Aug. 18, 1953 E. S. BALTHROP, JR 2,649,254

METHOD OF AND APPARATUS FOR WINDING YARN

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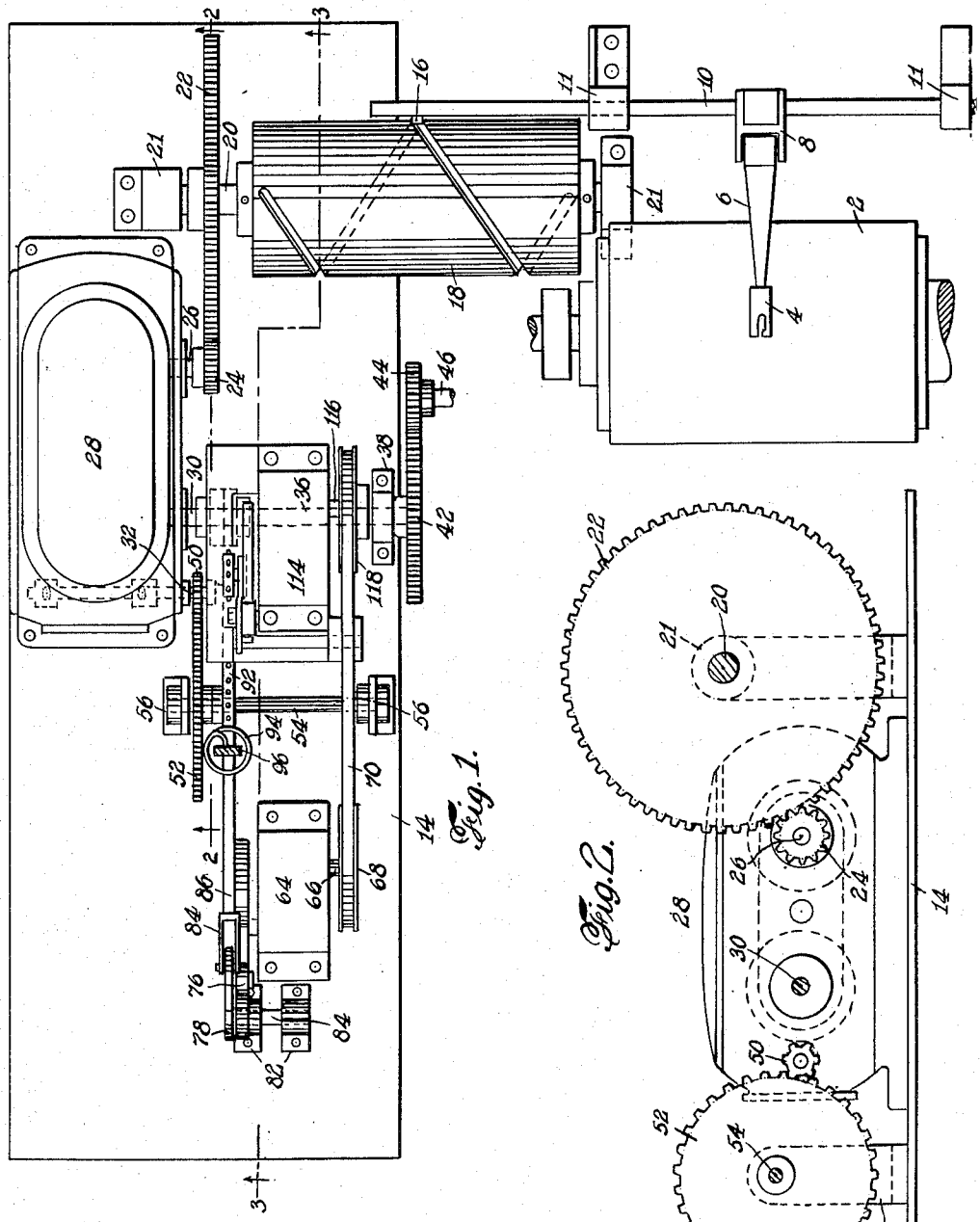


Fig. 1.

Fig. 2.

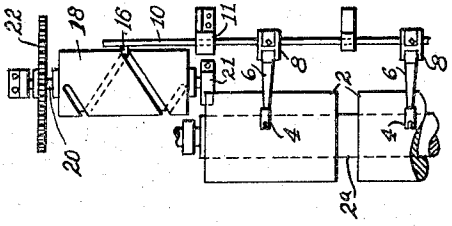


Fig. 11.

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METHOD OF AND APPARATUS FOR WINDING YARN

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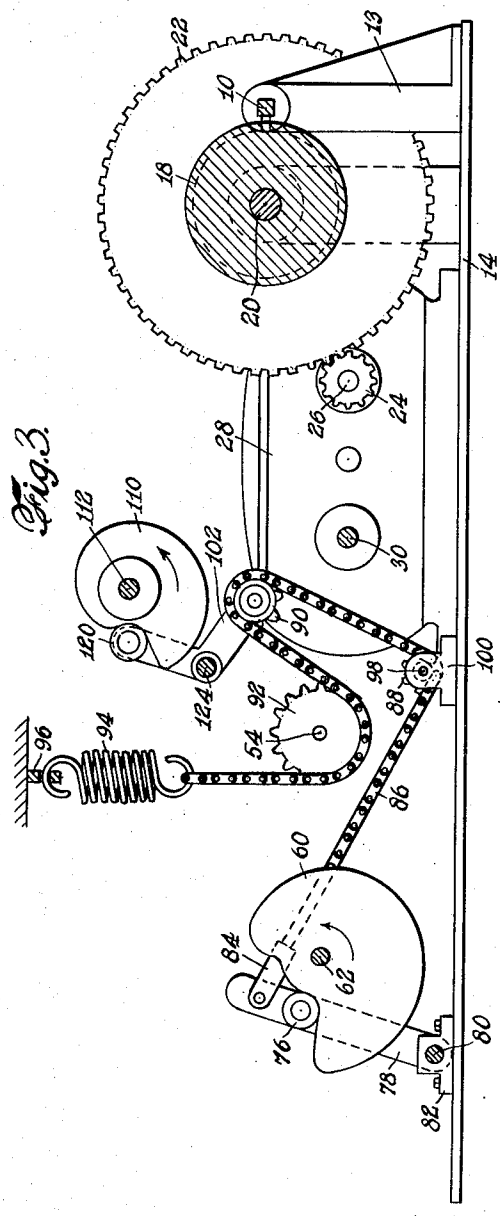


Fig. 3.

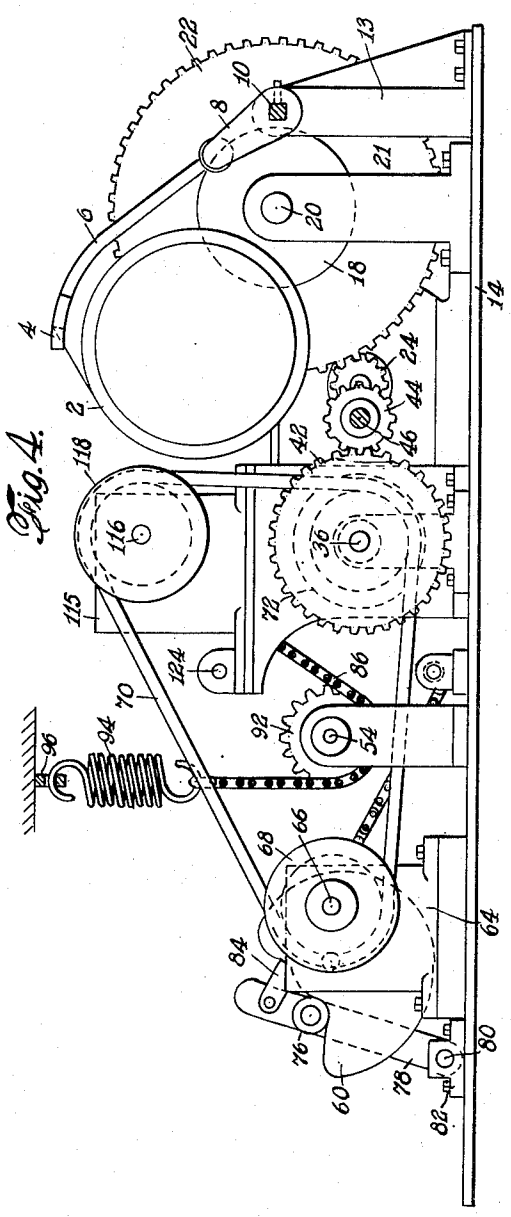


Fig. 4.

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METHOD OF AND APPARATUS FOR WINDING YARN

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Fig. 5.

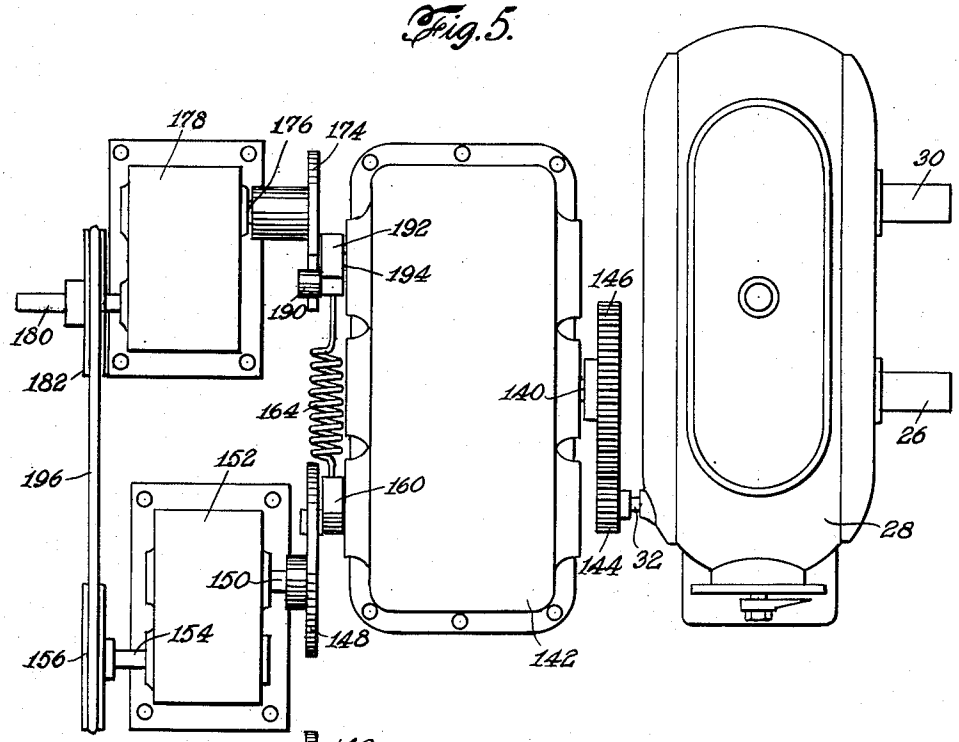


Fig. 6.

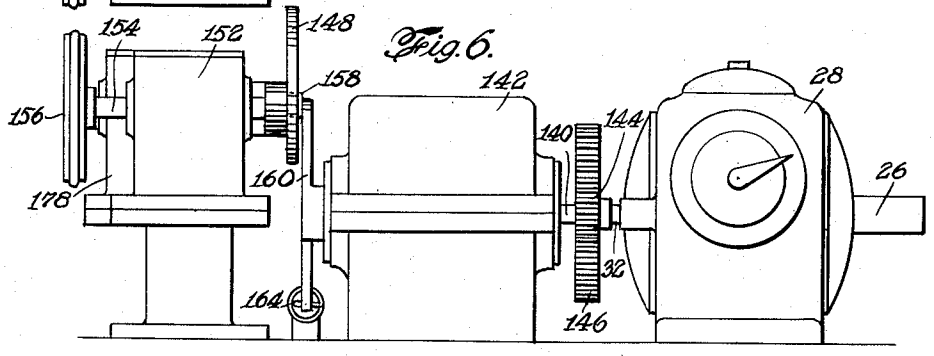
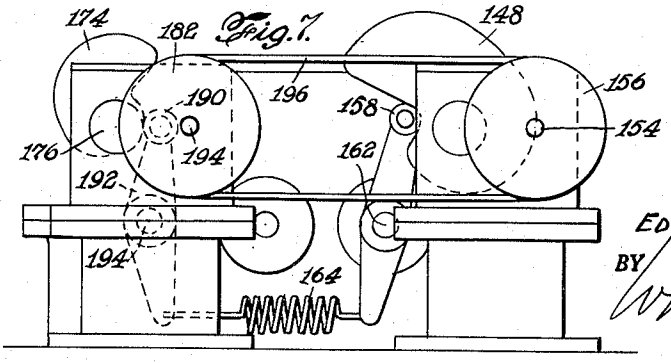


Fig. 7.



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METHOD OF AND APPARATUS FOR WINDING YARN

Filed Feb. 8, 1947 5 Sheets-Sheet 4

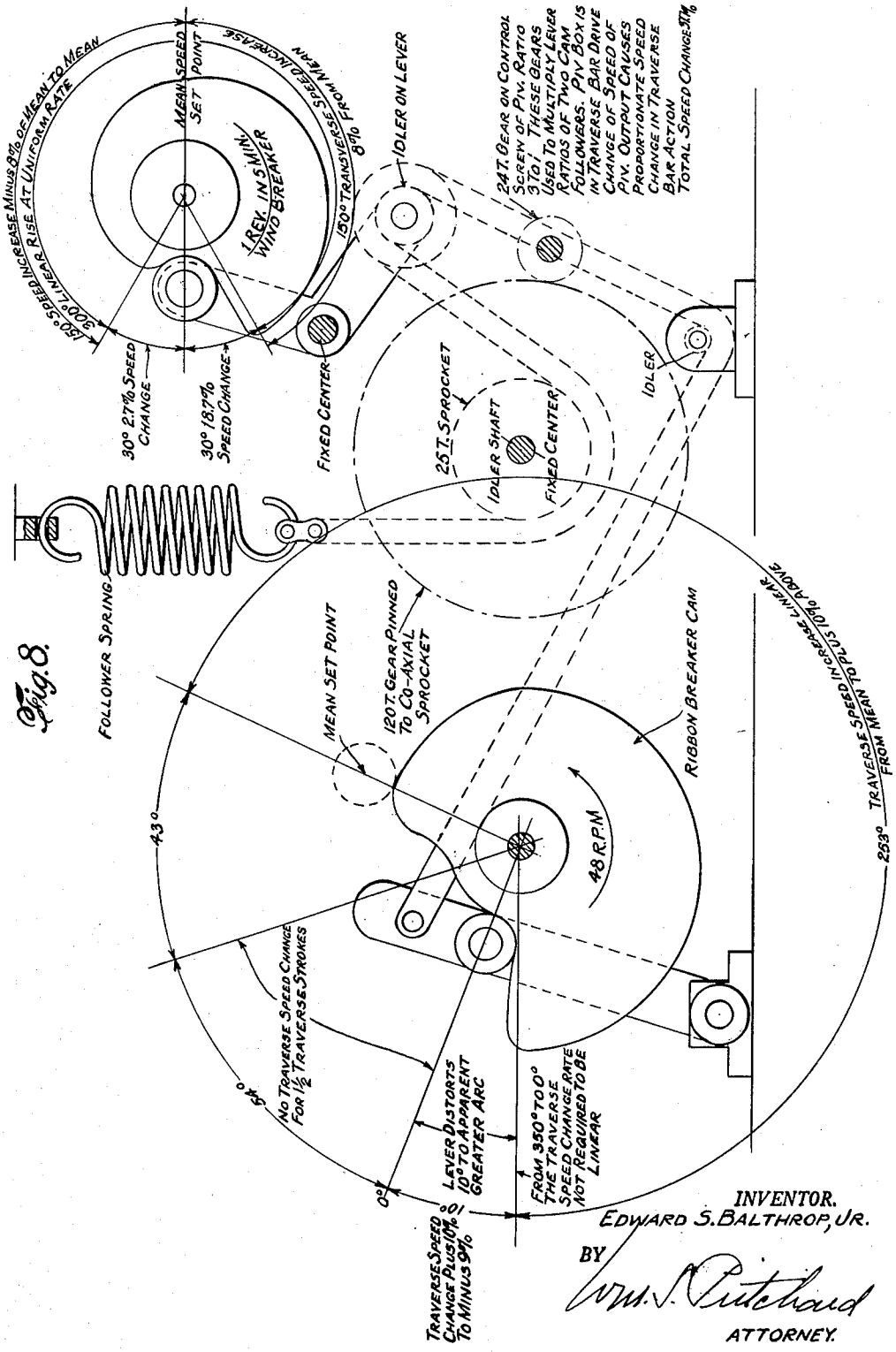


Fig. 8.

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METHOD OF AND APPARATUS FOR WINDING YARN

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Fig. 9.

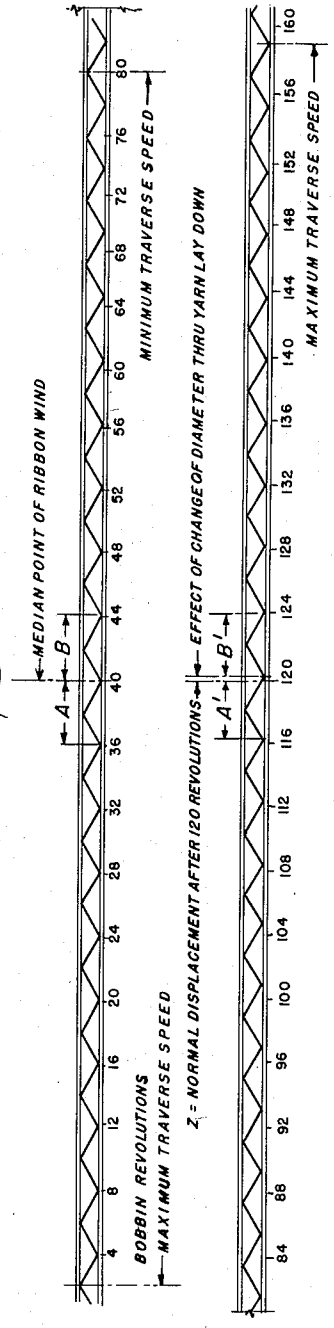
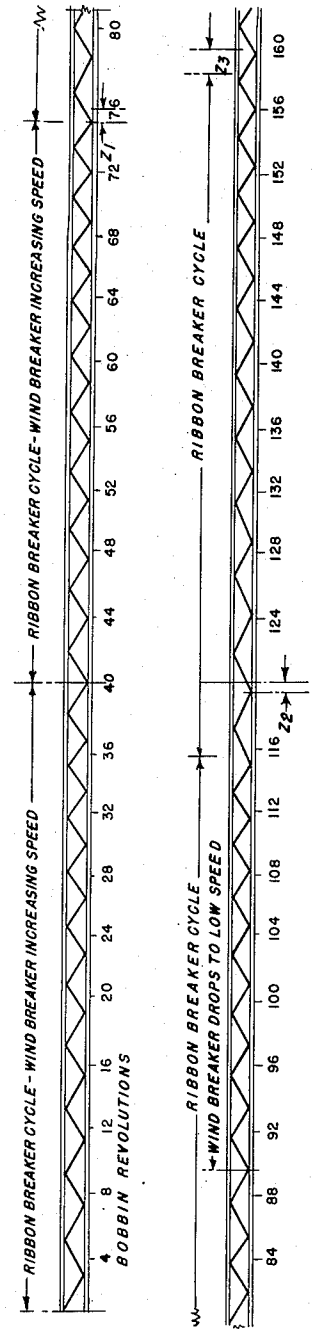


Fig. 10.



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Patented Aug. 18, 1953

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UNITED STATES PATENT OFFICE

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METHOD OF AND APPARATUS FOR WINDING YARN

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Application February 8, 1947, Serial No. 727,345

3 Claims. (Cl. 242—43)

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This invention relates to a new and improved method of and apparatus for winding yarn. More particularly, it relates to a method of and apparatus for producing a smoothly wound package of heavy denier yarn in a form such as a bobbin.

In the winding of threads to a take-up package or bobbin, it is frequently desirable to employ a face drive for the bobbin and a constant thread speed for the yarn supply. The yarn is disposed upon the bobbin by the reciprocating action of a traverse guide. The reciprocating motion is provided to distribute this yarn uniformly upon the bobbin by its lateral motion across the bobbin face. However, the yarn may not be so distributed completely because of the occurrence of numerous bulges or protruding geometric patterns produced by periodic deviation of the nature of thread enrollment from a random to a repetitive path upon the bobbin surface. These patterns, which stand out, may be produced periodically throughout the progress of the winding and result because of the periodic occurrence of certain relations between the changing rate of rotation upon the bobbin in R. P. M. and the constant rate of oscillation of the traverse in strokes per minute.

When a constant thread supply speed is employed, the rate of rotation of the bobbin changes continuously in order that a constant peripheral speed may be maintained, and therefore the relationship between bobbin R. P. M. and traverse frequency changes continuously. The principal repeating pattern of thread enrollment is termed a "ribbon wind." It occurs when the traverse guide lays thread upon the bobbin in the same peripheral location on each succeeding stroke, or when the thread is laid essentially alongside the previous helix, forming a band or ribbon. This is possible whenever the constantly changing speed of rotation of the bobbin adjusts itself to present the same point on the bobbin face to the traverse guide on consecutive revolutions or, in other words, whenever the speed of the bobbin rotation in R. P. M. is a multiple of, or when the traverse speed is a divisor of, the bobbin R. P. M. There can be many of such values, resulting in many of such ribbon winds of varying degrees of severity throughout the winding of the bobbin.

The recurrent patterns are caused not only when the successive helices are laid essentially parallel and adjacent to or on top of the preceding helices producing a primary pattern, but also when harmonics of these fundamental patterns are formed. These harmonics are characterized by the laying of only the second, third or fourth turns and so on repeatedly alongside or on top of the preceding or reference turn. In these wind effects of ribbon-like nature, the turns which should be laid at random are bunched together in a helical band and thereby produce a bulge, leaving those parts of the bobbin periphery lying outside the helical band without benefit of yarn lay-down to increase the diameter of those segments. Also, the crossing points of the turns of this helical band, being of double thickness, accentuate the bulge.

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These ribbon winds handicap proper winding. They represent areas of higher relative compactness than adjacent band-free areas. On face-driven winders, the ribbon-like bulges produce bouncing of the bobbins upon the driving rolls, damaging yarn and causing a loss of speed control due to the uncontrolled skidding between the package and the roll. Also, these relatively higher density areas are objectionable when the yarn in package form is to be treated with appropriate liquids because they require a longer period of time for the penetration of treating liquids. They also serves as planes of cleavage, allowing the portions of yarn above and below to slide axially over each other. Ribbon winds occur with more or less severity in all yarn bobbins wound with a sufficiently large change in the relationship of bobbin and traverse guide speed to permit the necessary coordination unless some mechanism is employed to avoid them. Those packages, and particularly large poundage packages, which change very little in diameter with respect to time, prolong and increase intensity of the ribbon wind when formed.

Conventional methods employed to prevent the formation of these ribbon winds on face-driven packages as well as non-face-driven packages were of two types. Each employed a different type of mechanism. In the first of these, the traverse guide drive was positively connected to the bobbin drive through a compensating mechanism which continuously adjusted the traverse speed at a linear rate to prevent the ribbon-forming coordination. In the case of a non-face-driven bobbin, such as a cone winder, the traverse drive was connected to the yarn package drive with a gear train of a fixed ratio. Such compensation or fixed ratio maintained the value of the quotient of bobbin R. P. M. divided by traverse speed, which may be, for example, a compound decimal fraction in which at least the first two places in the decimal have values other

than zero. In this way, the number of times that any one point on the bobbin periphery was opposed to the traverse guide was negligible.

In the second type, a mechanism called a "ribbon breaker" which changed the traverse frequency in a pulsating manner was employed when it was not desirable to use a positive connection between bobbin and traverse. Such ribbon breakers employed an essentially rectangular rate of change of traverse guide frequency. The amount of change was equal on both halves of the oscillatory cycle and the cycles were of equal period on successive repetitions. Each cycle was very short and had considerable dwell at each repeating cycle. In other words, such ribbon breakers employed essentially a simple harmonic type of motion to produce an essentially simple harmonic rate of change of the traverse frequency and, in consequence, produced a considerable period of essentially zero change of traverse rate at the terminal values of the harmonic motion cycle. Such a ribbon breaker scattered the ribbon winds into segments by changing the ratio of traverse guide oscillation rate to bobbin rotational speed in a manner more rapid than occurred through natural decrease in bobbin speed alone. However, coincidence or superimposing of the segments occurred when the scattered pattern on one ribbon breaker cycle was repeated upon the second cycle with essentially zero change in bobbin diameter as affected the peripheral location of the first turn of yarn in each cycle. As previously mentioned, the coincidence and superimposition of the segments resulted in the objectionable bulges or protuberances.

Additionally, the normal ribbon breakers were not efficient in preventing ribbon wind since it was possible for the ribbon-breaking mechanism to dwell and produce no change in wind during the time in which a ribbon was forming. This was particularly objectionable on large denier wet yarn packages because the proximity of even a few turns of helical coincident yarn resembling a ribbon was sufficient to be objectionable due to their excessive protuberance from the otherwise uniform package or bobbin. In general, the effectiveness of the normal ribbon breaker depended on the conditions of winding, such as average traverse rate to bobbin speed ratio, hereafter called "wind ratio," size of package of yarn, size of yarn wound, and percent of moisture.

In the winding of heavy denier wet yarn upon large packages, the use of gang doffing was imperative on a multiposition machine with the first-mentioned system. Gang doffing with its limitations on processing flexibility was not required with the second system, but the size of thread and the size of yarn package employed were not optimum for good ribbon breaker action and the wind ratio was of a value close enough to unity to be extremely critical. A regular ribbon breaker was ineffective with these conditions.

Wind ratios approaching a value of 7 or less together with the heavy denier thread are very conducive to the formation of bounce-producing ribbons. It is within this range of wind ratio values that it is necessary to operate with wet yarn in order to prevent slumping down of the bobbin shoulders. This prevents selecting less critical ratios in which conventional ribbon breakers are effective.

An object of this invention is to provide a new and improved method of and apparatus for producing a smoothly wound package of yarn.

Another object of this invention is to provide a new and improved method of and apparatus for producing a smoothly wound package of heavy denier wet yarn in the form of a bobbin.

An additional object of this invention is to provide a method of and apparatus for counteracting the formation of the ribbon winds which normal ribbon-breaking mechanisms have been unable to prevent.

A further object of this invention is to provide a method of and apparatus for preventing ribbon winds which may be formed by the conventional ribbon breaker action when it coordinates with the natural thread lay-down point at wind ratios other than those of ribbon winds.

A still further object of this invention is to provide a method of and apparatus for preventing the coincidence or superimposing of ribbon winds that are scattered by regular ribbon breaker action.

A still further object of this invention is to provide a method of and apparatus for utilizing an increased degree of randomness of the traverse motion to disperse recurring patterns of other than normal ribbon wind character which result because of the continuance of winding at an essentially slow changing average wind ratio value.

Other and additional objects will become apparent hereinafter.

The objects of the invention are accomplished, in general, by constantly changing the rate of change of the traverse frequency and constantly varying the duration of the cycle of change during the traverse frequency.

The necessary degree of randomness and extent of range for the values of the wind ratio is provided by the conjoint use of two independent cooperating mechanisms, herein called a "ribbon breaker" and a "wind breaker." Herein, a ribbon breaker is the mechanism which disperses or scatters the successive helices in a ribbon wind into segments; and a wind breaker is the mechanism which gradually changes the wind ratio slowly over a considerable range of at least 1½ full number ratio values independently of the natural change in wind ratio due to the change in the diameter of the package. It is to be noted that this fluctuation of at least 1½ full number ratio values occurs a considerable number of times during the package winding. The wind breaker is independent of the ribbon breaker. To illustrate, based on the figures given in Example I, the bobbin R. P. M. at the start is about 318. The base traverse speed is 42½ strokes per minute. Accordingly, the wind ratio, defined as the bobbin R. P. M. divided by the traverse speed, is about 7.38 at the start. During wind-up the bobbin R. P. M. is diminished as the cake builds up to maintain thread speed constant. After, say, about five minutes the bobbin speed is about 316 R. P. M. The wind ratio would then be (316÷42.5) about 7.33. This natural change is then about 0.05. However, the traverse speed is changed in accordance with this invention, as shown in Example I, to a maximum of 58.5 strokes per minute. The wind ratio, accounting for this change in traverse speed, is (316÷58.5) about 5.40. The difference (7.38—5.40) is 1.98 and subtracting 0.05, the natural change, the change ratio, in-

dependent of this natural change, is 1.93 which is more than 1.5 full number ratio value.

By changing the wind ratio slowly over a considerable range, scattered ribbon segments are not superimposed to form bulges by the recurrent actions of the ribbon breaker. Protuberant crossings characteristic of continued winding in one particular ratio at a value close to but not within the range of the ribbon wind are interspersed with other winds of similar characteristics but which have their bulges located in other points on the periphery, with the result that such intermingling smooths out the bobbin contour.

The combination of the ribbon breaker and the wind breaker of this invention produces a curvilinear rate of change of traverse frequency with essentially zero dwell at the reversal points and changes the duration of the cycle of repetition or period in successive cycles. This curvilinear rate of change and its irregular increment of change eliminate the ribbon effect which the conventional ribbon breakers with their constant rate of change and constant increment of change will tend to produce by virtue of their own action.

In carrying out the invention, yarn is directed onto a face-driven bobbin by a traverse guide oscillated laterally across the face of the bobbin by a cam that is driven by a mechanical variable speed drive in which the speed is varied in accordance with the conjoint action of the ribbon breaker and wind breaker of this invention. The variable speed drive, in one embodiment of the invention, is a P. I. V. drive wherein the speed of the output shaft is varied by oscillating the speed-control shaft thereof in accordance with the action of the conjoint action of the ribbon breaker and wind breaker of this invention. If desired, the conjoint action of the ribbon breaker and the wind breaker can be amplified by a gear train or a differental gear, in which event the output shaft of the gear train or differential gear is coupled to the speed-control shaft of the P. I. V. drive.

The ribbon breaker action is provided by means of a timing mechanism, such as a ribbon breaker cam and a ribbon breaker cam follower, and the desired rates of change in the rate of rotation and extent of rise of the ribbon breaker cam are translated into oscillating motion in the follower shaft. The contour of the ribbon breaker cam is such as to produce a short period, high intensity, change of rate, oscillatory ribbon breaker action to change the traverse rate in the same manner as is shown by the irregular periphery of the ribbon breaker cam in Figure 8. The design of the ribbon breaker cam is also such that essentially instantaneous cycle reversals are obtained.

The wind breaker action is also provided by a timing mechanism, such as a wind breaker cam and wind breaker cam follower. The contour of the wind breaker cam is such as produces a change in traverse speed of an intensity approximately equal to but of much longer duration of cycle than that of the ribbon breaker cam. The contour of the wind breaker cam is such that essentially instantaneous cycle reversals are obtained.

The two cam follower oscillations, which vary as to time and degree of rotation, are each connected to a shaft which is geared to the control shaft of the P. I. V. drive. By this arrangement, either the ribbon breaker cam or the wind breaker cam can move the P. I. V. control shaft independently of the other, but the resulting motion caused by the combined effect has a rate and direction of rotation which is an instantaneous sum or vector resultant of the directions and magnitudes of motion of the wind and breaker motions. Thereby, the motions are said to be added geometrically. This geometric sum of the traverse speed increments is always positive or tends to increase the speed of the traverse at a rate sufficiently high to scatter a ribbon wind except for the essentially instantaneous reversals, which are negligible.

The ribbon breaker cam rotates more rapidly than the wind breaker cam. An acceptable rate will be determined by the size of the yarn being wound on the bobbin. The ribbon breaker cam may or may not provide for dwell at the end of the throw, but it does provide a gradual rise in the contour followed by a quick return to the follower starting point after reaching the maximum rise. Additionally, provision for a faster than normal rate of rise from the low position of the follower to some intermediate value may be made to guard against lost motion dwell in the P. I. V. control shaft due to wear.

The wind breaker cam employs the same essential features of contour of the ribbon breaker cam. It rotates, however, at a slower rate and has a different increment of rise than the ribbon breaker cam. As in the case of the ribbon breaker cam, the wind breaker cam also has its increment of rise and rate of rotation dictated by the particular type of production being wound on the bobbin.

The wind breaker cooperates with the ribbon breaker to give sufficient randomness to its action with reference to both duration and rate to more effectively break a ribbon. The wind breaker also distributes patterns of other than ribbon-like nature by means of its longer cycle and it is assisted by the cooperation of the ribbon breaker to give it (the wind breaker) more randomness. The increased randomness prevents ribbon winds of the type which may be formed by the conventional ribbon breaker action when it coordinates with the natural progression of the thread lay-down at wind ratios other than those of ribbon winds.

The invention will be more clearly understood by reference to the following detailed description when taken in connection with the accompanying drawings, in which:

Figure 1 is a plan view of the invention, showing only one winding position;

Figure 2 is a section taken on the line **2—2** of Figure 1;

Figure 3 is a section taken on the line **3—3** of Figure 1;

Figure 4 is an elevation of Figure 1;

Figure 5 is a plan view of a modified form of the invention, the bobbin, the traverse and the traverse cam being omitted for convenience;

Figure 6 is an end view of the apparatus shown in Figure 5;

Figure 7 is a side view of the apparatus shown in Figure 5;

Figure 8 is a schematic arrangement illustrating the contours of the ribbon breaker and wind breaker cams.

Figure 9 illustrates the yarn lay down occurring when a conventional breaker is used alone; and

Figure 10 illustrates the yarn lay down occurring when the wind and ribbon breaker combination of this invention is used and this figure

shows the irregular increment of change resulting in elimination of ribbons.

Fig. 11 shows the arrangement for multiple winding positions.

Referring now to the drawings, wherein like reference numerals designate like parts, the reference numeral 2 designates a bobbin which is rotated about its horizontal axis by constant speed face-driving rolls of the well-known type 2a, as shown in Figure 11. A thread, not shown, is fed from a suitable source of supply to a traverse guide 4 which is carried at one end of a traverse arm 6. The other end of the traverse arm 6 is secured to a traverse support 8 which, in turn, is secured onto a traverse bar 10. The traverse bar 10 is slidably mounted in a plurality of traverse guides 11 arranged in spaced relationship. Each traverse guide is at the top of a support 13, which is appropriately secured at its bottom to a base 14.

It is to be understood that the above is one position of a machine wherein there is a plurality of bobbons driven from a single series of face-driving rolls at constant speed, and each bobbin receives yarn as a single end from a warp sheet of a plurality of ends traveling at identical speeds. In such machine, a traverse guide cooperates with each bobbin but the traverse bar is common to all.

The traverse bar 10 is provided with a follower 16 which cooperates with a traverse cam 18 of such design that during operation the traverse bar 10, and hence the traverse guide 4, are reciprocated laterally across the face of the bobbin 2. The traverse cam 18 is secured onto a shaft 20, the ends of which are rotatably mounted in bearings 21. A gear 22 secured to the shaft 20 is in cooperative relationship with a gear 24 carried on the output shaft 26 of a P. I. V. drive, generally indicated by the reference numeral 28. The reference numeral 30 designates the input shaft and the reference numeral 32 designates the control shaft of the P. I. V. drive. Since the details of construction of the P. I. V. drive are well known, and such details of construction thereof form no part of this invention, a detailed description is not believed necessary. The input shaft 30 of the P. I. V. drive 28 is coupled to a shaft 36 which is appropriately mounted in bearings 38 carried by the base 14. A gear 42 on one end of the shaft 36 is driven by a gear 44 carried at the end of a motor shaft 46.

From the description of the apparatus thus far, it is manifest that the traverse cam 18 will be driven by the output shaft 26 of the P. I. V. drive and the traverse bar 10 will be oscillated at a frequency determined by the rate of rotation of the P. I. V. shaft 26 and the gears 22 and 24. The rate of rotation of the P. I. V. output shaft 26 is controlled in the well-known manner by the control shaft 32. The control shaft 32 is oscillated in accordance with the actuation thereof by the means constituting this invention, as hereinafter described.

The P. I. V. control shaft 32 is provided with a gear 50 which is in cooperative relationship with a gear 52 carried on an idler shaft 54 rotatably mounted in bearings 56 mounted on the base 14. The shaft 54 is oscillated by means, hereinafter described, whereby the control shaft 32 of the P. I. V. drive is moved in accordance therewith.

A ribbon breaker cam 60 is rotatably mounted on an output shaft 62 of a reducing gear train (not shown) in the gear box 64, which is appropriately mounted on the base 14. The input shaft 66 of such gear train is provided with a flanged pulley 68 which is driven by a V-belt 70 from a pulley 72 on the main drive shaft 36. A cam follower 76 is carried on an arm 78, the lower end of which is pivotally mounted on a shaft 80 mounted in bearings 82 secured to the base 14. Adjacent its top, the arm 78 is pivotally secured between the legs of a U-shaped link 84. The bottom of the lnk 84 is secured to one end of a chain 86 which, as shown in Figure 3, passes beneath an idler sprocket 88, over a sprocket 90, around an idler sprocket 92, and the other end thereof secured to one end of a spring 94, which is secured at its other end in an appropriate support 96. The sprocket 88 is mounted on a shaft 98 rotatably mounted in bearings 100 on the base. The sprocket 90 is mounted on one arm of a lever 102, which will be hereafter more fully described. The sprocket 92 is secured onto the shaft 54.

A wind breaker cam 110 is rotatably mounted on an output shaft 112 of a reducing gear train in the gear box 114 appropriately secured on a support 115. The input shaft 116 is provided with a flanged pulley 118 which is driven by the V-belt 70. A wind breaker cam roller 120 cooperates with the wind breaker cam 110. The wind breaker cam roller 120 is carried at one end of the lever 102 which is pivotally mounted at 124.

It is manifest that the control shaft 32 of the P. I. V. drive 28 will be oscillated in accordance with the oscillations of the shaft 54, which are amplified by the gears 50 and 52. The oscillations of the shaft 54 are the result of the geometric addition of the motions of the ribbon breaker cam 60 and the wind breaker cam 110, as hereinbefore explained.

The rate of rotation and the contour of the ribbon breaker cam 60 are such as to produce a short period, high intensity change of rate, oscillatory ribbon breaker action to change the traverse rate in the same manner and also to provide essentially instantaneous cycle reversals (see Figures 4 and 8). The wind breaker cam 110 is rotated at such a rate and is of such a contour as to produce a change in traverse speed of an intensity approximately equal to but of much longer duration than that of the ribbon breaker cam. The wind breaker cam is also of such design that essentially instantaneous cycle reversals are obtained. In general, the wind breaker cam 110 employs the same essential features of contour of the ribbon breaker cam 60, but it operates at a slower rate and has a different increment of rise than the ribbon breaker cam 60. In both cams, the respective increments of rise and the rate of rotation thereof are dictated by the particular type of production being wound on the bobbin.

The contour of the ribbon breaker and wind breaker cams is generally shown in Figure 8, wherein mean speed denotes the specified value of the traverse bar cam when the wind breaker cam is at the set point and the ribbon breaker cam is at the set point corresponding to 107° past the 0° point. Mean speed equals the number of revolutions per minute of the cam of the traverse bar when the wind breaker cam is in the mean speed position and the ribbon breaker cam is starting through the linear 253° travel.

The arrangement is such that the change in P. I. V. causes a proportionate speed change in

the traverse bar action, the total speed change being 37.7%.

In a modified form of the invention, the traverse bar is varied in its rate of oscillation through the action of a P. I. V. drive which is controlled by a ribbon breaker and wind breaker through a differential gear drive. In such embodiment, the output shaft of the differential gear drive is connected to the control shaft of the P. I. V. drive. The ribbon breaker follower is attached to a shaft of a differential gear of the differential gear drive while the wind breaker cam is also coupled to the differential gear. The arrangement is such that the oscillation of either of the cam followers by the respective cam produces partial rotation of the output shaft of the differential. Preferably, such rotation of the output differential shaft is amplified by a gear set before it is transferred to the P. I. V. control shaft.

Referring now to Figures 5–7, wherein the modified form is shown, the input shaft **30** of the P. I. V. drive **28** is driven as in the previously described modification, and the output shaft **26** of the P. I. V. drive **28** drives the traverse cam **18**, as also described in the previous embodiment. The control shaft **32** of the P. I. V. drive **28** is driven from the output shaft **140** of a differential gear drive, generally designated by the reference numeral **142**, by the gear sets **144** and **146**. Since the details of construction of the differential gear drive are well known, and such details of construction do not form any part of this invention, it is deemed unnecessary to describe the differential gear drive in detail.

A ribbon breaker cam **148** is secured to the output shaft **150** of a speed reducer **152**, the input shaft **154** of which carries a flanged pulley **156**. A ribbon breaker cam follower **158** is carried at the upper end of a lever **160** which is secured to a shaft **162** of a differential gear of the differential gear drive. The lower end of the lever **160** is secured to one end of a spring **164**.

A wind breaker cam **174** is rotatably mounted on the output shaft **176** of a speed reducer **178**, the input shaft **180** of which is provided with a flanged pulley **182**. A wind breaker cam follower **190** is carried at the upper end of a lever **192** which is secured to a shaft **194**, which is coupled to the differential gear in the differential gear drive **142**.

A belt **196** passing over pulleys **156** and **182**, and which is driven from the input shaft **30** of the P. I. V. drive in any convenient manner, operates the speed reducers **152** and **178** at constant speed.

In this embodiment, the wind breaker cam has a cycle of 5 minutes and changes the speed of the P. I. V. output 24% when the ribbon breaker cam is stationary. This gives ±12% change from mean speed. The ribbon breaker cam speed is 4 R. P. M. and it changes the P. I. V. output speed 12½% when the wind breaker cam is stationary and is cut to give a cycle as follows: Low point to a point 35° of rotation to give a P. I. V. increase of 4½%, not of necessity a linear motion; from 35°–350°, there is a straight line motion, giving a speed increase to the P. I. V. output of 8%; from 350°–360°, the speed is returned to the starting value. The 4½% speed increment in cam contour is to pick up P. I. V. control screw backlash.

The following specific examples are given to illustrate certain specific embodiments of the invention, it being understood that the invention is not restricted thereto:

Example I

On each of a plurality of bobbins, 6'' in diameter and 10'' in length, without heads, and driven from a single series of face-driving rolls at constant speed of 6,000'' per minute, is wound an 1100-denier rayon yarn, of either zero twist or twisted yarn with 150%–300% moisture as a single end from a warp sheet formed of a plurality of such yarns travelling at identical speed, to form a package in which the final bobbin diameter is approximately 9.5''.

The ribbon breaker cycle is 12.5 seconds as determined by a rate of rotation of the ribbon breaker cam of 4.8 R. P. M. The speed change consists of zero change for approximately 1.8 seconds; a 9% increase in approximately 1.5 seconds; a uniform rate increase of 10% in approximately 8.8 seconds; and a decrease to the initial value in the remainder of the 12.5 seconds. The dwell is to provide approximately 1½ traverse strokes at zero speed change for the ribbon breaker, permitting the lead in the helix angle to be shifted to the opposite shoulder of the bobbin. The rise of 9% in 1.5 seconds is to pick up the lost motion in the mechanical linkage which might develop through wear. The increase in speed of 10% in 8.8 seconds is the important speed change range and the quick return is provided as required, for the reasons previously explained.

The wind breaker has a complete cycle of speed increase and decrease in 5 minutes. This speed change is distributed as follows: 25 seconds speed increase, giving 2.7% change in traverse speed, at any rate, linear or otherwise; 4.17 minutes speed increase at an essentially uniform rate, giving a 16% change in traverse rate; and finally, a reversal to the cam starting point, giving an 18.7% change in traverse rate in 25 seconds.

The base traverse speed is selected as 42½ strokes per minute since it has been shown experimentally that this lower speed can be used if the subsequent change is rapid. The maximum traverse speed then becomes (42½)

$$(9\%+10\%+16\%+2.7\%)+42\tfrac{1}{2}=58\tfrac{1}{2}$$

strokes per minute.

Since the speeds of rotation of the two cams are dissimilar, it will be seen that the overall sum of instantaneous value of the traverse speed varies on successive ribbon breaker cycles. It will also be seen that the length of the ribbon breaker cycle varies because of the effect of reversal of the wind breaker.

In Figure 9 the yarn laydown using a conventional breaker is shown. As can be seen, A, B, A' and B' are equal to each other. Thus, the successive layer of yarn is directly on top of the previous laydown and the median point of a ribbon is formed.

In Figure 10 is shown graphically the yarn laydown occurring in several ribbon breaker cycles during which cycles the wind breaker speeds are changing. There is an irregular increment of change and ribbons are eliminated.

Packages of wet yarn containing the equivalent of 4 to 7 pounds of dry yarn wound in this manner possessed smooth uniform surfaces.

Example II

Winding of 1100–denier rayon yarn, with 150%–300% moisture at a speed of 3600'' per minute and upon 6'' diameter x 10'' long bobbin cores, without heads, and having a yarn build-up to 9½'' diameter.

The equipment is the same as in Example I,

except that the basic starting speed of 42½ strokes per minute is changed to give the same wind ratio value at 3600'' per minute as obtained with 42½ strokes on 6000'' per minute. This is 25½ strokes per minute. The cycle times of both ribbon breaker and wind breaker can be the same or can be extended an amount equal to the ratio of the speeds making the ribbon breaker cycle 2.8 seconds and the wind breaker 7.5 minutes. The speed change increments percentagewise are retained as well as the cam contours.

Example III

Winding of 2200-denier rayon yarn, with 150%–300% moisture at 3600'' per minute on 6'' diameter x 10'' long bobbins producing a finished package size of 9½'' diameter. The equipment is the same as in Example I, except that the cycles and increments of change of the traverse bar speed as determined by the ribbon and wind breakers are changed.

Since the rate of yarn deposit is established in Example I for 1100-denier yarn at 6000'' per minute and the wind breaker cycle is based on the length of duration of a ribbon wind at this rate of build-up, the value must be changed when winding at a different speed and denier. Therefore,

$$5\times\frac{6000}{3600}\times\frac{1100}{2200}=4.2 \text{ minutes}$$

The percentage of change of speed and the cam contour are the same for the wind breaker as in Example I. It is permissible to employ a 5 minute cycle.

The ribbon breaker has sufficient randomness for wide spacing of either denier and is adjusted to combine with the wind breaker to give a level of starting speed for the traverse bar speed change range which will give the same wind ratio value as given in Example I. Therefore, the basic speed becomes

$$42\tfrac{1}{2}\times\frac{3600}{6000}=25\tfrac{1}{2} \text{ strokes per minute}$$

Example IV

Winding of 300-denier rayon yarn, with 150%–300% moisture at 6000'' per minute on 6'' diameter x 10'' long cores to a finished diameter of 9½'' using no heads on the bobbins.

The equipment is the same as in Example I, except that the traverse speed change cycle times of the ribbon and wind breaker units are altered. The basic traverse speed remains at 42½ strokes per minute.

The rate of yarn build-up for 1100-denier at 6000'' per minute is compensated for by a 5 minute wind breaker cycle. Since 300-denier builds up 3.67 times less rapidly, the cycle should be 5×3.67, or 18⅓ minutes.

Since the traverse speed change rate must be at least 20% per minute and the average speed change of the ribbon breaker-wind breaker combination is of this approximate value when the wind breaker cycle is lengthened, the ribbon breaker cycle and increments of change remain the same as in Example I.

Since the effect of the wind breaker upon the cycle length of the ribbon breaker is felt less often because of the lengthening of the wind breaker cycle, the ribbon breaker cam must be driven from the traverse bar P. I. V. variable speed shaft so arranged that the cycle time of 12.5 seconds is experienced when the wind breaker is at the low speed value. Thereby, the variation in wind breaker in changing the traverse speed also changes the speed of rotation of the ribbon breaker cam and, therefore, its length of cycle.

In the examples, the use of rayon yarn of 150%–300% moisture has been set forth. The invention is equally effective on either moist or dry yarn, or with yarns other than rayon, or strands of whatever nature.

The range of package sizes described is based on a 6'' diameter core with a 10'' length, but the bobbins can be any size or length as long as the principles employed in setting up the operation of the combination for 1100-denier yarn on the stated size of package are followed. For example, the selected length of time or duration of the wind breaker cycle and its increment of change is based on fundamental principles that can be applied to any size of package. Similarly, the ribbon breaker is based upon a 20% per minute rate of change for a shorter than 1 minute duration to keep the total increase in speed low. Also, the minimum speed of traverse is determined by the minimum helix angle expressed as wind ratio which can be used with a given yarn type, and this will not vary greatly with the size of the yarn package selected. With wet rayon, this is approximately 7 to 1 wind ratio.

Although the means for accomplishing the changes in speed described in the examples is entirely mechanical, it may be hydraulic, electrical or mechanical, or any combination of these which will cause the speed of oscillation of the traverse guide to vary as described. Instead of a P. I. V. drive, other drives, such as a direct current motor with the ribbon and wind breaker oscillations controlling field resistors which control the speed, can be used. Capacitance control of the firing of a thyratron rectifier or inductance control can be employed to vary the current to the motor, the change in capacitance or inductance being accomplished by the wind and ribbon breakers which, in turn, may be electronic capacitance timers.

The drives for the timing devices, such as cams, may be derived from any constant speed source. To obtain more effective ribbon breaking action, it is desirable to drive the ribbon breaker cycling device from the variable speed side of the traverse drive as it is coupled to the traverse cam. It is not imperative except as stated in Example IV.

Although the examples disclose the use of face-driven packages, the invention can be used as a substitute for the less effective conventional ribbon breakers on any textile or other strand-winding machine which employs multiple positions with a common drive and a common traverse, as for example an uptwister or a bobbin bucket-spinning machine where exact wind or ratio does not characterize the winding.

Since it is obvious that many changes and modifications can be made in the above-described details without departing from the nature and spirit of the invention, it is to be understood that the invention is not to be limited thereto except as set forth in the appended claims.

I claim:

1. In a yarn-winding machine having a plurality of winding units, a ribbon breaker and a wind breaker with a common drive and a common oscillating traverse, the combination comprising means for imparting a short period of high intensity change in the oscillating action of said ribbon breaker; a second means for producing a change in the action of said wind breaker

of approximately the same intensity as said ribbon breaker but of longer duration; and means to transmit the geometric addition of the change of said first means and the change of said second means to said traverse.

2. In a yarn-winding machine having a plurality of winding units with a common drive and a common oscillating traverse, the combination comprising a variable speed-control mechanism for driving said traverse; a ribbon breaker; a wind breaker; means for varying the speed of said ribbon breaker; means for varying the speed of said wind breaker; and means to vary the speed of said variable speed mechanism in cooperation with said means for varying the speed of said ribbon breaker and with said means for varying the speed of said wind breaker to produce random winding of said yarn.

3. In a yarn-winding machine having a plurality of winding units with a common drive and a common oscillating traverse, the combination comprising a variable speed-control mechanism for driving said traverse; a ribbon breaker; a rotating cam for imparting a short period of high intensity change of rate in the oscillating action of said ribbon breaker; a wind breaker; a second rotating cam for producing a change in speed of said wind breaker of approximately the same intensity as the said change in speed of said ribbon breaker but of longer duration; and means to vary the speed of said speed-control mechanism in accordance with the geometric addition of the said change in speed of said ribbon breaker and the said change in speed of said wind breaker.

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