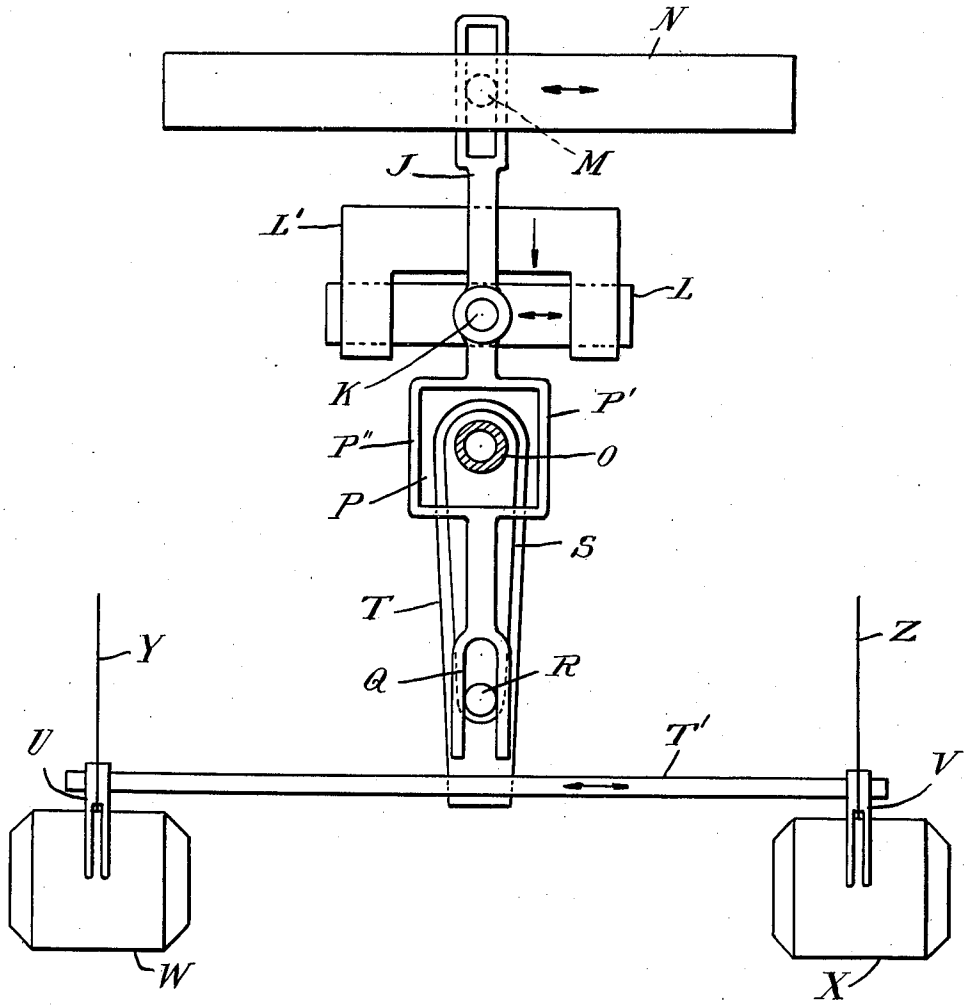
Nov. 18, 1941. W. G. LEA 2,262,850

WINDING LONG FLEXIBLE BODY

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Fig. 1,



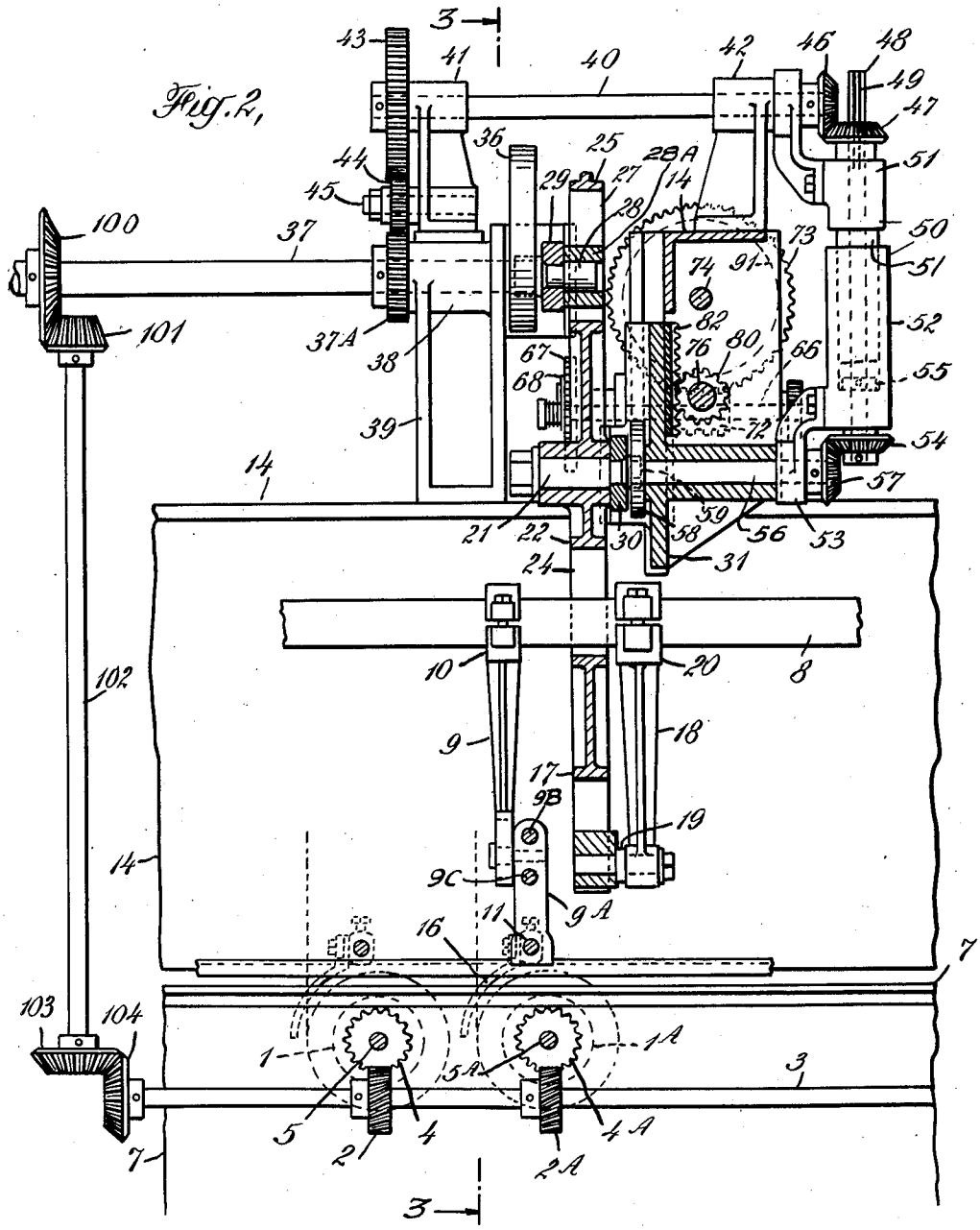
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WINDING LONG FLEXIBLE BODY

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Fig. 2,



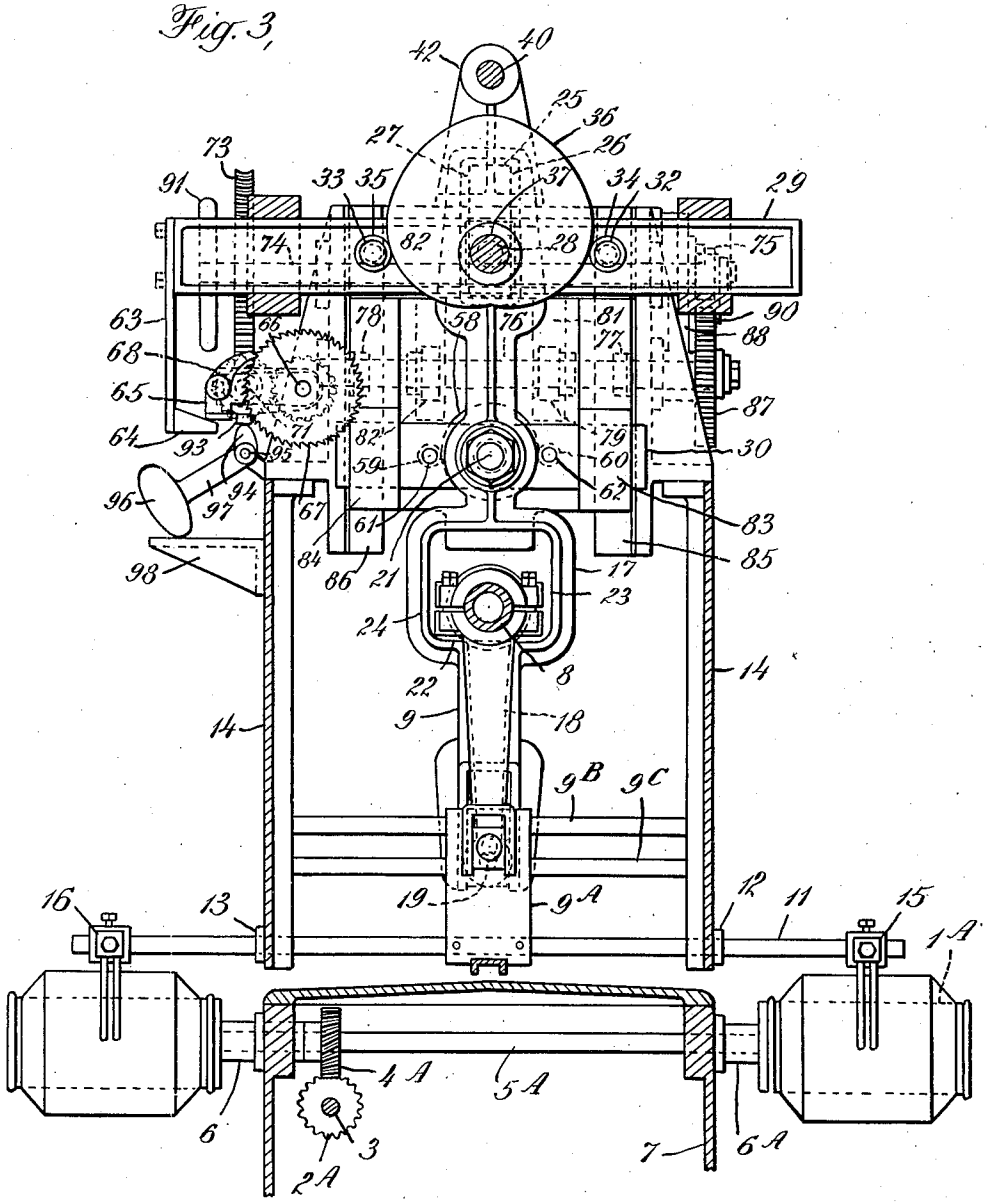
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Fig. 3,



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WINDING LONG FLEXIBLE BODY

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Fig. 4,

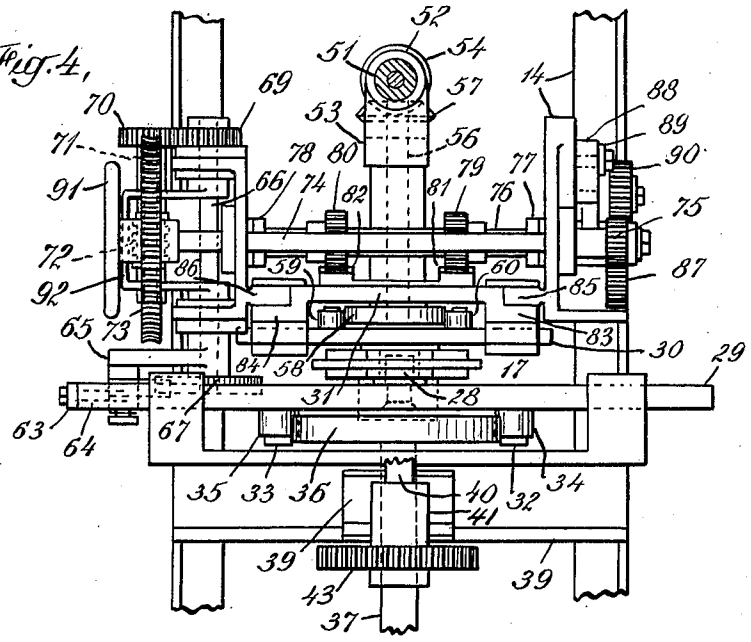


Fig. 6,

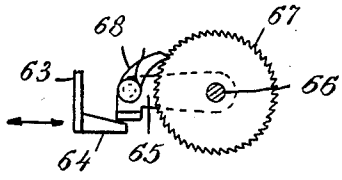


Fig. 7,

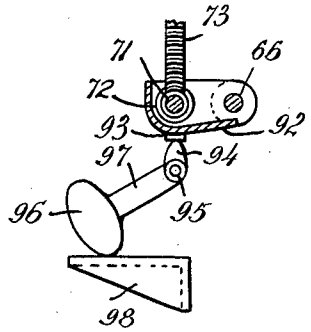
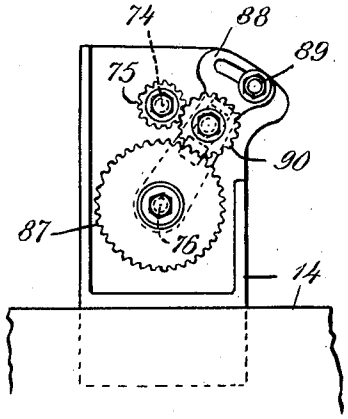


Fig. 5



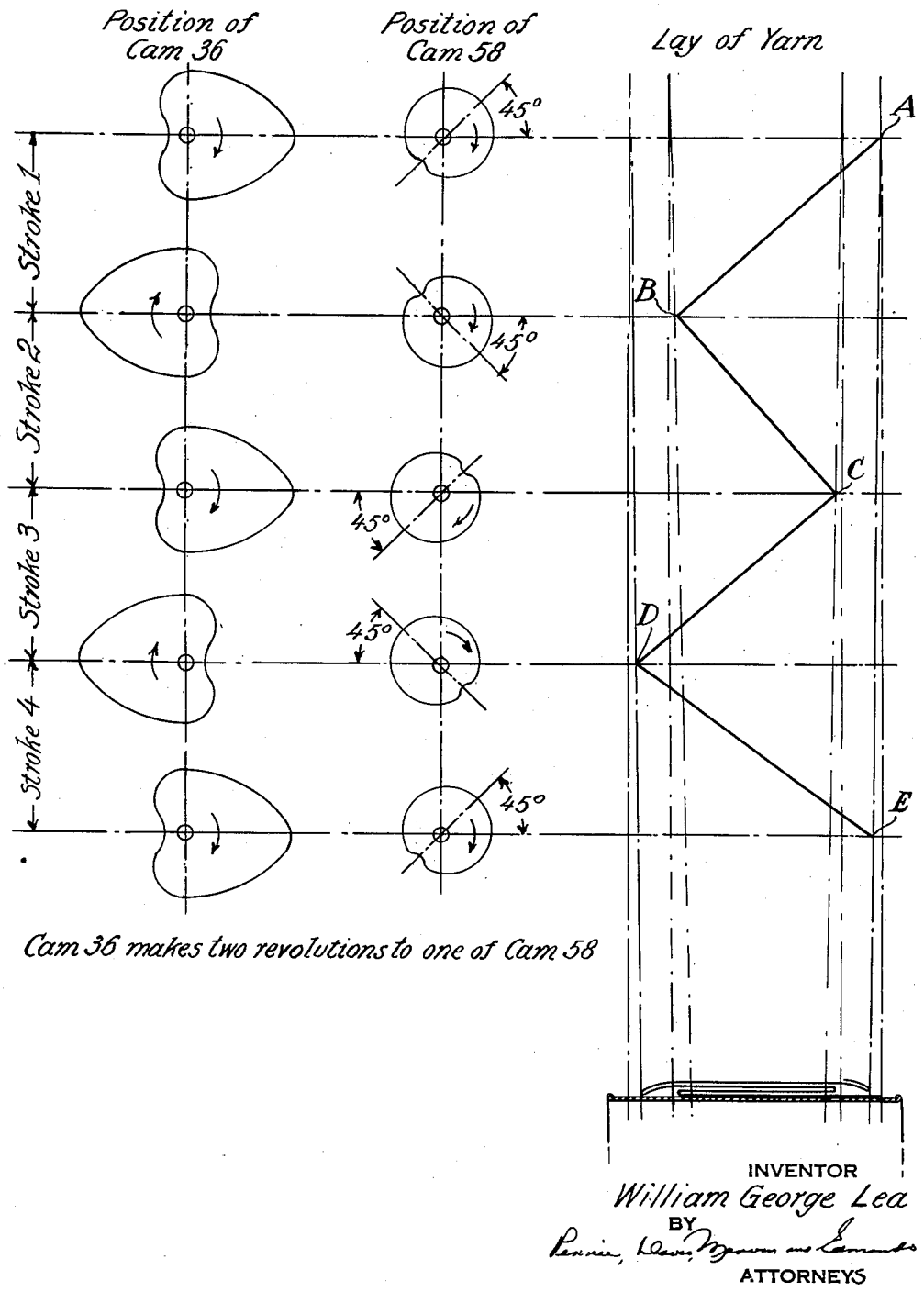
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Fig. 8,



Cam 36 makes two revolutions to one of Cam 58

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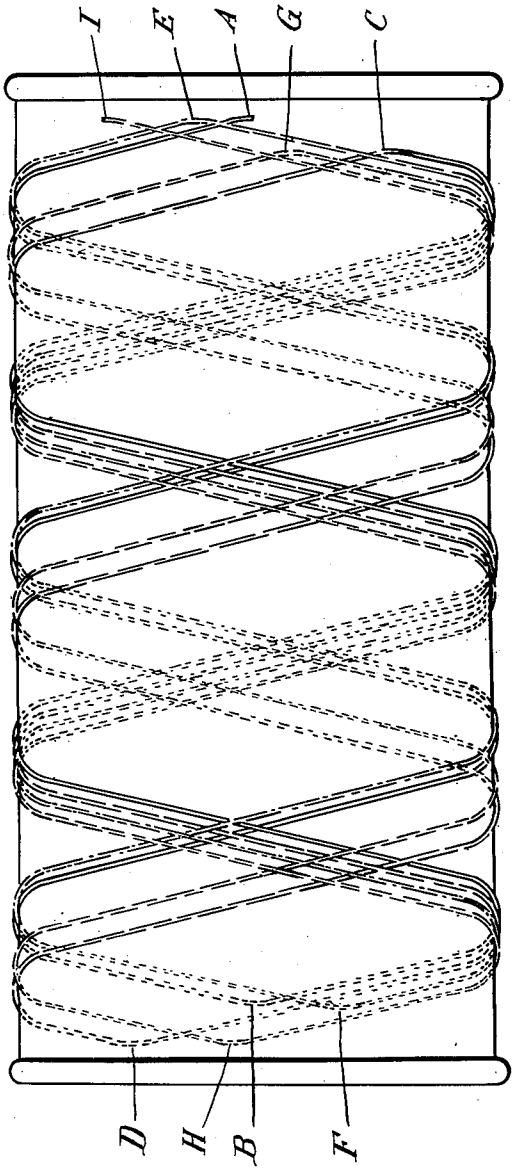


Fig. 9.

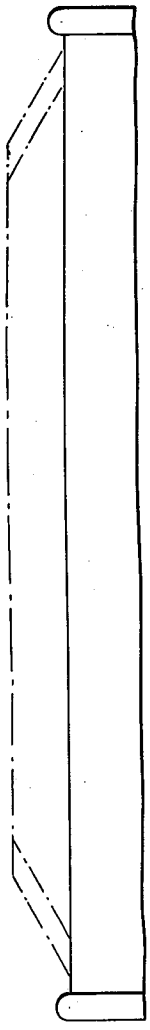


Fig. 10.

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UNITED STATES PATENT OFFICE

2,262,850

WINDING LONG FLEXIBLE BODY

William George Lea, Rome, Ga., assignor to Tubize Chatillon Corporation, New York, N. Y., a corporation of Delaware

Application August 27, 1938, Serial No. 227,100

3 Claims. (Cl. 242—43)

This invention relates to winding long flexible bodies such as yarn or thread on bobbins or similar rotating retaining means and is concerned particularly with forming yarn packages which are to be subjected to washing or comparable treatment with fluids forced through the package or which are to be unwound at relatively high speed. The invention aims to produce a yarn package of improved washability and resistance to sloughing during unwinding.

In the production of viscose artificial silk and other artificial filaments, the filaments as they are formed are withdrawn from a bath of coagulant or precipitant and collected as a package on a bobbin or spool. Thereafter, it is customary to wash and desulphurize the resulting yarn package while still retaining it on the bobbin. In one of the heretofore customary practices, this is accomplished by winding the yarn on a bobbin made in the form of a foraminous drum. After winding, the drum is withdrawn from the winding machine and its ends are closed. Washing liquor is then forced through the yarn package either by immersing the package in a bath and applying suction to the inside of the drum to draw the liquid through the package or by forcing the liquid into the interior of the drum from whence it escapes through perforations and thence through the package itself. In either case, it is important that the yarn be wound on the drum in such a way as to provide a minimum of intercommunicating voids through which the liquor will pass in preference to diffusing through the package as a whole. A channel of such intercommunicating voids or spaces through the package offers a relatively low resistance to the flow of fluids and in many cases the presence of such a channel "short-circuits" the flow and thus prevents effective washing of the package even when large quantities of washing liquor are employed.

Following the washing operation, the yarn is dried and then unwound from the package, usually during a twisting operation in which the package is spun at relatively high speed on its axis of rotation so that the yarn tends to be thrown outwardly from the axis. In any case, if the package is rotated rapidly during unwinding about the axis upon which it was wound, a considerable centrifugal force is exerted upon the package so that successive layers of the yarn tend to become separated and the whole package to assume a loose condition. This tends to cause the package to "slough." Sloughing may bring about tangling of the yarn with resultant breakage of some or all of the filaments.

As a result of my investigations, I have discovered that a yarn package having improved washability and greater resistance to sloughing during unwinding may be formed by winding yarn upon a rotating body, such as a bobbin, while the yarn is reciprocating through a stroke transverse to the length of the yarn, provided that the length of the stroke is progressively reduced as the yarn builds up on the body and while the position of the traverse stroke back and forth along the body if shifted. This traverse motion results in a package with tapered interlocking ends, and in which superposed cross-wound helices of yarn are so disposed that a high degree of washing efficiency may be obtained by forcing a minimum amount of fluid through the package. Moreover, a package thus formed has a very high resistance to sloughing, even though the yarn be unwound from the package while the package is rotated at very high speed so that the yarn tends to be thrown outward from the package by centrifugal force. My invention, therefore, contemplates the improvement in a process of winding yarn upon a rotating body while the yarn is reciprocated through a stroke transverse to the length of the yarn which comprises progressively reducing the length of the stroke as the yarn builds up on the body while shifting the position of the stroke back and forth along the body, whereby there is formed a package with tapered interlocked ends having improved washability and greater resistance to sloughing during unwinding. A preferred apparatus for practicing my above-described improvements in the process of winding long flexible bodies is described and claimed in my co-pending application, Serial No. 122,493, filed January 27, 1937, now Patent No. 2,159,032.

My invention will be more clearly understood in the light of the following detailed description taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a diagrammatic representation of a mechanism of my invention for controlling traverse motion;

Fig. 2 is a side elevation, partly in section, of a preferred form of traverse mechanism of my invention;

Fig. 3 is a sectional elevation, taken along the line 3—3 of Fig. 2;

Fig. 4 is a partial plan of the apparatus of Fig. 2;

Figs. 5, 6 and 7 are detailed elevations of various parts of the apparatus of Fig. 2.

Fig. 8 is a diagrammatic illustration showing how the cross-wound helices and the tapered in-

terlocked ends of a yarn package are obtained; and

Figs. 9 and 10 are diagrammatic illustrations of such a yarn package.

Referring now to Fig. 1, it will be seen that the principal member of the apparatus is a lever J, disposed with its longitudinal axis more or less vertical and mounted on a pivot, such as a lug K, at a point about midway along the lever. The lug in turn is mounted on a horizontally disposed lower slider L which is adapted to reciprocate back and forth in a horizontal direction. The upper end of the lever is slotted to receive a pin M, which is mounted on a second or upper slider N. This second slider is also adapted to reciprocate in a horizontal direction, preferably through a longer stroke than the first slider but at a fixed rate with respect thereto.

The rocking shaft O, with its longitudinal axis at right angles to the first and second slider, passes through a large aperture P in the lower portion of the lever. The aperture is defined by branches P', P'' of the lever and is wide enough to permit the lever to swing through a full stroke without touching the rocking shaft. The extreme lower end of the lever is forked, to define a slot Q having parallel sides. Into the slot Q is slidably fitted a wrist pin R which is mounted on a rocker arm S. The rocker arm S is fastened rigidly to the rocker shaft, which in turn carries at least one rigidly mounted traverse arm T, the lower end of which fits slidably into a horizontal cross member T'. The cross member is adapted to slide longitudinally in supports or bearings (not shown). One or more filament guides U, V are mounted on the cross member.

Reciprocation of the upper slider causes the lever to swing. The swinging lever, through the rocking arm, causes the rocking shaft to rock back and forth, swinging the traverse arm. In turn the traverse arm imparts reciprocation to the cross member and the attached filament guides (which latter are disposed respectively adjacent rotatable bobbins W, X and oscillate back and forth along the length of the bobbins). Filaments Y, Z passing through the guides are thus wound in a series of spirals of alternating direction on the respective bobbins.

At the same time, however, the lower slider is also reciprocated. Thus, the position along the cake at which the filament is laid onto the cake is changed. This results in a periodic "scrambling" or staggering of the spirals of filaments being wound on the bobbins. Interstices between adjacent filaments in preceding spirals are thus overlapped, and the development of continuous channels in the cake of wound filaments through which washing solutions will pass in preference to penetrating the whole cake is precluded.

If a cake with tapered ends is desired, this is secured by gradually increasing the distance between the lug K at the pivot and the pin M on the upper slider, while the yarn is being wound through the guides onto the bobbins. If the lug and pin are both reciprocated through strokes of constant length, and the distance between them is increased gradually, the result is a gradual decrease in the length of stroke of the lower end of the lever, and in consequence a gradual decrease in the length of the stroke of the filament guides. As the stroke of the guides is decreased the lengths of the spirals of filaments formed on the bobbins grow progressively shorter as the cakes of wound filaments build up.

In the apparatus of Fig. 1, this progressive shortening of stroke is obtained by gradually dropping guide L' in which the lower slider is mounted.

The means for accomplishing the simultaneous horizontal reciprocation of both upper and lower sliders of Fig. 1 and the gradual increase in the distance between them is shown in detail in the other figures, to which attention is now directed.

Referring now to Figs. 2, 3 and 4, it will be seen that a plurality of horizontally disposed rotatable bobbins 1, 1A, are placed side by side in the lower portion of the apparatus, and are rotated by spiral gears 2, 2A mounted firmly on a horizontal drive shaft 3 running the length of the apparatus at right angles to the axes of rotation of the bobbins. The worm gears mesh respectively with spiral cogs 4, 4A fastened to shafts 5, 5A of the respective bobbins. The horizontal drive shaft is rotatable in synchronism with the traverse mechanism by a means such as a conventional compensating mechanism (not shown) which decreases the rotational speed of the bobbins as cakes of filaments build up on them.

In the apparatus illustrated, each bobbin shaft 5, 5A supports a bobbin at either end. This is a conventional system of mounting bobbins for rayon winding, the advantage of such a system being that a single mechanism serves to drive a plurality of guides and bobbins in synchronism with each other. It will be understood, however, that the invention is applicable to the control of a single filament guide and a single filament collecting means.

The bobbin shafts are each supported in a pair of bearings, 6, 6A fastened respectively to opposite sides of a hollow base 7 of conventional form.

Extending lengthwise of the apparatus in a horizonal line above the center of the base is a rocking shaft 8 supported in conventional bearings (not shown).

A plurality of traverse arms 9 (one for each bobbin shaft) are clamped on the rocking shaft by collars 10 and hang from the rocking shaft.

Each traverse arm (through a slotted horizontally slidable connector 9A supported on horizontal rods 9B, 9C, which are fastened to a housing 14) connects with a horizontal guide arm 11, which is supported in bearings 12, 13 in the lower portion of the housing 14 for the traverse mechanism. The arm 11 is adapted to slide lengthwise through these bearings, and carries filament guides 15, 16 at its two ends.

Filaments, such as freshly spun rayon yarn, are fed from above through the guides and thence to the bobbins to be wound. As the rocking shaft is swung back and forth, the guide arm reciprocates so that the guides move back and forth to wind the filaments along the bobbins.

In the apparatus shown in Figs. 2, 3 and 4, only one traverse control mechanism is provided for a plurality of pairs of bobbins. The action of the traverse control mechanism is dependent upon the movement imparted to a main lever 17. The lower end of this lever is connected to a rocking arm 18 through a wrist pin 19 which is slidably mounted in a longitudinal slot in the lever. The rocking arm is fastened rigidly at its upper end to the rocking shaft by a split collar 20.

The main lever is suspended on a horizontal pivot lug 21 mounted on a lower slider 30 above the rocking shaft with its longitudinal axis parallel thereto.

Before proceeding further, it is desirable to consider the main lever in detail. It hangs more

or less vertically on the pivot lug at about its midpoint. Just below the point of mounting, the lever has an expanded portion 22, defined by two outwardly bent side pieces or branches 23, 24, between which the rocking shaft passes. The distance between the two side pieces is such as to permit the lever to swing through its maximum stroke without touching the rocking shaft.

It would be possible to dispense with the rocking shaft altogether by mounting the horizontal guide arm 11 or the guides themselves directly on the lower end of the main lever. The rocking shaft is only employed so that it may support a plurality of guide arms and guides, and thus avoid placing additional weight on the main lever. It would also be feasible to mount the rocking shaft to one side of the main lever and still impart a rocking motion to it through the rocking arm. In either of these cases it would be unnecessary to have the expanded portion in the main lever with the hole between. However, the illustrated type of structure is preferable because it is symmetrical and permits many traverses to be controlled by a single mechanism.

The portion of the main lever extending above the pivot lug has a longitudinal slot 25 in its upper end defined by two sides 26, 27. In the slot is slidably disposed a pin 28 which is fastened at its front to a horizontally disposed upper slider 29 which is adapted to be reciprocated in a horizontal direction through a constant and relatively long stroke. In other words, the pin 28 is fastened to the horizontal slider 29 and acts as a bearing for a sliding block 28A which is free to move up or down between the sides 26—27 of the longitudinal slot 25 in the rocking lever.

The pivot lug upon which the main lever hangs is mounted on a lower slider 30 which is adapted to be reciprocated horizontally through a constant but relatively shorter stroke than the upper slider 29. The lower slider 30 is slidably mounted in a guide member 31 which is grooved horizontally at either end to accommodate said lower slider. The guide member is adapted to be lowered gradually and progressively during the operation of the apparatus, thereby increasing the distance between the fulcrum lug and the pin on the upper slider.

The manner in which the main lever functions will now be apparent. The upper slider reciprocates through its relatively long stroke and swings the upper end of the main lever through this stroke, so that the filament guides are swung back and forth along the length of the bobbins. Simultaneously the pivot upon which the lever swings is also reciprocated back and forth through a constant but shorter stroke, preferably in a constant timed relationship with the motion of the upper slider. Thus periodically the horizontal movement of the lower end of the main lever J is increased and decreased and then increased again, so that staggering and overlapping of successive spirally wound layers of filaments occur on the bobbins.

At the same time, if filament packages with tapered ends are desired, the pivot lug is lowered progressively during the winding. This has the effect of increasing the distance between the fulcrum lug and the pin on the upper slider. This, in turn, increases mechanical advantage in favor of the upper portion of the main lever as compared with the lower portion thereof, which has the effect of progressively shortening the average horizontal movement of the lower end of the main lever, with a consequent shortening of the average stroke of the filament guides. If a square ended filament package is desired, means for progressively lowering the pivot lug may be eliminated from the machine, or better still, included in the machine with means for rendering it inoperative when square-ended packages are desired.

The upper slider carrying the pin on its rear face has a pair of horizontal pins 32, 33 on its front face, spaced equidistant from the middle of the slider. Each pin has a roller 34, 35 mounted concentrically on it, and fitted between the two rollers is an eccentric heart-shaped cam 36, mounted on a horizontal drive shaft 37 which extends parallel to the rocking shaft at about the same elevations as the rollers. The shaft 37 is adapted to be turned continuously from a horizontal main drive mechanism such as a motor (not shown) through any of the conventional compensator mechanisms (not shown) for decreasing the speed of rotation of the bobbin as the filament is built up on it. The same compensating mechanism preferably also is employed for rotating the horizontal shaft 3, for example, through a pair of mitre gears 100, 101, a vertical shaft 102, and another pair of mitre gears 103, 104. As shown in Fig. 2, the mitre gear 100 is mounted on the drive shaft 37, the vertical shaft carries the gears 101, 103, and the remaining mitre gear 104 is mounted on the shaft 3.

The shaft 37 is supported in a bearing 38 formed integrally with a support 39 which in turn rests on the traverse mechanism housing 14.

Rotation of the shaft 37 causes the heart-shaped cam to bear first against one of the rollers and then against the other, causing the upper slider to reciprocate and swing the upper end of the main lever back and forth. I prefer to employ the heart-shaped cam, because of the improved motion it imparts to the filament guide. However, if desired, a simple eccentrically-disposed circular cam may be employed, or cams of other shapes may be used.

Now considering the portion of the mechanism employed to reciprocate the lower slider upon which the fulcrum lug is fastened, it will be seen that a horizontal auxiliary shaft 40 extends lengthwise down the center of the machine at its uppermost part. The auxiliary shaft is supported at its front end in a bearing 41 which, like the bearing 38, is formed integrally with the support 39. At its rear end the auxiliary shaft rests in a bearing 42 which in turn is fastened to traverse mechanism housing 14. A gear 43 mounted on the front of the auxiliary shaft meshes with an idler gear 44 which is rotatably mounted on a stud 45 which fastens into the support 39. The idler gear in turn meshes with a gear 37A fastened rigidly on the shaft 37. At the rear of the auxiliary shaft is fastened a 45° mitre gear 46 which meshes with a companion mitre gear 47 mounted on a vertical axis at the rear of the mechanism. The companion gear 47 is keyed slidably on a vertical shaft 48 by means of a key 49, so that while both vertical shaft and companion gear may be rotated together, the shaft may slide up and down as the occasion requires.

The vertical shaft is carried in a telescopic bearing 50, the upper portion 51 of which is slidable inside the lower portion 52. The upper portion is fastened to the rear bearing 42 of the auxiliary shaft 40. The lower portion 52 is carried

by a bracket 53 which in turn is mounted on the rear of the guide member 31 which carries the lower slider on which the fulcrum is mounted. A 45° mitre gear 54 is mounted rigidly on the bottom of the vertical shaft. A collar 55, carried inside the lower portion of the telescope bearing and rigidly mounted on the vertical shaft, takes the thrust of the vertical shaft and keeps it in constant vertical relationship with the lower portion of the telescopic bearing. The thrust collar 55 is pinned to the vertical shaft 48, thus setting the relationship between the shaft 48, the mitre gear 54 and the lower portion 52 of the telescopic bearing. Hence, the thrust collar 55 carries the weight of the shaft 48 and the mitre gear 54. When the slide 31 is raised back into starting position the collar 55 is the means by which the shaft 48 and the gear 54 is raised with the slide.

The bearing 52, which, as indicated above, is fastened to the slide 31 (by means of the bracket 53) is bored out to the point where the collar 55 rests; and the bearing 51 (which is held stationary by the upper structure 42, etc.) has a lower reduced portion milled on its outside surface and integral with the bearing 51. The milled surface of the bearing 51 fits slidably into the bearing 52. Thus, the parts 51 and 52 form a telescopic bearing which allows the part 52 to move downward carrying the shaft 48 with it.

A short horizontal shaft 56 is rotatably mounted in and passes through the bracket 53 and the guide member 31. A 45° mitre gear 57 is rigidly mounted on the rear of the short shaft in continuous engagement with the mitre gear carried on the lower end of the vertical shaft. A small heart-shaped cam 58 is rigidly and eccentrically mounted on the front of the short shaft between a pair of rollers 59, 60, carried respectively on pins 61, 62 mounted on the rear face of the lower slider 30.

The pivot lug 21 is thus reciprocated by power transmitted from the horizontal drive shaft through the gear train 37A, 44, 43, the auxiliary shaft 40, the mitre gears 46, 47, the vertical shaft 48, the mitre gears 54, 57, the short horizontal shaft 56, and the circular cam 58, all of which rotate simultaneously. The rotation of the circular cam causes the rollers 59, 60 and the lower slider to reciprocate horizontally, thus imparting horizontal reciprocation to the pivot lug.

Having considered the means whereby horizontal reciprocation is imparted to the lower and upper sliders, there remains to be described the means whereby the vertical distance between these two sliders may be progressively increased during the winding operation, to the end that the average traverse stroke is progressively decreased and the package with tapered ends is wound.

The upper slider 29 projects through the sides of the housing and on one end is bolted a downwardly-projecting vertical strap 63 which in turn carries a wedge 64 pointing in toward the housing and having an inclined surface sloping in the direction of the housing. Resting on the upper surface of the wedge is an end of a ratchet lever 65 which is rotatably mounted on a horizontal shaft 66 passing through the housing from front to back. A ratchet wheel 67 is rigidly mounted on the shaft 66 and on the upper face of ratchet lever 65 a ratchet pawl 68 is mounted. (See Fig. 6.)

As the upper slider is reciprocated, the wedge is also reciprocated, thus periodically pressing the ratchet lever up and then permitting it to drop. The ratchet pawl carried on the ratchet lever thus periodically engages the ratchet wheel and turns it and the horizontal shaft 66 to which it is attached in a clockwise direction as viewed from the front. (See Fig. 6.)

At the rear end of the shaft 66 a gear 69 is rigidly mounted. This gear meshes with another gear 70 disposed at the outside thereof and mounted rigidly on a horizontal shaft 71 which runs lengthwise of the machine, i. e. parallel to the rocking shaft (see Fig. 4). The shaft 71 also carries a rigidly mounted worm 72. The worm engages a worm wheel 73 disposed on a horizontal axis above the worm and at right angles thereto. The worm wheel is rigidly mounted on a shaft 74 parallel to the upper slider and at about the same elevation but disposed behind it in the machine. On the left end of the shaft 74, as viewed from the front, a pinion 75 is fastened. (See Fig. 5.)

Another horizontal shaft 76 is mounted in a pair of bearings 77, 78 fastened in the housing near the respective extremities of said shaft. The shaft 76 is disposed parallel to, but substantially below, the shaft 74, and carries a pair of pinions 79, 80 which engage respectively a pair of vertical racks 81, 82 mounted on the sliding member 31, upon which the lower slider is mounted.

The sliding member 31 is provided with vertical rails 83, 84 formed integrally therewith on both sides, said rails being slidably mounted respectively in vertical guides 85, 86 which are fastened to the housing 14.

The right end of shaft 76, viewed from the front, carries a rigidly mounted spur pinion 87, and a rotatably mounted sector arm 88. The pinion 87 meshes with idler gear 90, which in turn meshes with pinion 75. (See Fig. 5.) The sector arm slants upwardly to the rear of the machine from the shaft 76, and at its upper end is provided with an arched groove through which a keeper 89 passes. The keeper 89 is mounted on the housing 14 and is adapted to clamp the sector arm to the housing.

About midway upon the sector arm and meshing with the spur pinion 87 on the shaft 76 is an idler pinion 90. The idler pinion also meshes with the pinion 75 which, as indicated hereinbefore, is mounted on the right end of the shaft 74.

On the end of the shaft 74 opposite bearing 78 (on the left) is a hand wheel 91 for turning the sliding member 31 back to an upper position after packages with tapered ends have been wound on the bobbins. The hand wheel 91 is rigidly fastened to the worm gear 73 and rotates with it during the winding operation. At the end of the winding operation it is necessary to return the slide 31 to its starting position and to do this the worm gear must be freed. So the worm is dropped out of mesh by lifting the counterweight 96 which has the cam end 94 supporting the worm in mesh position with worm gear 73. Lifting of the counterweight frees the worm gear (see Fig. 7). The worm gear can then be turned by the hand wheel 91. Through the train of gears at the other end of the shaft 74, i. e., gears 75, 90 and 87, the rack pinions 79 and 80 raise the slide 31 up to starting position.

There remains for description only that portion of the mechanism whereby the means for lowering the sliding member 31 is cut out of the

machine (i. e. when it is desired to wind packages with square ends).

The shaft 71 which carries the pinion 70 and the worm 72 is mounted in a horizontal bearing fastened to a bracket 92 which is rotatable around the shaft 66 on which its inner end is fastened (see Fig. 7). On the lower side and at the outer end of the bracket is a button 93. When packages with tapered ends are to be formed the button is held up by a rest 94 pivoted around a shaft 95 and having a counterweight 96 fastened to it by a lever 97. The counterweight rests on a horizontal shelf 98 fastened to the outside of the housing on the left side of the machine as viewed from the front. When the counterweight is raised to a position slightly above the shelf, the bracket drops and disengages the worm and the worm gear. With the counterweight in this position, the sliding member 31 may be raised by turning the hand wheel.

When packages with tapered ends are to be wound, i. e. when the average traverse stroke is to be progressively shortened as the filaments build up on the bobbins, the pivot lug upon which the main lever is mounted is progressively lowered, so that the ratio of the distance from upper slider to fulcrum lug to the distance from pivot lug to lower end of the main lever is gradually increased. This is accomplished by means of the reciprocating upper slider 29 which periodically, i. e. for each complete rotation of the shaft 37, pushes the wedge 64 in against the pawl lever 65 and thus causes the pawl ratchet 68 to push the sprocket 67 through a fixed number of degrees in a clockwise direction.

If the counterweight 96 is dropped onto the shelf 98, so that the worm 72 engages the worm wheel 73, the rotation of the sprocket 67 will be imparted to the worm wheel through the shaft 66, the pinions 69, 70, the shaft 71 and the worm 72. Rotation of the worm wheel in turn causes the shaft 74 to turn and with it the pinion 75. The rotation of pinion 75 is imparted to the shaft 76 through the idler pinion 90 and the pinion 87. Rotation of the shaft 76 causes the pinions 79, 80 to lower the racks 81 and 82 and with the racks the sliding member 31 which carries the lower slider with the pivot lug 21 mounted upon it.

When the packages have been wound the counterweight is raised and the bracket drops so that worm and worm gear are disengaged. Then by turning the hand wheel so that the direction of rotation of the shaft 74 is reversed, the sliding member 31 is moved up again to the starting position.

It will be noted that as the sliding member 31 is lowered the reciprocation of the lower slider 30 is not interfered with, because the shaft 48 connecting the two sets of mitre gears 46, 47, 54, 57 at the rear of the machine, in effect becomes longer because of the sliding key 49.

The two cams 36, 58 of the apparatus preferably turn in the same direction in the apparatus just described, although this is not necessary. Preferably the various gear ratios are such that the upper and larger cam 36 makes two complete revolutions for every revolution of the lower and smaller cam 58.

The relative size of the upper and lower cams will depend upon the particular pattern of winding desired on the bobbin. In general, however, the cam 36 should have about ten times the throw of the smaller cam.

The formation of a yarn package with cross-wound helices and tapered interlocked ends is illustrated diagrammatically in Fig. 8, which shows how the motion of the cams 36, 58, and the gradual shortening of the stroke affect the "lay" of the yarn on the package. The "lay" of the new yarn in a package in accordance with the invention is illustrated by Fig. 9.

Considering Figs. 8 and 9, it will be observed that the yarn in being wound in a package is first wound around a bobbin from a point A to a point B. The course of the yarn between points A and B is shown by a full line. The yarn is then wound in the opposite direction to a point C on the bobbin, the course of the yarn between B and C being shown by a full line. The yarn next pursues a path from C to D and thence back to E along a course shown by a series of long dashes. The yarn is then wound from point E to point F and thence back to point G, the course of the yarn in this instance being shown by a dot and dash line. Lastly, the yarn is wound from point G to point H and thence back to point I, the course of the yarn from G to I being shown by a line of short dashes.

Fig. 10 shows diagrammatically the tapered interlocked ends of the yarn package brought about by the gradual shortening of the transverse strokes at the same time that alternate strokes are overlapped.

It will be apparent that modifications in the mechanism described hereinbefore may be made by men skilled in the art without, however, departing from the basic concept of my invention.

I claim:

1. In a process in which yarn is wound upon a rotating body while the yarn is reciprocated in a stroke approximately parallel to the axis of rotation of the body to form a package in the form of a series of cross-wound helices, the improvement which comprises progressively reducing the length of the stroke while periodically displacing the position of the stroke alternately in opposite directions substantially parallel to the axis of rotation, whereby sloughing of the yarn from the body during unwinding, by rotation of the package at relatively high speed, is inhibited.

2. In a process in which yarn is wound upon a rotating body while traversing back and forth in a stroke along the body to form a package and subsequently unwound from the package, the steps which comprise progressively shortening the length of the stroke as the yarn builds up to form the package while periodically displacing the position of the stroke in opposite directions along the body so that a package with tapered interlocked ends is formed and thereafter unwinding the yarn by centrifugal force while the package is rotated at a relatively high speed.

3. In a process of winding yarn upon a rotating body while the yarn is reciprocated through a stroke transverse to the length of the yarn and along the body, the improvement which comprises progressively reducing the length of the traverse stroke as the yarn builds up on the body while shifting the position of the traverse stroke back and forth along the body, whereby there is formed a package with tapered interlocked ends having improved washability and greater resistance to sloughing during unwinding.

WILLIAM GEORGE LEA.