since the dry thread leaving the tunnel 12 passes through thread guide 15 and through hook guide 16 in passing to the rollers. Between guide 15 and hook guide 16 the thread exerts a certain tension longitudinally of its path of movement. Within certain limits this tension decreases with an increase in sag and increases with a decrease in sag. Accordingly, an increase in tension will move the hook guide 16 toward the guide 15 while a decrease will move the hook guide 16 away from the guide 15. Accordingly, if the thread exhibits an abnormally high tendency to shrink, the tension between guides 15 and 16 will be higher than average and the guide 16 will be moved toward the guide 15, thereby displacing the thread toward the small diameter end of the rollers 13 and 14 where the lower take-up rate adjusts for the unusually high tendency to shrink. If the thread exhibits an unusually low tendency to shrink, the reverse occurs and the guide 16 moves away from the guide 15, thereby leading the thread onto the large diameter of the rollers 13 and 14 whereby the take-up rate is increased.

It is known that, in a true catenary, the tension decreases to a certain limit when the sag increases from an almost straight line and it is in this range that the arrangement described above operates. The counterweight 18 is so arranged that when no thread is running between the guides 15 and 16 the guide 16 assumes the broken line position shown in Figure 2. It is noted that the guides 15 and 16 are located approximately in the plane of contact of the rollers 13 and 14. The thread after passing through the rollers 13 and 14 is led to a point of collection such as a twister or any other take-up device which can handle thread arriving at variable speeds.

The drying chamber or drying tunnel 12 in which the thread is heated can be provided with arrangements for blowing hot air or other hot gases therethrough or can be equipped for infrared drying or high frequency electrostatic heating. It is essential however, that in the drying zone the thread hang entirely free in a sort of chain line or catenary entirely free of any mechanical influence. By doing this the accuracy of the response of the adjusting apparatus associated with the take-up rollers 13 and 14 is insured.

If now reference is made to Figures 3, 4 and 5, it will be seen that there is illustrated in those figures another type of apparatus for causing the magnitude of the sag of the thread in its passage through the drying tunnel to adjust the rate at which the thread is taken up. In Figures 3 and 4 there are shown two frusto conical rollers 20 and 21, the lower roller 20 of which is driven at a constant rate of speed by means not shown. As stated in conjunction with rollers 14, this rate of speed is so correlated with the rate of delivery of thread to the drying zone that in the middle of the take-up rollers between the ends, the take-up surface will have a take-up speed to compensate for the average shrinkage which occurs during a drying operation. In front of the frusto conical draw off rollers 20 and 21 and in the thread path between the drying tunnel and those rollers, there is located a fixed thread guide 22 which has cylindrical tines 23 and 24 which define a thread-guiding slit. The thread-guiding slit between the tines 23 and 24 slopes with respect to the horizontal plane of the axis of the roller 20 while the thread guide itself lies in a

plane parallel to the vertical plane of the axes of rollers 20 and 21. The tines are arranged so that the slit rises from the large diameter end of roller 20 to the small diameter end thereof. When working with viscose thread, spun under normal conditions, an angle of 45° between the slit of the guide 22 and the horizontal has given very satisfactory results. The slit extends for sufficient length so that the thread cannot drop off or pull out from between the tines 23 and 24 during operation. In this regard note that the tines 23 and 24 are at one end connected by an integral loop 25 and that they are bent to define a vertical threading slit 26 at the upper end of guide 22. As stated above, for normal or average operation the thread will pass to the take-up rollers 20 and 21 at about the mid-point between their ends, and the thread, in that position, passes between the tines 23 and 24 exactly tangent to them, see in this regard, Figure 5.

If, in consequence of increasing shrinkage of the thread during drying, a smaller sag, and consequently a higher tension of the thread is produced, a force acts between the thread and the top defining tine 23 of the slit. This force exerted upon the tine 23 produces a horizontal component because of the angular disposition of that time. Consequently, the action of the horizontal component is to move the thread upwardly in the slit from left to right as it is viewed in Figure 4. This results in a reduction in the take-up speed due to the fact that the right-hand end of the take-up rollers is the end of smaller diameter. As soon as the thread has restored itself to a tangent position with respect to the tine 23, the component urging the thread to the right of Figure 4 ceases to exist and the thread runs at the new speed until other adjustment is necessary.

On the other hand, when sag increases as a consequence of decreasing shrinkage during drying and tension accordingly decreases, a force is exerted between the thread and the lower tine 24 of the slit of guide 22. This force produces a component acting to the left of Figure 4 and shifts the thread to the left of the Figure 4 position, whereby the take-up speed is increased and compensation is effected.

It can be seen by reference to Figures 3, 4 and 5 that the thread returns to the normal position as soon as a temporary deviation from normal sag has passed and that sag and tension in the thread remains practically unchanged from the desired value; that is to say, it fluctuates with small deviation from the position of equilibrium.

While the thread has been shown as passing between the tines 23 and 24 tangent thereto, it is perfectly apparent that in normal operation the threads can actually pass between the tines without touching either of them. Then, when deviation from normal occurs, they will touch either one or the other of the tines whereby shifting will occur in the desired compensatory direction. Similarly, by modification of the position of the tines 23 and 24, the thread can touch both tines in normal position and surround them with a certain predetermined angle of wrap. In this case right and left components exist concurrently and in equilibrium are equal. Upon deviation from equilibrium one or the other of the components dominates and the thread is shifted for compensation.

Referring now to Figures 6 and 7, there is shown a still further modification of the present invention whereby thread during drying is maintained at a predetermined angle of sag. In this form of the invention the thread is not shifted by an auxiliary agency such as the thread guide 22 or hook guide 16, but is shifted because of the inclination of the axes of the take-up rollers themselves.

In Figure 6, the take-up rollers are designated by numerals 27 and 28. It is perfectly apparent that the sagging thread leaving the drying tunnel lies at all times in a vertical plane. The lower frusto conical roller 27 of the take-up pair is so disposed that its axis 27*a* lies parallel to the vertical plane of the thread and at an angle β with the horizontal. Just as in the other examples, the peripheral speed of the frusto conical rollers is chosen in such a way that when the thread passes over the rollers at the mid-point between their ends the take-up speed is correlated with the feeding speed of the roller which delivers the thread to the drying zone in a manner to effect compensation for fully shrunk thread. This state of equilibrium is always present when the thread crosses the axis 27*a* at right angles thereto. Naturally the angle β determines the permissible degree of sag of the catenary in the drying chamber since the angle which the tangent to the catenary makes with the vertical at the point of contact with the roller always equals β. This angle is indicated α in Figure 6.

If excessive shrinkage occurs during drying the sag decreases in consequence of which the tension in the arriving thread increases and the thread no longer runs at right angles onto the axis of the roller. This causes a component which acts on the thread to the left of the Figure 6 view and results in migration of the point of contact of the thread to the left of that figure. The migration continues until the angle between the thread and axis 27*a* again equals 90°. Naturally migration to the left of Figure 6 results in decrease in the take-up speed of the rollers 27 and 28 due to the frusto conical shape of the take-up device. On the other hand, if the sag increases from normal the thread migrates to the right of Figure 6 until compensation has been effected.

In order to prevent the thread from sliding off the ends of the lower roller 27, the thread guides 29 and 30 are provided to limit the side movement of the thread.

After the thread has run round the lower roller 27 with an angle of wrap of 90°, part of the thread can still move around the upper roller, after which it is advanced to a suitable winding arrangement by means of the thread guide 31.

It has been found that, for practical puposes, a taper of 10% of the frusto conical rollers 13—14, 20—21, or 27—28 is sufficient in all cases. Thus, the increase and decrease of the velocity respectively on both sides of the center position of the rollers amounts to 5%.

In order to prevent slippage of the threads on the take-up rollers, it is advisable to cover them with an outer layer which is suitable for such purpose, such as rubber, leather or the like. The surprising practical result of the method and apparatus of this invention is that during continuous drying a practically fully-shrunk rayon is obtained.

It is believed that the excellent results flow from maintaining the tension in the sagging thread during drying permanently and evenly at a very low value.

According to this invention it has been found that, for the manufacture of shrunk artificial

thread, the tension in the thread when passing through the drying chamber should not be higher than one gram per 100 denier and preferably not higher than 0.2 gram per 100 denier. With the arrangements according to Figures 3 to 7, it is possible to adjust the tension on 100 denier thread to a value as low as 0.23 gram.

In connection with the fact that it is desirable to be able to set the tension in the drying zone as low as possible, it is important to decrease the weight of the sagging thread as far as possible. This has become possible to an important extent after experiments had shown that a certain degree of predrying under constant length is possible without exerting a disadvantageous influence on the full-shrinkage of the thread. It was found that it is permissible to predry the washed and aftertreated thread, which may often contain more than 200% of water, to a water content of about 70% calculated on dry substance, before this thread is supplied to the drying chamber with drawing-off arrangement according to the invention. This predrying can be executed in the well known way by means of drying rollers, drying reels, thread-advancing rollers, crossed rollers etc. without decrease in velocity.

Due to this predrying it becomes possible to decrease the tension of the thread in the drying zone, and that for two reasons; firstly, because of the fact that the weight of the thread per unit of length decreases, and secondly, because of the fact that the zone required for a complete drying of the thread can be shortened as the thread is supplied with a lower water content.

In the description of the forms of the invention shown in Figures 1 to 7, inclusive, either direct or inferential reference has been made to a horizontal type drying chamber. It has been found, however, as a part of this invention, that drying under controlled tension conditions can be conveniently and efficiently effected by passing the thread more or less vertically through a vertically disposed drying chamber.

Referring specifically to Figures 8 and 9, the thread which may be pre-dried to about 70% moisture content is delivered by right cylindrical rollers 32 and 33 at a constant speed. It is understood of course that the rollers 32 and 33 will be driven at a constant rate of speed by any type of conventional apparatus not shown. The thread issuing from between the supply rollers 32 and 33 is allowed to hang or sag in a vertically arranged drying chamber 34 in such a way that the lower end of the loop of thread eventually touches a polished plate 35 which is arranged in a sloping position, preferably at an angle of 45° to the horizontal, in the bottom of the drying chamber. The relative disposition of the supply rollers 32 and 33 with the plate 35 is such that the vertically sagging thread first touches the sloping plate 35 at its highest side. After touching the plate 35 the thread is drawn upwardly to frusto conical drawoff rollers 36 and 37, the lower one of which is arranged with its axis horizontal or approximately so and with its center in the axial sense vertically above the center of the drying chamber 34. The drying chamber 34 is rectangular in horizontal cross section and may be made of any suitable material and supplied with a heated drying medium by known means.

The dimensions and the speed of the draw off device consisting of the rollers 36 and 37 is so chosen that the take-up speed at the axial center of the rollers 36 and 37 is equal to the average speed of the thread in shrunk condition. At the opposite extremities of these two rollers a peripheral speed 5% higher and lower than average is afforded. Thus it is that, if the drying thread moves downwardly perpendicularly from the supply device consisting of the rollers 32 and 33 and also perpendicular to the draw off device consisting of the rollers 36 and 37, the discharge speed is about 5% lower than the average speed of the thread in shrunk condition. Consequently the loop slides down the polished plate 35. This causes a shift in the point where the thread is drawn on to the rollers 36 and 37 so that the thread is gradually taken up at a higher peripheral speed. If the take-up speed then exceeds that required to compensate for shrinkage, the loop begins to progress up the polished plate 35 so that the axial take-up point on the rollers 36 and 37 again moves toward the smaller end of those rollers. By this arrangement equilibrium is always maintained and the take-up speed fluctuates to compensate for variations in shrinkage due to non-homogeneity in the thread or other causes.

On both sides of the take-up device 36—37, rod-shaped guides 38 are provided. The function of these devices is to prevent the thread from running off the ends of the rollers 36—37.

The assembly appearing to the left of the chamber 34 of Figure 8 is a duplicate of the assembly comprised of delivery rollers 32—33, chamber 34 and draw off rollers 36—37 and is included in Figure 8 for the purpose of showing how a plurality of vertical chambers are to be arranged in a plant assembly.

In the event the drying of thread is effected by hot air, the vertical chamber renders easier its circulation and the maintenance of the desired temperature. Vertical chambers also afford a considerable measure of space economy.

Sometimes, if hot air is used as the drying medium, the convection currents will displace the thread to such an extent that its coaction with the polished plate 35 becomes too inaccurate to afford the proper degree of control of draw off speed. Should this problem become at all acute under any desired conditions of supply of the heating medium, it can be solved by resort to apparatus of the type shown in Figures 10 and 11.

In Figures 10 and 11 a vertical drying chamber 39, similar to drying chamber 34, is divided by a vertically extending partition 40 into two compartments, one for the descending thread and the other for the ascending thread. Between the partition 40 and a sloping plate 41 corresponding to the sloping plate 35 of Figures 8 and 9, there is defined a thread slot indicated at 42 the function of which is to receive the loop of thread. In Figures 10 and 11 the thread is fed to the drying chamber by rollers 43 and 44 corresponding respectively to rollers 32 and 33 of Figure 8 and is collected on frusto conical rollers 45 and 46 corresponding in structure and function to the rollers 36 and 37. Rod-shaped thread guides 47 are also provided and again these correspond in structure and function to the rods 38.

In the situation illustrated in Figures 10 and 11 where the drying chamber is divided into two compartments by an intermediate vertical partition such as the partition 40, it is desirable to provide the upper portion of the partition with

a curving surface such as is shown at 48 so that, in threading up the machine, the loop formed between the feed rollers 43, 44 and the take-up device 45—46, will rest on that curving surface and be guided thereby into and through a slot 49 defined between the partition 40 and the vertical wall of the tank and leading to the slot at 42.

In operation, the movement of the bottom of the thread loop in the slot 42 corresponds to the movements described in connection with the plate 35 of Figure 8. In other words, under conditions of increasing shrinkage the lower end of the thread loop moves along the smoothly rounded surface of the lower edge of the partition 40 in a lateral direction, and at decreasing shrinkage along the plate 41 in the opposite lateral direction. In both cases the change in the discharge speed resulting therefrom compensates the end speed of the thread produced by the differences in shrinkage, so that a state of equilibrium is established. In contrast to the arrangement of Figures 8 and 9, the thread supply device may be disposed above the center of the drying chamber.

The lateral movements of the lower portion of the thread loop which may occur due to the air circulation are small in the arrangement of Figures 10 and 11 as compared to those occurring under like conditions in a drying channel without a partition. When drying by circulation of hot air, the air circulation in the first part of the drying channel may be larger than in the second part, whereby the rising thread may run comparatively quietly.

Of course, the whole matter of air circulation is avoided in cases where radiant heating is used and, accordingly, the arrangement of Figures 8 and 9 is fully satisfactory under radiant heating conditions.

Again in Figure 10, as in Figure 8, a duplicate chamber is shown to the left of the chamber 39 to demonstrate how multiple chambers are arranged side by side in plant assembly. Also in the case of Figure 10 it is preferable that the slot 42 be disposed at an angle of 45°.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed, it is declared that what is claimed is:

1. In the drying of synthetic thread by the method which involves delivering thread to a drying zone at a constant rate of speed and drawing the thread substantially horizontally through the zone while it is suspended from points outside of the zone to hang with sag in the zone, the improvement which comprises effecting the drawing of the thread with a frusto conical draw-off roller and controlling the position of the thread axially of the roller as a function of the magnitude of the sag.

2. In the drying of synthetic thread by the method which involves delivering thread to a drying zone at a constant rate of speed and drawing the thread substantially horizontally through the zone while it is suspended from points outside of the zone to hang with sag in the zone, the improvement which comprises effecting the drawing of the thread with a frusto conical draw-off roller and guiding the thread onto the roller at a position along the roller axis determined by the tension of the thread which is functionally related to the magnitude of the sag.

3. In the drying of synthetic thread by the method which involves delivering thread to a drying zone at a constant rate of speed and drawing the thread substantially horizontally through the zone while it is suspended from points outside of the zone to hang with sag in the zone, the improvement which comprises drawing the thread with a frusto conical draw-off roller having its axis disposed at an angle to the horizontal equal to the complement of a pre-determined angle of sag of the thread and having its end of small diameter above the end of large diameter whereby under normal conditions the thread is received at one point along the length of the roller while deviation from normal sag produces migration of the thread toward an end of the roller thereby to cause variation in the effective take-up rate of the roller.

4. In the drying of synthetic thread by the method which involves delivering thread to a drying zone at a constant rate of speed and drawing the thread substantially through the zone while it is suspended from points outside of the zone to hang with sag in the zone, the improvement that comprises effecting the drawing of the thread with a frusto conical draw-off roller driven at a constant R. P. M. while varying the effective take-up speed of the draw-off roller by shifting the point of contact of the thread with the roller axially of the roller in response to variations in sag from a pre-determined normal.

5. In apparatus for drying synthetic thread which includes a drying chamber, means for delivering thread to the chamber at a constant rate of speed and means for withdrawing thread from the chamber so that thread is suspended from points outside of the chamber to hang with sag in the chamber, the improvement which comprises a frusto conical roller for drawing the thread from the chamber, means for driving the roller at a constant R. P. M. and stationary guiding means for varying the point along the axis of the roller at which the thread is received in response to changes in the angle of sag of the thread.

6. In apparatus for drying synthetic thread which includes a drying tunnel, means for delivering thread to the tunnel at a constant rate of speed and means for withdrawing thread from the tunnel so that thread is suspended from points outside of the tunnel to hang with sag in the tunnel, the improvement which comprises a frusto conical roller for drawing the thread from the tunnel, means for driving the roller at a constant R. P. M. and guiding means intermediate the tunnel and the draw-off rollers for varying the point along the axis of the rollers at which the thread is received in response to changes in the angle of sag of the thread.

7. An apparatus as claimed in claim 6 wherein the means intermediate the draw-off roller and the tunnel is a stationary thread guide in front of the roller defining a slot extending diagonally relative to the face of the roller.

8. An apparatus as claimed in claim 6 wherein the means intermediate the draw-off roller and the tunnel comprises a thread guide movably mounted adjacent the draw-off roller to shift from one end of the roller to the other to guide the thread onto the roller at any point along its surface, and means to bias the guide toward the end of larger diameter of the roller whereby the magnitude of the tension of the thread will control the point at which the thread is taken on the roller and hence the thread take-up speed.

9. An apparatus as claimed in claim 6 wherein the means intermediate the draw-off roller and the tunnel comprises a stationary thread guide

adjacent the end of smaller diameter of the roller, a movable thread guide pivotally mounted to shift from one end of the roller to the other to guide the thread onto the roller surface at any point along its length and a counterweight acting on said movable guide to bias it toward the end of larger diameter of the roller whereby the magnitude of the tension of the thread between the stationary guide and the movable guide will control the point at which the thread is taken onto the roller and hence the thread take-up speed.

10. In apparatus for drying synthetic thread which includes a drying tunnel and means for delivering thread to the tunnel at a constant speed, the improvement which comprises a frusto conical draw-off roller for drawing the thread from said tunnel, said roller having its axis disposed at an angle to the horizontal and its end of smaller diameter above its end of larger diameter, the thread between said delivering means and said roller hanging with sag in said tunnel, the angle of disposition of said roller being equal to the complement of the average angle of sag.

11. An apparatus for drying synthetic thread which comprises a vertically arranged drying chamber, means for delivering thread to the chamber at a constant rate of speed and a frusto conical roller for withdrawing the thread from the chamber so that thread is suspended from points outside the chamber to hang with sag in the chamber, means for driving the roller at a constant R. P. M. and stationary guiding means disposed within the chamber in a position to be engaged by the sagging thread loop for varying the point along the axis of the roller at which the thread is received in response to changes in the sag of the thread.

12. An apparatus as claimed in claim 11 wherein the stationary guiding means comprises a plate disposed at an angle to the horizontal and constituting the bottom surface of the chamber.

13. An apparatus as claimed in claim 11 wherein the stationary guiding means is a plate disposed at an angle of 45° to the horizontal and constitutes the bottom surface of the chamber.

14. Apparatus for drying synthetic thread

which comprises a vertically arranged drying chamber, means for delivering thread to the top of the chamber at a constant rate of speed, a frusto conical roller for withdrawing thread from the top of the chamber so that the thread is suspended from points outside of the chamber to hang said sag in the chamber, means for driving the roller at a constant R. P. M., a stationary plate at the bottom of the chamber disposed at an angle to the horizontal and functioning to vary the point along the axis of the roller at which the thread is received in response to changes in the angle of the sag of the thread and a vertically extending partition subdividing the chamber above said plate into two zones that are in communication along the surface of the plate and along the wall of the chamber contiguous to the upper end of the plate.

15. Apparatus for drying synthetic thread comprising a vertically arranged drying chamber, means for delivering thread into the top of the chamber at a constant rate of speed, a frusto conical roller for withdrawing thread from the top of the chamber so that thread is suspended from points outside the chamber to hang with sag in it, means for driving said roller at a constant R. P. M., and a sloping plate in the chamber having its high side vertically below the small end of the roller so that the plate can function to vary the point along the axis of the roller at which thread is received in response to changes in the magnitude of sag of the thread.

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Certificate of Correction

Patent No. 2,539,978 January 30, 1951

PIETER VAN DIJK

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

In the heading to the printed specification line 6, following "Serial No. 89,449" insert *In the Netherlands May 25, 1948*;

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 17th day of April, A. D. 1951.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.