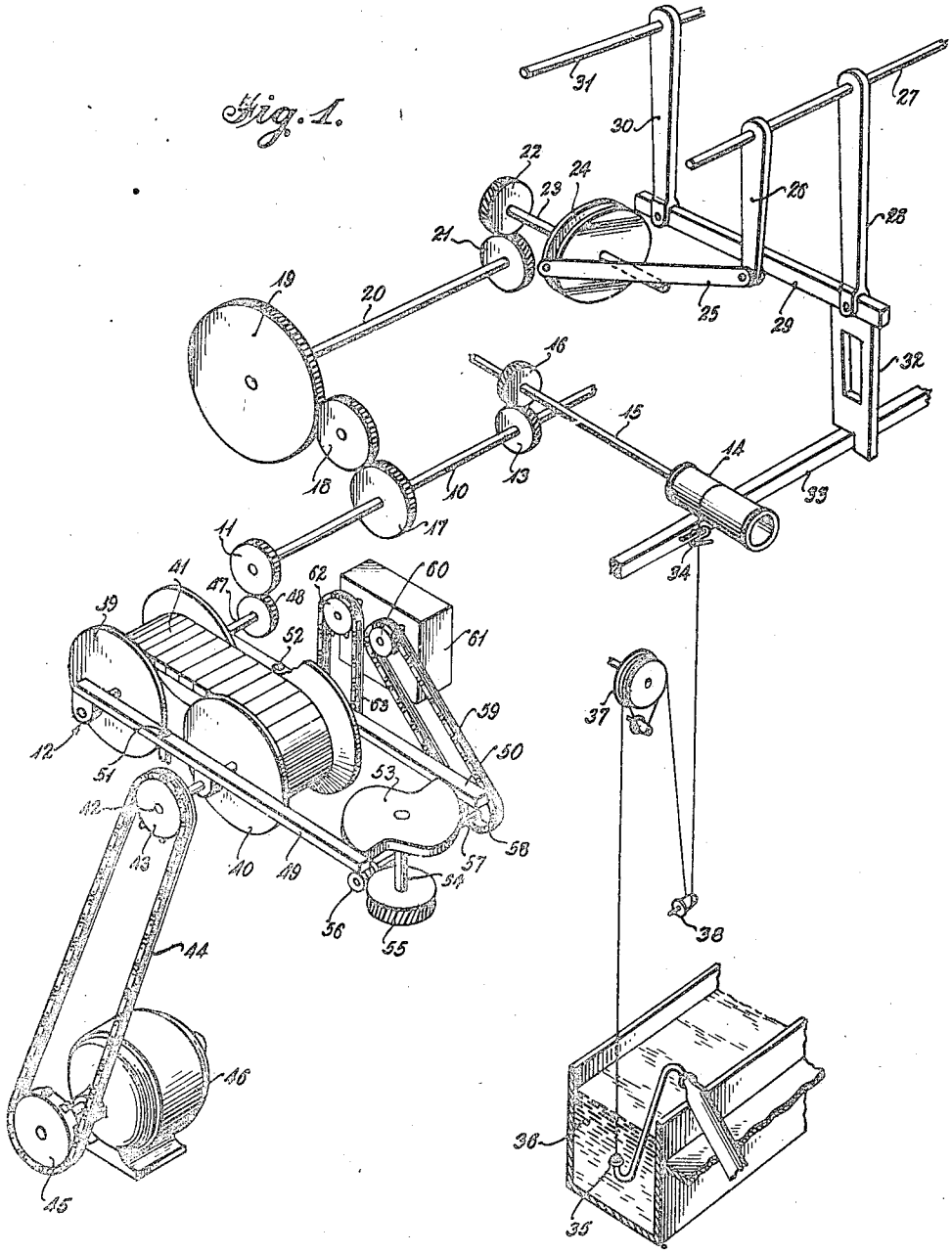
Feb. 11, 1947. J. J. SCHILTHUIS ET AL 2,415,764

TENSION CONTROL

Filed Oct. 7, 1942 3 Sheets-Sheet 1

Fig. 1.



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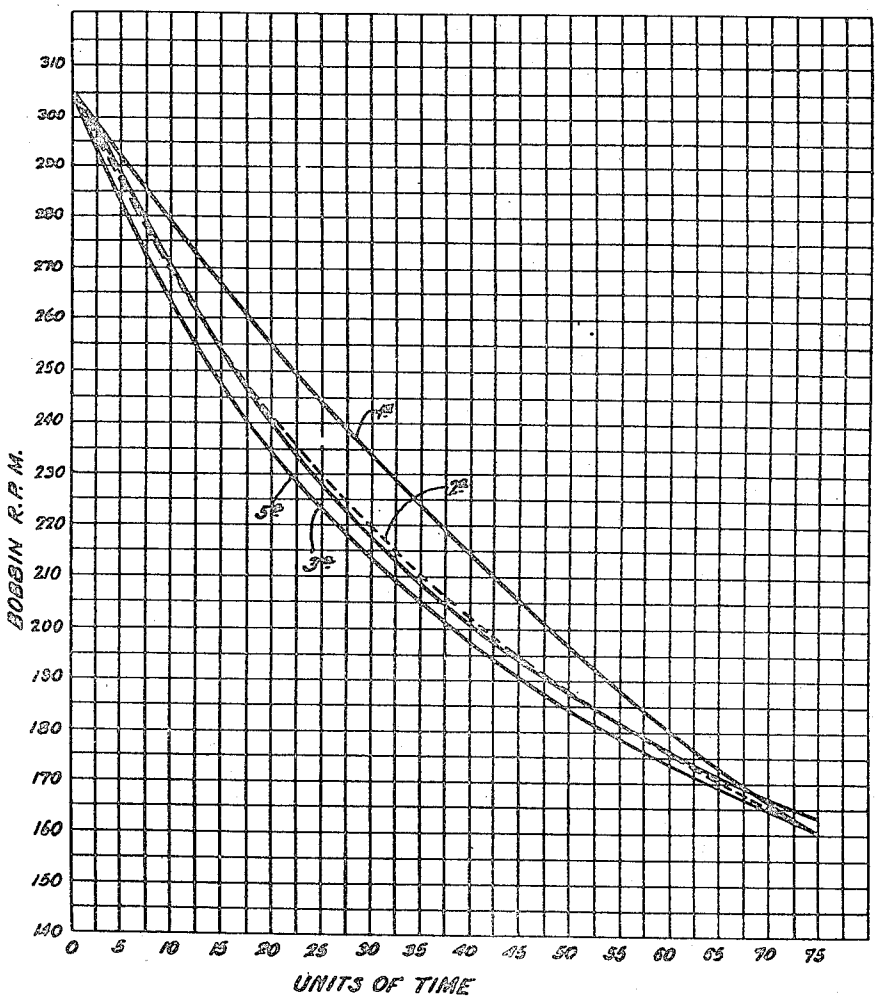
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Fig. 2.



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TENSION CONTROL

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Fig. 3.

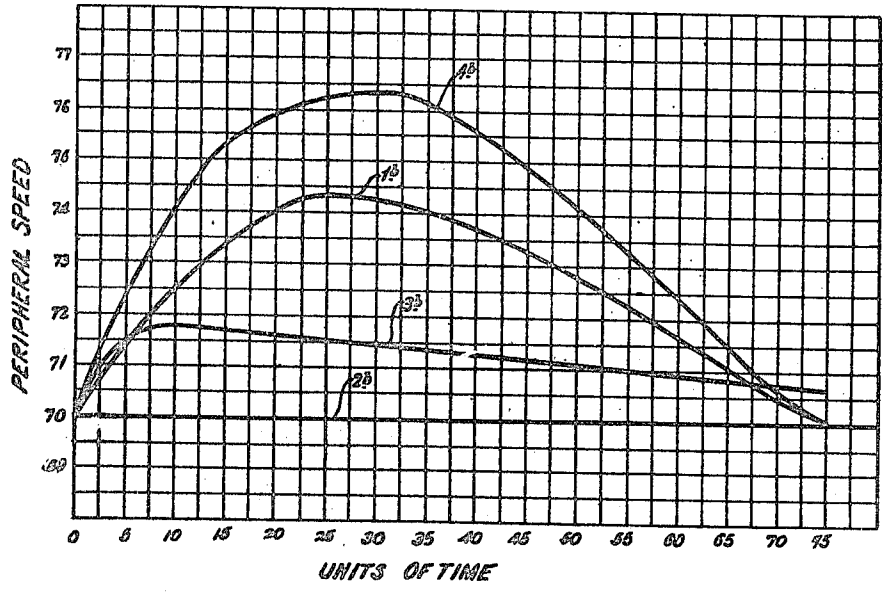
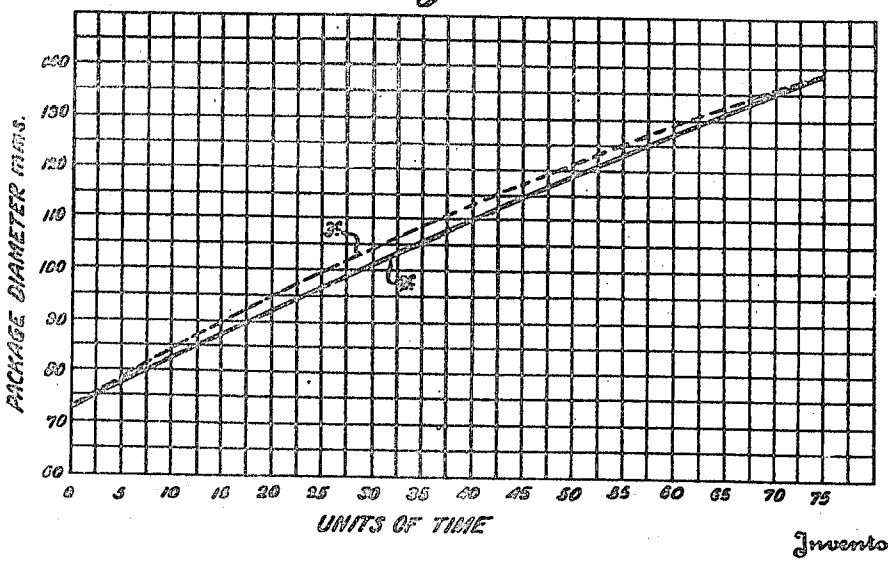


Fig. 4.



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2,415,764

UNITED STATES PATENT OFFICE

2,415,764

TENSION CONTROL

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Application October 7, 1942, Serial No. 461,162

5 Claims. (Cl. 242—45)

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This invention relates to the manufacture of threads of synthetic origin and is more particularly concerned with the bobbin spinning of rayon thread of superior quality.

In the bobbin spinning of rayon, the customary procedure is to collect the freshly formed thread on a rotating bobbin after its issuance from the spin bath, one or more godets being interposed in the path of the thread to impart to the thread such stretch as may be desired. Then, at the end of the spinning period, the wound body of thread on the bobbin is subjected to such after-treatment as may be necessary or desirable in any particular instance.

During the spinning period the thread is withdrawn from the spin bath by a driven godet and led either directly to the collecting bobbin or to another godet propelled at a greater speed than the first so as to cause stretching of the thread. The denier of the thread is controlled by correlation of the spinning pump speed and the take-up speed of the bobbin package. The last godet in the path of thread travel between the spin bath and the collecting bobbin serves to regulate closely the tension applied to the thread as it is delivered to the bobbin, and for that reason is generally propelled at a constant speed. However, during the spinning operation the package increases in thickness so that the peripheral or take-up speed thereof would normally increase. Since the spinneret delivery and the speed of the godet from which the thread is drawn onto the bobbin are substantially constant, this increase in the peripheral speed of the bobbin package would have the effect of progressively decreasing the denier of the thread and at the same time increasing winding tension throughout the winding period, if no compensation were introduced. It has long been recognized that this condition, if permitted, would be exceedingly harmful to the thread as denier variations would result and might even effect tensions of sufficient magnitude to cause filament breakage. Accordingly, it is now and has long been customary to gradually reduce the rotational speed of the bobbin throughout the winding period so that the winding speeds at the beginning and the end thereof are approximately the same.

Although the beginning and end speeds of the bobbins have been controllable, the intermediate speeds have followed the characteristics of the particular variable speed unit employed. These characteristics are not such that the peripheral speeds of the package will remain constant throughout the winding period. This is due primarily to the fact that the increases in diameter of the package being wound on the bobbin are not proportional to the increases in volume of thread or spinning time. Moreover, the rate of change of speed of a commercial variable speed unit is different from the change of diameter of the thread package and is therefore not a simple function thereof. This means that a deceleration of the rotational bobbin speed which is uniform with time produces a non-uniform winding speed and that conversely a uniform winding speed can only be obtained by a predetermined non-uniform deceleration of the rotational speed. One very common type of variable speed apparatus used for this purpose is the Reeves drive involving pairs of cones connected by a belt, the variable delivery speed being produced by gradually moving the pair of cones in one end of the transmission toward one another and in the other end away from each other so that the cone diameters contacted by the belt result in a change in delivery speed. Usually the cones are shifted by rotation of a screw and under such circumstances, for every unit of time there will be a proportionate displacement of the cones resulting in a reduction in rotary speed of the bobbin.

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In winding packages of freshly spun thread, it has been customary to drive the bobbin at a uniformly, or substantially uniformly decelerating rotational speed. Such conventional packages were, for all practical purposes, wound at a sufficiently constant peripheral speed. However, the peripheral speeds and therefore the tensions during the winding period were not properly controlled and were not constant to the extent of following a straight line when plotted against units of time. (Unexpectedly, as a more uniform deceleration is imparted to the bobbin, a more variable peripheral speed is imparted to the thread package.) In the interest of economy, the rayon industry has commenced the production of thick packages, e. g., packages having a diameter of more than 150% of the empty bobbin. It was immediately apparent that in winding such packages of increased thread length, the variations in peripheral or winding speeds became so pronounced that prohibitive tensions were created in the packages, thereby limiting the amount of thread that could be feasibly wound on the bobbins. Incidentally, such wide variations in peripheral speeds were not predictable because the deceleration of a bobbin driven by the conventional speed change mechanisms was of the same order or just as constant for packages hav-

ing a diameter greater than 150% of the empty bobbin, as conventional packages of smaller diameters.

Therefore, although it has been found that apparatus of the type described may be used with a fair degree of success where the ultimately wound thread package is of a diameter less than 150% of the diameter of the empty bobbin, it is evident that the reduction of bobbin speed in substantially equal decrements per unit of time, even for conventional packages, is not entirely satisfactory. As stated before, this is particularly evident in the winding of packages of increased size, thickness and weight, which practice has been made possible by recent developments. In winding these heavier, thicker and larger packages with conventional speed and tension control it has been found that soft and tight portions occur in the package, the former being squeezed out to distort the ends of the package as well as the general pattern of the cross wind. This occurs more particularly with packages built with square ends. This tendency has resulted in the production of an acid yarn package of poor permeability and non-uniform washability and has tended in some measure to nullify the effects of improved methods and apparatus for pattern control. It has also been found that the physical properties of the thread have been detrimentally influenced by variations in stretch applied during the winding resulting in variations in tensile strength. Variations in winding speed have also resulted in undesirable variations in dye rate and denier.

It is therefore an object of this invention to overcome the difficulties heretofore encountered and to provide for the winding of freshly spun rayon onto a collecting bobbin under accurately controlled tension regardless of the thickness or configuration of the package formed, the duration of the winding-on period, or the degree of stretch to which the thread may be subjected before collection.

Another object of this invention is to provide a control means for a variable speed drive which will cause the rotational speed of the bobbins to decrease at a rate which is a simple function of substantially a simple function of the rate of increase of package build-up on the bobbins whereby the thread constituting the package is free from variations in denier and dye rate and is of uniform tensile strength throughout its length.

It is a further object of this invention to provide a method and apparatus for controlling the tension under which freshly spun rayon may be wound so that packages, of a diameter in excess of 150% of the bobbin diameter, in frusto conical or right cylindrical form may be prepared having a better and more stable configuration.

It is further contemplated according to this invention that a predetermined winding pattern be better reproduced to result in larger wound packages more readily susceptible to uniform after-treatment, and if the rayon is collected under reduced tension, the tension is maintained at a substantially constant valve to prevent filament breakage in the stretching zone.

Other objects and advantages of this invention will be apparent upon consideration of the following detailed description when considered in conjunction with the annexed drawings wherein

Figure 1 is a schematic perspective view of a single unit of a bobbin spinning machine in which the traverse and bobbin are driven in synchronism at a speed progressively reduced throughout the winding period by apparatus constructed according to this invention;

Figure 2 is a graph in which the rotational speeds of a bobbin are plotted against units of time to illustrate various rates of speed reduction;

Figure 3 is a graph in which the peripheral speeds of a bobbin package are plotted against units of time, the illustration serving to afford a basis for comparing different types of rotational speed control mechanisms; and

Figure 4 is a graph in which bobbin package diameters are plotted against units of time to illustrate the effect of the speed control arrangement constituting a part of this invention in the preparation of right cylindrical packages and cylindrical packages having frusto conical ends.

Referring now to Figure 1, it can be seen that a portion of a bobbin spinning machine is therein illustrated. Although it is within the purview of our invention to employ any type of traverse operating mechanism, the one shown has been found to be particularly suitable. As illustrated, both the bobbins and the traverse mechanism are driven from a shaft 10 which is propelled through gear 11 from the variable side of a variable speed transmission generally indicated at 12. At spaced points along the length of shaft 10 gears 13 are provided, corresponding in number to the number of bobbins with which the apparatus is equipped. In the interest of convenience of illustration, only a single bobbin is shown in Figure 1. This bobbin is designated by the numeral 14 and is mounted on a bobbin holder of conventional form which is attached to a drive shaft 15 which shaft carries also a gear 16 meshing with and driven by gear 13. Since it is contemplated that all of the gears 13—16 be respectively of the same size, it is evident that all of the bobbins 14 with which the machine is equipped will be driven throughout the winding period at a speed directly proportional to the speed of shaft 10. Shaft 10, in addition to gears 13, carries a gear 17 which meshes with gear 18 which, in turn, drives a gear 19 keyed to a shaft 20. Shaft 20, at its extremity remote from gear 19, carries an additional gear 21 which meshes with and drives a gear 22 thus imparting rotation to a shaft 23. Mounted on shaft 23 is a cam 24 provided with a peripheral groove adapted to receive a follower. This follower extends inwardly from a bar 25 and is suitably supported or guided so that reciprocation of the latter is brought about by rotation of cam 24, the characteristics of said cam determining the amplitude of displacement of bar 25 per degree of angular displacement of shaft 23. Bar 25, at its end remote from the cam follower, is pivotally connected to an arm 26 attached to and depending from a rock shaft 27. It can thus be seen that rotation of shaft 10, through the various gears, brings about rotation of cam 24 which, through bar 25 and arm 26, causes oscillation of rock shaft 27. Depending from rock shaft 27 and attached thereto is an arm 28. The free end of arm 28 is pivotally connected to horizontal bar 29, the other end of which is pivotally connected to a depending arm 30 attached at its opposite end to another rock shaft 31. Depending from bar 29 is a bracket 32 which supports a traverse bar 33 upon which thread guides 34 are mounted at spaced points to direct the laying up of thread on the various bobbins 14. Although not illustrated, it is contemplated that another bracket similar to bracket 32 may be mounted at the op-

posite end of bar 29 to serve another traverse bar on the opposite side of the machine.

The apparatus described thus far may be used in conjunction with any of the well-known spinning schemes wherein the thread is ultimately collected on a bobbin 14. In one spinning scheme such as that shown in Fig. 1, a spinning solution is extruded through a spinneret 35 into a spin bath indicated at 36, the rate of delivery of the solution being controlled by a gear pump operated at a constant speed throughout the spinning period from a power source, not shown. From spinneret 35 the thread may be led around a driven godet 37, also propelled at a constant speed throughout the winding period. From this godet it is passed to and around a freely rotatable roller 38. From the godet and roller the thread is drawn by rotating bobbin 14 and is wound thereon according to a pattern predetermined by the movement of traverse bar 33. It will be understood that godet 37 is merely illustrative in nature and that any number or arrangement of godets may be provided depending upon the thread characteristics sought. It is evident, however, that the last godet in the path of the thread before it reaches bobbin 14 will have a substantially constant peripheral speed throughout the winding period and that the stretch of the yarn between the last godet and the bobbin will therefore depend upon the take-up speed of the latter.

If a spinning scheme is employed involving two or more godets such as described in application Serial No. 339,974 filed June 11, 1940, now Patent No. 2,302,971, the above problems are further magnified for in that process the thread passes from the spinneret, through the coagulating bath, over a godet, and into a stretching zone, where a high degree of stretch and tension are applied thereto. Then, usually, there is in the path of thread travel a tension release godet over which the yarn runs with some measure of gliding friction or slippage. Finally, the yarn is wound under reduced tension onto the spinning bobbin. The yarn tension in the latter zone is an indicative factor of the yarn tension in the zone of higher stretch. The latter may be about ten times as high as the former. Thus, comparatively small tension fluctuations in the tension release zone give occasion to high tension in the stretch zone, perhaps so high that filament breakage results or that the dye rate may be decreased. This, of course, is detrimental to yarn quality.

Regardless of the spinning scheme employed, according to this invention the take-up speed of bobbin 14 is maintained at the desired value by the operation of change speed mechanism 12. Change speed mechanism 12 consists essentially of two pairs of cones 39 and 40 connected by a belt 41. Cones 40 are mounted on a shaft 42 driven through a sprocket 43 by a chain 44, in turn propelled by a sprocket 45 mounted on the rotor shaft of a constant speed electric motor of suitable characteristics designated by numeral 46. Thus, as power is delivered by motor 46, it is transmitted through chain 44 to shaft 42 which, in turn, brings about the rotation of cones 40. The sloping faces of cones 40 engage belt 41 and through it propel cones 39. The latter are mounted on a shaft 47 which carries a gear 48 meshing with main drive gear 11 on shaft 10. Levers 49 and 50, pivoted respectively at 51 and 52, serve to slide the pairs of cones 39 and 40 toward and away from one another along their respective

shafts 47 and 42 so that the diameter of the driving and driven periphery contacted by the belt may be varied to produce different driving speeds on the part of shaft 47. The variable speed unit 12, as thus far described, is conventional in form and has, in the past, only properly controlled the beginning and end speeds of the bobbins.

It is customary to shift the levers 49 and 50 by operation of a screw propelled from a constant speed source. Such a screw will displace the levers a constant distance per unit of angular displacement of itself and the speeds effective at shaft 47 will follow an improper curve when plotted against units of time. It has been hereinbefore explained that this results in highly undesirable variations in thread tension in the path between godet 38 and bobbin 14. Thus, as an important part of this invention, levers 49 and 50 are operated by a cam 53. Cam 53 is provided with two faces of identical curvature 180° apart, each face acting on one of the levers 49—50. Cam 53 is propelled at a constant speed throughout the spinning period through a shaft 54 to which it is keyed. Shaft 54 has mounted thereon a worm gear 55 driven by a worm 56. Worm 56 is mounted on a shaft 57 which also carries a sprocket 58. Sprocket 58 is connected by a chain 59 to another sprocket 60, mounted in a box generally designated by the numeral 61. The reduction system in box 61 is propelled by a sprocket 62 connected by a chain 63 with another sprocket, not shown, keyed to shaft 42. It can now be seen that cam 53 will be caused to turn very slowly throughout the winding period and that the displacement of pairs of cones 39 and 40 per unit of time will depend upon the curvature of its faces.

It has been found by experimentation that, if a screw is used to displace levers 49 and 50, or if cam 53 were to be one of straight line characteristics, the rotational bobbin speed when plotted against units of time would follow the path of line 1—*a* of Figure 2, but that, under the same conditions, the peripheral speed of the bobbin would follow the line 1—*b* of Figure 3. Upon reference to line 1—*b* it will be seen that there is a precipitate rise in peripheral speed at the beginning of the winding period which is finally reduced at the end thereof to approximately the same value as at the beginning of the winding. These variations in take-up speed of the bobbin result in marked variations in thread tension during the winding on period. From the curves 1—*a* and 1—*b*, it is most evident that the effect of the normal reduction in rotational speed of the bobbin per unit of time is unsatisfactory from the point of view of the rayon manufacturer since the thread tensions between the godet and the bobbin under such conditions vary within very wide limits.

As distinguished from the foregoing, if cam 53 is used and the rotational speed of bobbin 14 is thereby properly controlled to follow line 2—*a* of Figure 2, the peripheral speed of the bobbin will follow line 2—*b* of Figure 3. It will be noted that line 2—*b* is a straight one and that there is no variation in peripheral speed throughout the winding period so that there is no variation in tension brought about by relative speed changes between bobbin 14 and godet 37. Under these conditions the bobbin diameter increases as illustrated in line 2—*c* of Figure 4.

The description of Figures 2, 3, and 4 insofar as lines 1—*a*, 1—*b*, 2—*a*, 2—*b*, and 2—*c* are involved, is concerned with the winding of a

bobbin of cylindrical form having frusto conical ends. In the preparation of packages of right cylindrical configuration, i. e., packages with ends lying wholly in a plane normal to the bobbin axis, it has been found that the package may be satisfactorily built without distortion, particularly squeezing out at the ends, where the peripheral speed follows line 3—*b* of Figure 3 brought about by a rotational speed following line 3—*a* of Figure 2. Under these conditions it will be noted that at the beginning of the winding period there is a slight increase in tension of insufficient magnitude to detrimentally affect thread denier but sufficient to maintain package configuration. In this case, however, the line 3—*b* is substantially straight after the initial slight increase in tension. As distinguished from the peripheral speeds of line 3—*b* attention is directed to line 4—*b* which designates the peripheral speed changes during the winding of a right cylindrical package where the rotational speed of the bobbin is controlled by a conventional means to follow line 1—*a* of Figure 2. In Figure 4 line 3—*c* illustrates the rate of diameter increase of the right cylindrical package where the peripheral speed thereof is in accordance with line 3—*b* of Figure 3.

In the event a constant peripheral speed is desired during the winding of a right cylindrical package, the curvature of cam 53 may be designed to produce variations in the rotational speed of the bobbin following, upon development, line 5—*a* of Figure 2. Under these conditions the peripheral speed of the bobbin throughout the entire winding period will follow line 2—*b* of Figure 3.

Although the above described mechanism shows a cam designed for imparting a particular predetermined non-uniform reduction in bobbin R. P. M.'s for a given period so that the take-up speed of the thread is maintained substantially constant throughout the winding period, it is the predetermined control of the winding tension for the complete period that is broadly novel in our present concept. Such control may be effected through various types of speed change mechanisms either by a specially designed cam to control the transmission of the rate of speed variation, or by the design of the speed change mechanism per se. As the peripheral speed equals π times the diameter times the R. P. M., if the peripheral speed is to be maintained constant, then the deceleration of the bobbin is a simple function of the increase in diameter. Therefore, it is only necessary to first determine the desired peripheral speed, e. g., a constant one for conical packages, for a given period; determine the rate of increase in diameter of the package per unit of time, and then adjust the rate of change of the speed change mechanism so that the curve produced by plotting bobbin package peripheral speed against time will be a straight line. In the case of spinning right cylindrical packages it is desirable to slightly increase the peripheral speed of the package at the beginning of the spinning period and then gradually decrease the peripheral speed until at the end of the winding period the tension is slightly greater than at the beginning thereof. However in this method also, it is only necessary to adjust the speed change mechanism so that the effect when plotting the peripheral speed of the package against time, is a line similar to 3—*b*.

Rayon packages having a diameter greater than 150% of the diameter of the empty bobbins are defined in the specification and claims as "thick" packages.

What is claimed is:

1. In a method of manufacturing thread of synthetic origin wherein a thread is freshly spun and collected in package form on a rotating bobbin which is gradually decelerated in rotational speed to effect approximately the same surface speed of the thread on the package at the beginning and end of the winding period, the improvement which comprises positively driving the bobbin directly from a motivating source at a decelerating rotational speed, which deceleration is continuously varied throughout the winding period independent of the size of the package and in timed relation to the rotation of the bobbin so that at any instant of time during the winding period the change in the R. P. M. of the bobbin does not depart substantially from the R. P. M. change typified between curves 2*a* and 5*a* of Figure 2.

2. In a method of manufacturing thread of synthetic origin wherein a thread is freshly spun and collected in package form on a rotating bobbin which is gradually decelerated in rotational speed to effect approximately the same surface speed of the thread on the package at the beginning and end of the winding period, the improvement which comprises positively driving the bobbin directly from a motivating source at a decelerating rotational speed, which deceleration is continuously varied throughout the winding period independently of the size of the package and in timed relation to the rotation of the bobbin so that during the winding period the change in the R. P. M. of the bobbin generally follows a curve typified by 2*a* of Figure 2.

3. In a method of manufacturing thread of synthetic origin wherein a thread is freshly spun and collected in package form on a rotating bobbin which is gradually decelerated in rotational speed to effect approximately the same surface speed of the thread on the package at the beginning and end of the winding period, the improvement which comprises positively driving the bobbin directly from a motivating source at a decelerating rotational speed, which deceleration is continuously varied throughout the winding period independently of the size of the package and in timed relation to the rotation of the bobbin so that during the winding period the change in the R. P. M. of the bobbin generally follows a curve typified by 3*a* of Figure 2.

4. In a method of manufacturing thread of synthetic origin wherein a thread is freshly spun and collected in package form on a rotating bobbin which is gradually decelerated in rotational speed to effect approximately the same surface speed of the thread on the package at the beginning and end of the winding period, the improvement which comprises positively driving the bobbin directly from a motivating source at a decelerating rotational speed, which deceleration is continuously varied throughout the winding period independently of the size of the package and in timed relation to the rotation of the bobbin so that during the winding period the change in the R. P. M. of the bobbin generally follows a curve typified by 5*a* of Figure 2.

5. In a method of manufacturing thread of synthetic origin wherein a thread is freshly spun and collected in package form on a rotating bobbin which is gradually decelerated in rotational speed to effect approximately the same surface speed of the thread on the package at the begin-

ning and end of the winding period, the improvement which comprises positively driving the bobbin directly from a motivating source at a decelerating rotational speed, which deceleration is continuously varied throughout the winding period independently of the size of the package and in timed relation to the rotation of the bobbin so that after the initial winding period, the peripheral speed of the thread varies less than 2.0% and follows a straight line as typified by 2*b* and 3*b* of Figure 3.

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