

Jan. 11, 1944.

A. L. JACKSON
MANUFACTURE OF RAYON

2,338,722

Filed Feb. 3, 1943

3 Sheets-Sheet 1

Fig. 1.

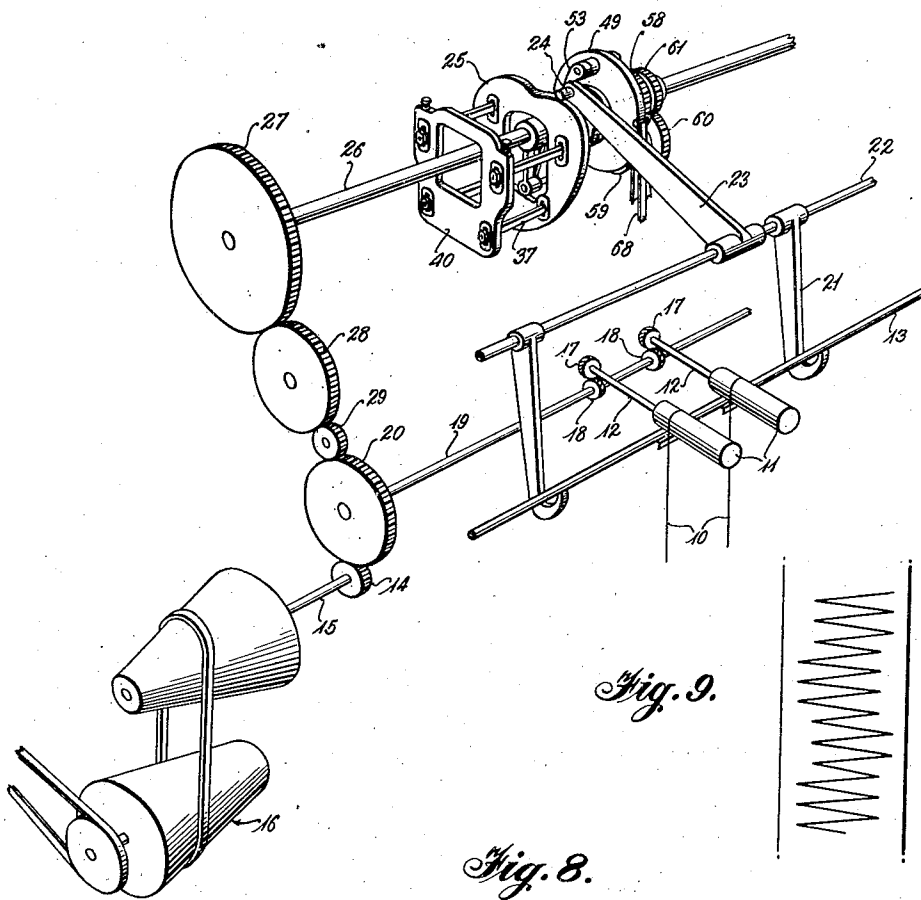
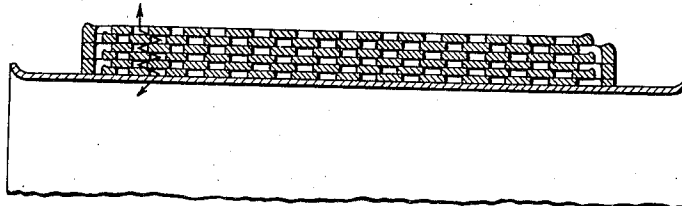


Fig. 9.

Fig. 8.



Inventor

Arthur L. Jackson

By *Alvin F. Knight*
Attorney

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A. L. JACKSON

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3 Sheets-Sheet 2

Fig. 2.

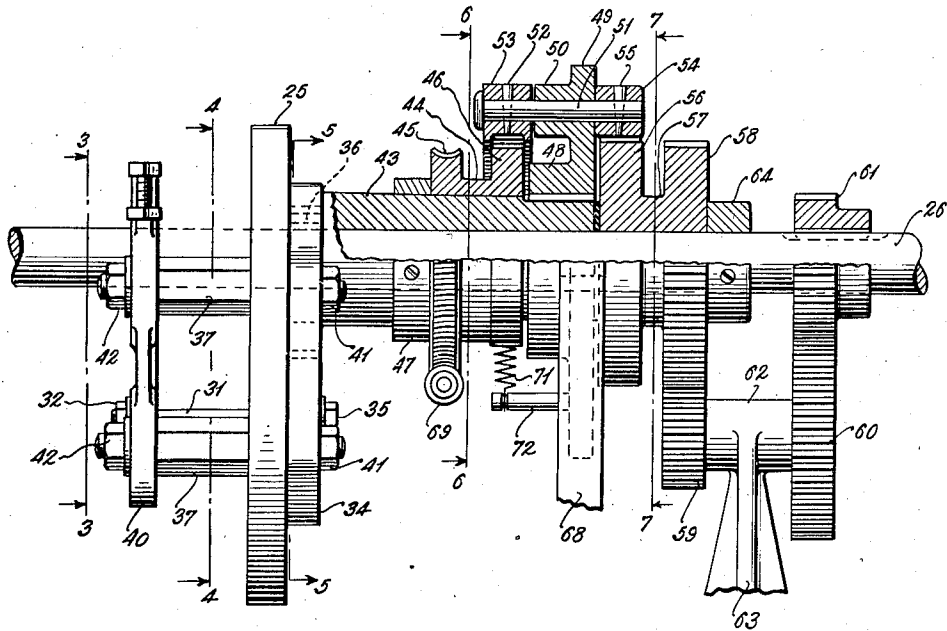
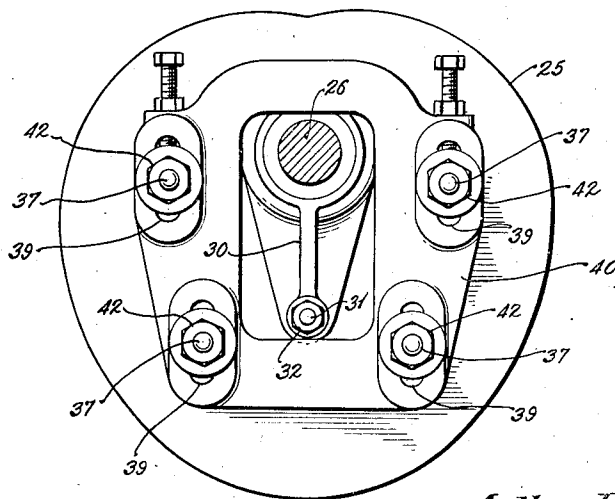


Fig. 3.



Inventor

Arthur L. Jackson

By *Alvin F. Knight*
Attorney

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3 Sheets-Sheet 3

Fig. 4.

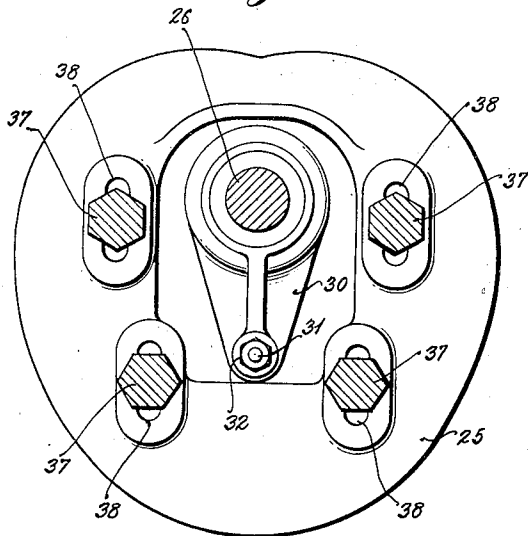


Fig. 5.

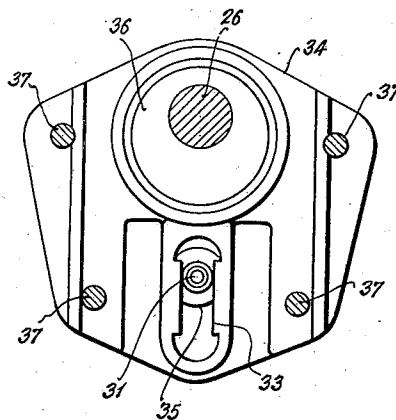


Fig. 6.

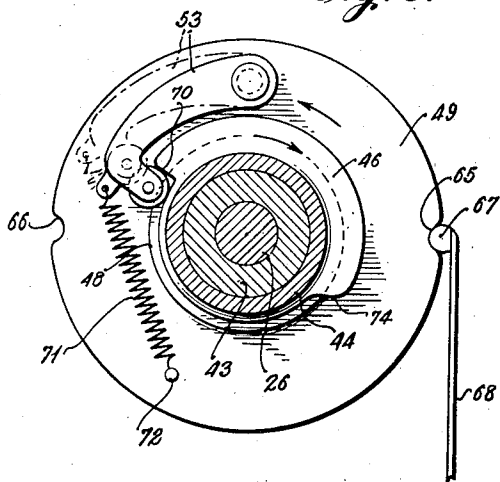
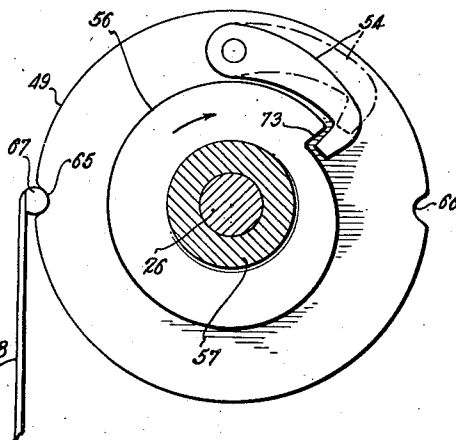


Fig. 7.



Inventor

Arthur L. Jackson

By

Albin F. Knight

Attorney

UNITED STATES PATENT OFFICE

2,338,722

MANUFACTURE OF RAYON

Arthur L. Jackson, West Asheville, N. C., assignor
to American Enka Corporation, Enka, N. C., a
corporation of Delaware

Application February 3, 1943, Serial No. 474,576

15 Claims. (Cl. 242—26)

This application constitutes a continuation-in-part of my applications Serial No. 350,215, filed August 3, 1940, and Serial No. 397,793, filed June 12, 1941.

The present invention relates to the production of thread or yarn packages of synthetic origin and more particularly to a process of and apparatus for preparing bodies of such freshly spun material in package form.

While wound packages of thread are employed incident to many industrial operations, one of the chief uses of such packages at this time is in conjunction with the manufacture of rayon by the bobbin spinning process.

In the manufacture of rayon according to the bobbin spinning process, freshly formed filaments are led directly from a spinning bath to a spinning bobbin on which they are wound in successive layers until a package of suitable size has been prepared. Ordinarily the bobbin is rotated and the yarn is laid up thereon in longitudinal courses by a traverse mechanism. Rayon yarn, after having been so prepared in package form is not yet, however, in finished condition, but must be later subjected to a number of after-treatments such as washing, desulphurizing, bleaching and drying. According to conventional practice any or all of these after-treatments may be accomplished while the yarn is still in package form as originally wound on the bobbin, a hollow perforated spinning bobbin being employed so that the package of yarn may be placed in either a pressure or vacuum system in which treating liquids are forced radially through the perforations in the bobbin and through the yarn body wound thereon.

In commercial practice of the above process, two problems are continuously present. One of these is the production of a package having satisfactory washing qualities, while the other is concerned with the weight and diameter of the package. Since the character of the finished product largely depends upon the uniformity of after-treatment, it is evident that the washing qualities of the package cannot be sacrificed in the interest of greater weight despite the fact that a heavy package involves the inherent advantage of reducing the amount of handling per pound of yarn produced.

In my said application Serial No. 350,215, many of the washing problems encountered in bobbin spinning of rayon are satisfactorily solved even where the thread is collected in package form under high tension. However, the process and

apparatus of said application is particularly concerned with the production of a package having conical ends.

It has long been recognized that enormous savings could be effected in the production of rayon if it were possible to produce and efficiently after-treat a large diameter package of truly cylindrical form, the ends of which would lie in a plane normal to its axis. Such packages, however, have not heretofore been deemed feasible since there is a tendency of the thread to tangle at the package ends where the traverse changes direction in substantially the same radius of the bobbin throughout the entire winding on period. In addition to the tangling difficulty, imperfections in the cam and follower mechanisms which operate the traverse cause the occurrence of humps adjacent the end of the package, these humps being of greater diameter than the remainder of the package and consequently requiring a longer washing time. It is evident that the additional time required for washing the humps is wasted as regards the remainder of the package and is consequently inefficient. These humps also contribute to the production of thread of non-uniform denier and therefore lower quality.

It is therefore, an object of this invention to overcome all of the foregoing difficulties and to produce wound thread packages having superior washing qualities and the thread per se, having a more uniform denier, said packages being characterized by a cylindrical shape and ends lying substantially in a plane normal to the package axis.

In accordance with the concept of the present process it is contemplated that a wound package of yarn or thread having ends substantially vertical with respect to its axis will be produced and will be characterized by considerable density while being uniformly permeable throughout to facilitate any fluid treatment deemed necessary or desirable.

The provision of readily adjustable apparatus for producing wound packages of uniform permeability under either high or low tension is also an object of this invention, while the apparatus is contemplated for use in ordinary bobbin spinning, in two bath spinning, or in other winding operations requiring the production of a dense package of controlled permeability throughout its axial length.

To this end it is contemplated to continuously wind packages of yarn according to a predetermined fixed pattern such as the "basket

weave" and to relatively axially displace successively wound portions of the pattern to produce a dense cylindrical wound package of controlled permeability.

Other objects and advantages of this invention will be apparent from a consideration of the following detailed description of a preferred embodiment thereof in conjunction with the annexed drawings wherein

Figure 1 is a schematic perspective view of a portion of a winding machine illustrating an assembly including a gear train for driving the bobbins and traverse mechanism in synchronism and an automatic tripping coupling for effecting intermittent axial displacement of the winding pattern;

Figure 2 is a view in side elevation in partial section of the traverse control mechanism;

Figure 3 is a view taken along line 3—3 of Figure 2;

Figure 4 is a view taken along line 4—4 of Figure 2;

Figure 5 is a view taken along line 5—5 of Figure 2;

Figure 6 is a view taken along line 6—6 of Figure 2;

Figure 7 is a view taken along line 7—7 of Figure 2;

Figure 8 is a view in longitudinal section of a thread package wound according to the teachings of this invention illustrating the effect of intermittent displacement of successively wound portions thereof; and

Figure 9 is a diagrammatic representation of axial displacement of the traverse path.

Referring to the winding machine shown in Figure 1, it will be seen that a series of yarns 10 issuing from a spinning bath, not shown, are wound on perforated bobbins 11 supported and driven by shafts 12. The yarns 10 are laid up in successive courses, axially of bobbins 11, by a reciprocating traverse bar 13 of conventional form which as shown, is driven at a rate of speed directly proportional to the speed of rotation of the bobbins.

When it is desirable to effect this synchronism as regards the operating speeds of traverse bar 13 and bobbins 11, each is driven indirectly from a single source of power, namely gear 14 which is attached to shaft 15 of a variable speed power source diagrammatically indicated at 16.

To effect a driving connection between each bobbin 11 and gear 14, the respective shafts 12 of bobbins 11 are provided with identical gears 17, gears 17 meshing with identical gears 18 attached at spaced intervals along a shaft 19. Shaft 19 is driven by gear 14 through gear 20 and, as a consequence, will cause all of the bobbins 11 to rotate in the same direction at a constant speed determined by the speed of rotation of shaft 15 and the relative diameters of gears 14 and 20. It will be recognized that although only two bobbins are shown in Figure 1, a large number of such bobbins will be employed simultaneously in commercial spinning.

The traverse bar 13 which operates in synchronism with bobbins 11 is also driven from gear 14 although the intermediate driving connections are somewhat more complex. It will be noted that traverse bar 13 is supported at spaced intervals by arms 21 which are attached to and depend from a rocker shaft 22 suitably journaled in a manner not shown. Upon oscillation of rocker shaft 22, arms 21 will also oscillate thus

causing traverse bar 13 to reciprocate and by means of suitable guides lay up yarn 10 in superimposed courses extending axially of each bobbin.

To effect the oscillation of shaft 22 an arm 23 is keyed thereto, this arm being provided with a cam follower 24 movable in response to rotation of a heart-shaped cam 25. Heart cam 25 is mounted for rotation with a shaft 26 which is provided at one end with a driving gear 27.

Since the rotation of shaft 26 is imparted to cam 25 which controls the reciprocation of traverse bar 13, shaft 26 is driven from gear 14 through gear 27 in order to bring about the synchronism discussed above. However, it is desirable that the speed of traverse bar 13 be considerably less than, although proportional to, the speed of rotation of bobbins 11 also driven from gear 14. To this end, a speed reduction gear train, including gears 28 and 29, is interposed between gear 14 and gear 27 to reduce the speed of shaft 26 with respect to that of shaft 19.

It will be understood that each of the shafts for the various gears is suitably supported in a journal not shown. Thus by rotation of shaft 15, movement will be imparted to shaft 19 through gear 20 and to shaft 26 through gears 27, 28, and 29. While but a single gear train for shafts 26 and 19 is illustrated in Figure 1, it is contemplated that a commercial installation include a second shaft, such as 19, on the opposite side of the machine, for driving another group of bobbins, said second shaft also being driven from shaft 15 through a gear train. Of course, on a two sided machine traverse bar 13, rocker shaft 22 and arm 23 are also duplicated.

The spinning machine as thus far described, if operated, would cause superimposed courses of yarn to be built up on the bobbins according to a fixed pattern determined by the speed ratio between traverse bar 13 and the periphery of bobbins 11. Each course of yarn would, however, exactly correspond to every other course in length. However, during the entire winding on period, the speed of shaft 15 is gradually reduced by operation of variable speed transmission 16 so that the takeup or peripheral speed of the bobbins 11 is maintained constant. Since cam 25 is also driven, albeit indirectly, from shaft 15 of variable speed transmission 16, it is evident that the speed of operation of traverse bar 13 will be likewise continuously reduced during the winding on period, the speed ratio between bobbins 11 and traverse bar 13 being maintained at a constant value predetermined by the characteristics of gear train 20, 27, 28, and 29. This synchronism, without more, would produce in theory a basket weave in which each course of the yarn body would directly overlie each preceding course and the yarn body as a whole would be truly cylindrical having ends lying in planes normal to the bobbin axis. Due to the fact that the development of cam 25 is not truly a straight line one, however, a lag at the changes of direction would result in "humps" of increased diameter adjacent the ends of the package.

To avoid the production of humps resulting from imperfections in the cam 25 and the follower linkages driven therefrom, and to avoid tangling of thread at the end of the package, it is proposed according to this invention to intermittently bodily displace cam 25 in a vertical sense thereby to axially displace portions of the wound thread with respect to preceding portions thereof. To this end a novel clutch arrangement is provided for driving cam 25 continuously

from shaft 26, while intermittently vertically displacing the same without alteration of its eccentricity.

Referring now to Figure 4, it will be seen that cam 25 is provided with a vertically elongated central aperture so that it is wholly out of direct contact with shaft 26. Within the elongate opening of cam 25 an arm 30 is disposed, this arm being entirely free of cam 25 but keyed to shaft 26 and extending radially therefrom. The end of arm 30, remote from the point of attachment to shaft 26, has therein a small aperture receiving a bolt 31 held in position by a nut 32. Bolt 31 extends from the end of arm 30 to the right side of the machine as viewed in Figure 2 passing through a vertical slot 33 (Figure 5) in a spider 34, said bolt 31 being held by a nut 35 on the other side of spider 34 as may be seen in Figures 2 and 5. Spider 34 is mounted for rotation about a cylindrical cam 36 having an eccentric interior bore through which shaft 26 passes. It can now be seen that spider 34 will turn about cam 36 as a bearing at a speed corresponding to the speed of rotation of shaft 26, the rotation being imparted through arm 30 and bolt 31. Spider 34 serves to drive heart cam 25 and to this end four bolts 37 are provided. Each bolt 37 is threaded at both ends and is provided with an intermediate polygonal shank portion of increased cross-sectional area. One end of each bolt 37 is passed through an aperture 38 in cam 25 and through a registering aperture in spider 34. The end of each bolt on the other side of the polygonal shank portion is passed through an aperture at 39 in a spider 40. Nuts 41 and 42 are then threaded on opposite ends of each bolt 37 to draw spider 34 against cam 25 and to draw cam 25 and spider 40 toward one another against the shoulders defined by the portions of bolts 37 which are of increased cross-section area, see Figures 2 to 5, inclusive.

From the foregoing, it is evident that arm 30 through bolt 31 drives spider 34, which, through the four bolts 37, drives cam 25 and so causes displacement of follower 24 and traversing movement on the part of bar 13. While cam 25 is driven from shaft 26, it should be noted that it rotates about the outer surface of cam 36 as an axis. It is likewise evident that if cam 36 were to be displaced in an angular sense 180° from the position shown in Figure 5, cam 25 would be raised vertically with respect to shaft 26, while its eccentricity with respect to cam 36 would remain the same. Such a movement will cause the traverse to begin and end its stroke of uniform length in axially offset radii of bobbins 11.

The apparatus for effecting intermittent angular displacement of cam 36 for 180° is best illustrated in Figures 2, 6 and 7 to which reference is now made. In Figure 2 it will be noted that cam 36 in spider 34 is integrally attached to sleeve 43 fitting concentrically over shaft 26 but not connected thereto in any way. This portion 43 of cam 36 constitutes a bearing surface for a sleeve 44 which latter carries an integral worm gear 45 and an integral cam 46 at its opposite ends. Sleeve 44 is freely rotatable about sleeve portion 43 of cam 36 and is held against axial displacement in one direction by a collar 47 and in the other direction by hub 48 of a disk 49 which is also mounted on sleeve portion 43 of cam 36 albeit keyed thereto. Near the margin of disk 49 it is provided with a boss 50 having an internal aperture through which a pin 51 is passed. Keyed to pin 51 at 52 is a cam follower

lever 53 disposed in a position to be engaged and acted upon by cam 46. At the other end of pin 51 a dog 54 is keyed thereto at 55. Dog 54 coacts with the surface of a cam 56 which is integral with and constitutes one end of a sleeve 57. The other end of sleeve 57 consists of a gear 58 which meshes with and is driven by a gear 59. Gear 59 is mounted on a stub shaft which also carries a gear 60 keyed to its opposite end. Gear 60 meshes with and is driven by a gear 61 which is keyed to shaft 26. The stub shaft which supports gears 59 and 60 is mounted in a bearing 62 supported by a bracket 63 from any convenient portion of the machine frame. While gear 61 is keyed to shaft 26, sleeve 57 including the integral cam and gear is mounted for free rotation on shaft 26. Sleeve 57 is held against axial displacement in one direction by a collar 64 and in the other direction by the end of sleeve portion 43 of cam 36.

Upon reference to Figure 6 it will be noted that disk 49 is provided with two marginal notches 65 and 66 disposed 180° apart. These notches are for the reception of a catch 67 urged radially inwardly of disk 49 by a spring 68 supported at its end remote from the catch from any suitable portion of the machine frame. The function of catch 67 is to prevent rotation of disk 49 brought about by frictional engagement with adjacent elements which may be driven. In other words, catch 67 serves to prevent creepage on the part of disk 49 or the cam 36 to which it is keyed.

It will be noted that worm gear 45 is in mesh with a worm 69 which continuously drives it in the direction indicated by the arrow in Figure 6. Worm 69 is driven from a source, not shown, which may be a gear train connecting it to shaft 26. Sleeve 57, and consequently cam 56, is continuously driven from shaft 26 through gears 61, 60, 59, and 58. The motion of cam 56, however, is not normally imparted to disk 49 due to the fact that dog 54 is held in its broken line position of Figure 7 by the action of cam 46 on cam follower 53. In other words, while follower 53 is in engagement with the surface of cam 46 it is raised to the broken line position of Figure 6. Being keyed to shaft 51, this position of follower 53 results in a corresponding position on the part of dog 54. Ultimately, however, cam 46 will be displaced by worm gear 45 so that cam follower 53 will drop inwardly off edge 70 of cam 46 under the action of spring 71 which is anchored to stud 72 extending from disk 49. When this occurs, dog 54 will be moved to its full line position of Figure 7. It will then be engaged by edge 73 of cam 56 and the rotation of the latter will be imparted to the disk which will be caused to rotate in the direction of the outer arrow shown on the disk in Figure 6. Of course, when disk 49 is rotated cam follower 53 and dog 54 move with it. Thus, cam follower 53 is brought into engagement with edge 74 of cam 46 and is moved radially outwardly by the cam. This restores dog 54 to its broken line position and catch 67 arrests movement of disk 49. Since disk 49 is keyed to the sleeve portion 43 of cam 46, it is evident that the latter will turn only when the former turns. Furthermore, it is evident that the amplitude of angular displacement will be 180° when cams 46 and 56 are arranged as in Figure 2.

By properly locating edges 70 and 74 of cam 46 and by driving that cam at a proper predetermined speed the position of the pattern on

the bobbin and the time of running at each position may be controlled. It is evident that the pattern can be placed at any desired point on the bobbin and at any desired sequence by the control or the design of cams 46 and 56.

Many modifications may be made without departing from the spirit and scope of the present invention, e. g., it is not necessary to drive the bobbin and traverse in synchronism if large square packages are to be produced and after-treated in accordance with the teachings of my application Serial Number 433,099, filed March 2, 1942. In such a case the traverse mechanism may be driven independently from the bobbin.

It is further contemplated to build packages wherein the type of crosswind varies throughout the winding period. More explicitly, the bobbin and traverse may be driven in synchronism to produce a pattern during the initial stages and then at predetermined periods their ratio changed or they may even be driven independently to produce random winding. The essential end in view is to provide a package which is sufficiently permeable in those portions that otherwise could not be properly washed and after-treated. As a further method of changing the density of portions of the package, the displacement of superimposed layers may be effected for only a part of the winding period.

The term "course" as employed in the specification and claims is intended to define the laying up of yarn axially of the rotating bobbin for a distance determined by the length of the stroke of the traverse bar. "Axially displaced" or "axially displacing" means shifting the traverse bar axially of the bobbin or shifting the bobbin axially of the traverse bar, for a predetermined period to effect laying up of a number of courses, all superimposed but displaced with respect to courses therebelow. However, the amplitude of the traverse stroke remains the same so that if the traverse and bobbin are driven in synchronism the pattern per se will not be altered although portions thereof throughout the body of the package will be axially displaced.

Having now described the invention in its preferred form, it is understood that variations and modifications may be made therein without departing from the spirit of the invention, and it is desired that the scope thereof be limited only by the spirit of the appended claims.

What is claimed is:

1. A freshly spun cross-wound package of rayon threads and the like, the package being characterized by a plurality of layers of thread, all of the layers constituting the body of the package being of the same axial length and throughout the body thereof at predetermined, spaced, radial points, a group of layers of threads axially displaced with respect to a group of layers therebelow whereby a cylindrical package is formed having overlapping layers which provide self-supporting ends lying substantially in a plane normal to the axis of the package.

2. A freshly spun permeable cross-wound package of rayon threads, each thread composed of substantially untwisted filaments, the package being further characterized by a plurality of superimposed layers of thread of the same axial length wound according to a fixed pattern and throughout the body of the package at predetermined points therein, a group of layers of thread axially displaced with respect to a group of layers therebelow whereby a cylindrical package is

formed having overlapping layers which provide self-supporting ends lying substantially in a plane normal to the axis of the package and the overall axial length of the package being greater than the layers constituting the body thereof.

3. A method for the preparation of cylindrical rayon cross-wound packages having ends lying substantially in a plane normal to the axis thereof which comprises winding freshly spun rayon threads onto a bobbin and throughout the winding period guiding the thread transversely a uniform distance across the surface of the package to form successive courses of equal axial length and at predetermined intervals axially displacing a plurality of courses to form overlapping layers having self-supporting square ends.

4. A method for the preparation of cylindrical rayon cross-wound packages having ends lying substantially in a plane normal to the axis thereof which comprises collecting a freshly spun thread on a bobbin and guiding it transversely a uniform distance across the surface of the package to form successive courses of equal axial length, forming a permeable package by superimposing a plurality of layers of thread on the bobbin according to a predetermined fixed pattern and, throughout the winding period, axially displacing a group of layers at intervals to form overlapping layers having self-supporting square ends.

5. A method for the preparation of large cross-wound packages of freshly spun rayon which comprises collecting such thread on a bobbin at a substantially constant linear speed and guiding it transversely a uniform distance across the surface of the package to form successive courses of equal axial length, maintaining a constant ratio between the rotational speed of the bobbin and rate at which the thread is laid transversely thereof to produce a predetermined pattern and axially displacing a group of layers at intervals throughout the winding period to form a cylindrical package of greater axial length than the layers constituting the body thereof, said layers overlapping to provide self-supporting square ends.

6. An apparatus for winding threads and the like into cylindrical cross-wound packages having ends lying substantially in a plane normal to the axis thereof which comprises a driven bobbin, a traverse mechanism including a thread guide moveable transversely of the bobbin, means for driving the traverse mechanism so that the stroke amplitude of the guide is maintained constant throughout the winding period and means for axially displacing the path of the traverse guide to displace the windings on the package to provide overlapping layers having self-supporting square ends.

7. An apparatus for cross-winding thread in package form which comprises a bobbin, a traverse mechanism, means for driving said bobbin and said traverse mechanism in synchronism to produce a pattern wind and means for axially displacing the path of the traverse guide to displace the windings on the package, without altering the pattern per se, to provide a permeable cylindrical package having ends lying substantially in a plane normal to the axis of the bobbin.

8. An apparatus for cross-winding thread in package form which comprises a bobbin, a traverse member, means for driving said bobbin and said member in synchronism and for maintaining the stroke amplitude of the traverse member constant throughout the winding period to pro-

duce a pattern wind of uniform axial length and means for axially displacing the path of the traverse guide to displace the windings on the package whereby a permeable cylindrical package having ends lying substantially in a plane normal to the axis of the bobbin is formed.

9. Apparatus for cross-winding thread in package form which comprises, a bobbin, traverse means for producing reciprocating strokes in a path of constant amplitude, means acting on said traverse means to periodically axially displace the path of reciprocation of the latter, and means for driving said traverse means and said bobbin in synchronism, whereby a permeable cylindrical package having its ends lying substantially in a plane normal to the axis of the bobbin may be produced.

10. Apparatus for cross-winding threads and the like into a cylindrical package having ends lying substantially in a plane normal to the axis thereof which comprises, a bobbin, a thread guide, a bell crank linkage for reciprocating said guide lengthwise of the bobbin, a cam for operating said linkage to control the character and length of stroke of the guide, means defining a bearing for said cam, said cam being fixed with respect to said bearing means for rotation thereabout as an axis, means for periodically vertically displacing said bearing means to axially displace the path of reciprocation of the guide, and means for driving said cam and bobbin in synchronism.

11. Apparatus for cross-winding thread and the like into a cylindrical package having ends lying substantially in a plane normal to the axis thereof which comprises, a bobbin, a thread guide, a bell crank linkage for reciprocating said guide lengthwise of the bobbin, a cam for operating said linkage to control the character and length of stroke of the guide, a sleeve constituting a bearing surface for said cam, a shaft, said sleeve being eccentrically mounted on said shaft, said cam being mounted to rotate about said sleeve with the center of the latter as an axis, means for periodically angularly displacing said sleeve about said shaft to axially displace the path of reciprocation of the guide, and means for driving said cam and bobbin in synchronism.

12. Apparatus for cross-winding thread and the like into a cylindrical package having ends lying substantially in a plane normal to the axis thereof which comprises, a bobbin, a thread guide, a bell crank linkage for reciprocating said guide lengthwise of the bobbin, a cam for operating said linkage to control the character and length of stroke of the guide, a sleeve constituting a bearing surface for said cam, a shaft, said sleeve being eccentrically mounted on said shaft, said cam being mounted to rotate about said sleeve with the center of the latter as an axis, means for periodically turning said sleeve 180° about

said shaft to axially displace the path of reciprocation of the guide, and means for driving the cam and bobbin in synchronism.

13. Apparatus for cross-winding thread and the like into a cylindrical package having ends lying substantially in a plane normal to the axis thereof which comprises, a bobbin, a thread guide, a bell crank linkage for reciprocating said guide lengthwise of the bobbin, a cam for operating said linkage to control the character and length of stroke of the guide, a sleeve constituting a bearing surface for said cam, a shaft, said sleeve being eccentrically mounted on said shaft, said cam being mounted to rotate about said sleeve with the center of the latter as an axis, means including a clutch biased to engaged position for rotating said sleeve about said shaft, cam means acting on a portion of said clutch to hold the same normally in disengaged position while having a position permitting the clutch to become engaged, the configuration of said cam means determining the duration of the period of disengagement and the angular velocity of the cam means determining the frequency of operation, a power source, means for driving said cam and bobbin in synchronism therefrom and means including a speed reduction gear train for driving said cam means from said power source.

14. Apparatus for cross-winding thread and the like into a cylindrical package having ends lying substantially in a plane normal to the axis thereof which comprises, a bobbin, a thread guide, a bell crank linkage for reciprocating said guide lengthwise of the bobbin, a cam for operating said linkage to control the character and length of stroke of the guide, a sleeve constituting a bearing surface for said cam, a shaft, said sleeve being eccentrically mounted on said shaft, said cam being mounted to rotate about said sleeve with the center of the latter as an axis, a disk, said disk being keyed to said sleeve for rotation therewith, a clutch element, means for driving said clutch element from said shaft, a coacting clutch element carried by said disk, resilient means biasing said last named element to engaged position, a second cam acting on said last named element in opposition to said spring means to bias the clutch to disengaged position, a portion of said second cam being of configuration to release said last named element to permit the resilient means to engage the clutch so that the disk and the sleeve to which it is keyed may be turned, a power source, means for driving said cam and bobbin in synchronism, and independent means for continuously rotating said second cam at a reduced speed.

15. In apparatus as claimed in claim 14, resilient means for holding said disk against creepage.

ARTHUR L. JACKSON.