March 10, 1964 G. L. FLANIGAN 3,123,968

YARN WINDING APPARATUS

Filed Dec. 3, 1959 3 Sheets-Sheet 1

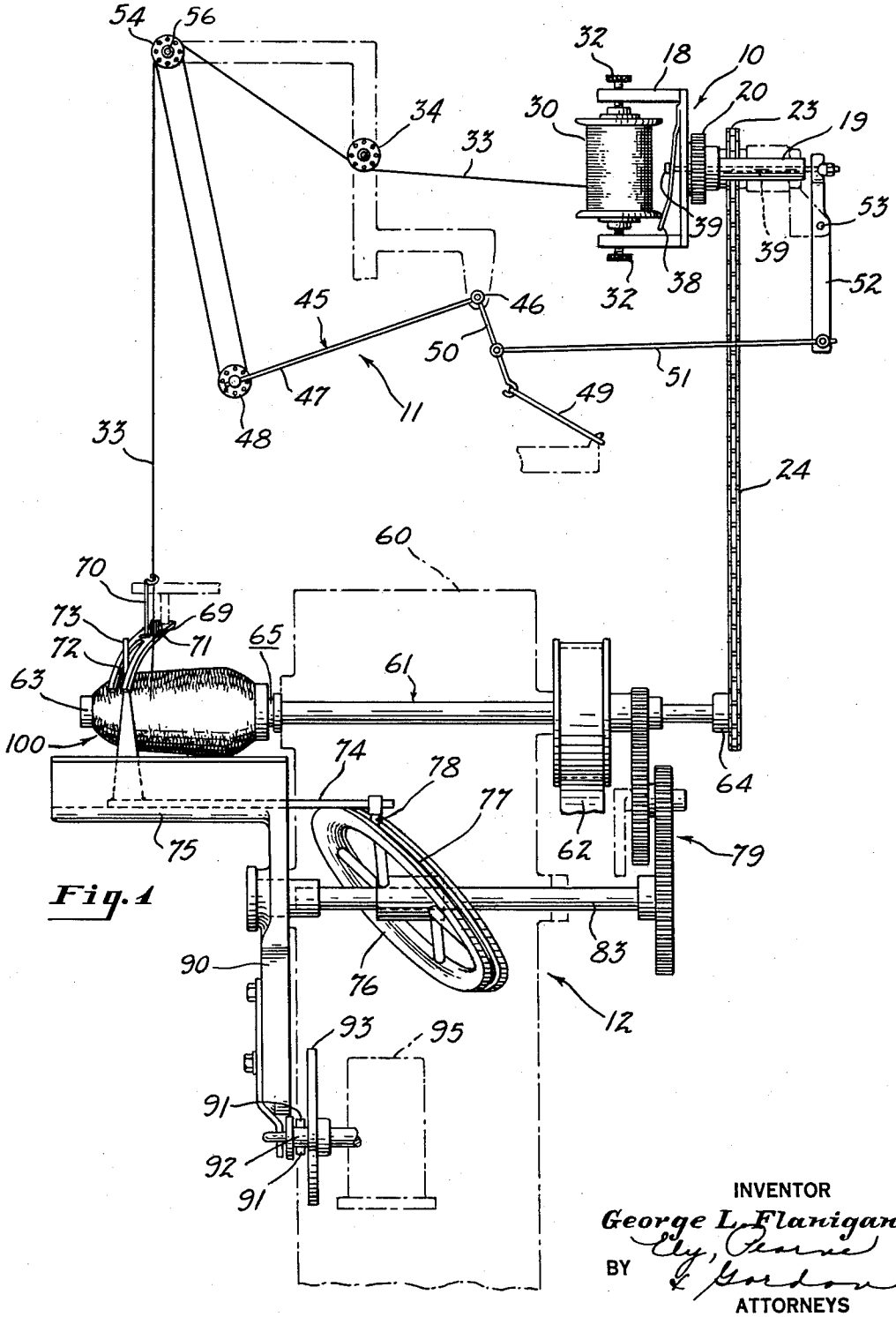


Fig. 1

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YARN WINDING APPARATUS

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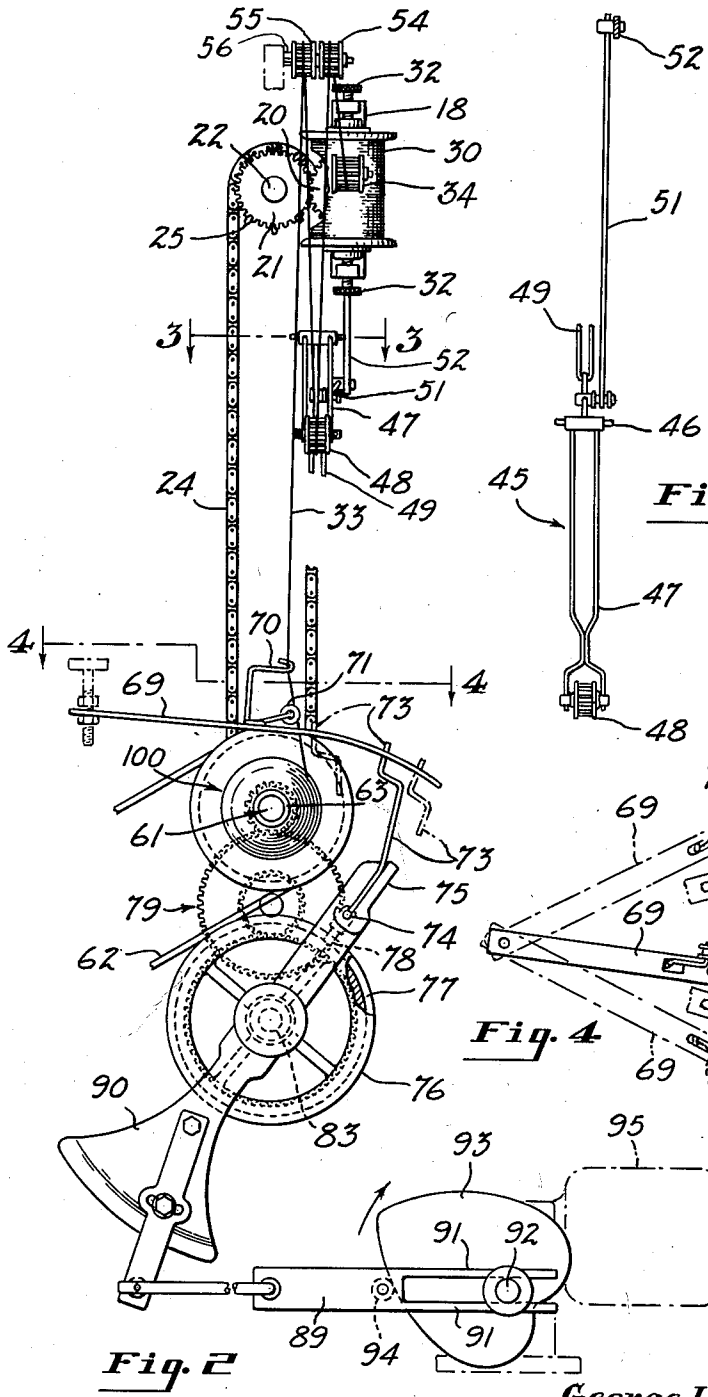


Fig. 2

Fig. 3

Fig. 4

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YARN WINDING APPARATUS

Filed Dec. 3, 1959 3 Sheets-Sheet 3

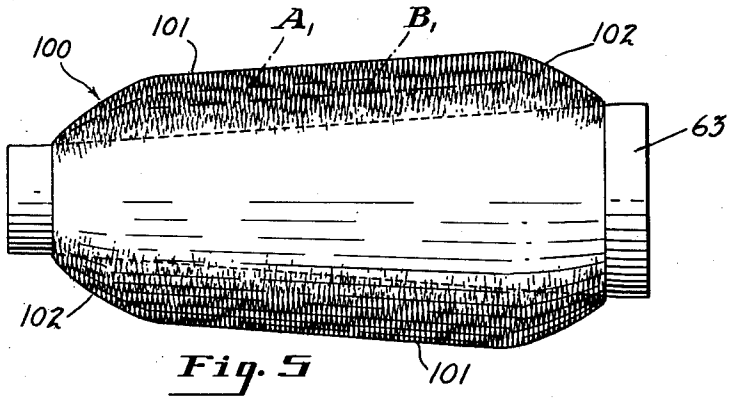


Fig. 5

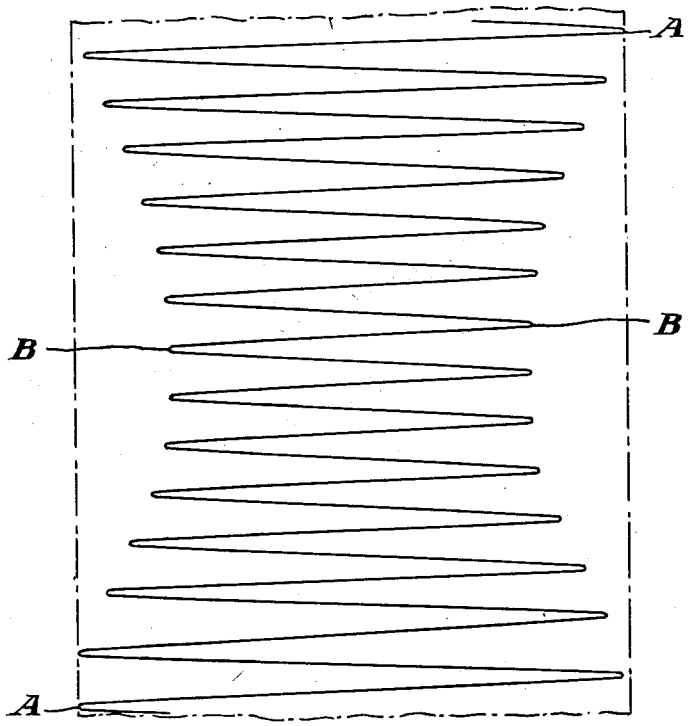


Fig. 6

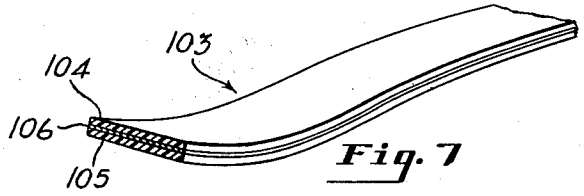


Fig. 7

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3,123,968

YARN WINDING APPARATUS

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Filed Dec. 3, 1959, Ser. No. 857,172
14 Claims. (Cl. 57—62)

This invention relates generally to the art of winding yarn and thread into packets from which the yarn is subsequently removed by overend take-off.

More particularly, the invention is concerned with the provision of a novel apparatus for winding a yarn packet in which a flat yarn is wound with an induced, predetermined, substantial twist about its longitudinal axis so that the yarn will exhibit no appearance of twist when it is subsequently unwound from the packet by overend take-off.

The invention is also particularly concerned with a soft, uniquely wound yarn packet having substantially equal coil compression and density and with the apparatus for forming the same, the packet being such as to minimize the tendency of concentric strata of yarn in the packet to "slough off," that is, drop to the bottom of the packet when the packet is placed on end. This packet is shown and described as a "pineapple" cone wound with a flat, monofilament yarn, although it is to be understood that the packet can be wound with round as well as flat yarns.

It has long been recognized in the weaving and knitting arts that it is more than advantageous, but practically necessary, to feed the yarn to knitting machines, warp beams, bobbin winders, etc. by "overend" withdrawal from a supply packet on which the yarn is circumferentially wound, that is, unwinding the packet by holding the packet stationary and withdrawing this yarn in a direction substantially parallel to the axis of the packet. In this way the inertial force of the mass of yarn remaining in the packet and the mass of the core and supports for the packet will not be imparted to the moving thread, as it would be if the yarn were unwound by revolving the packet. For example, if the thread were fed from a revolving spool or bobbin which has its axis perpendicular to the direction of yarn withdrawal, the abrupt starting or accelerated demand of the machines can often cause the thread to overstretch or break because of the counteracting force exerted by the accelerated spool. Likewise, if the machines were stopped or the yarn broke, the overrun of the rotating spools would continue to unreel the yarn, thereby causing it to back-lash and tangle.

Overend withdrawal of yarns wound circumferentially about the axis of a packet necessarily imparts a twist in a direction opposite to that in which the yarn is unwound. This result of overend withdrawal is usually regarded as unimportant or an advantage in handling ordinary spun staple and thrown multi-filament yarns, since the twist thus imparted can become a final step in the spinning or throwing of the yarn. It becomes a particularly serious problem, however, in connection with flat, unspun metallic yarn comprising narrow laminated microtapes enclosing a metallic foil or metalized layer or with other microtape yarns, which may comprise one or more plies of slit or extruded film. It has been found that twisted flat yarns will not enter the looms and knitting machines evenly since the twists tend to bunch together, thus causing the yarn to tangle, snarl, or break at the point of entry. Even if the twists do enter the machine, the resultant fabric will be rough where the yarn is twisted and may have striations or color bars produced by the twists. Another disadvantage is that metallic yarns may be so stretched by the twists as to effect localized losses or variation in brilliance or color, even if breakage does not occur.

The machines which manufacture flat yarns conveniently and conventionally produce the yarn in such a fashion that spooling or reeling is the only practical manner of initially packaging the yarn. Various types of unwinding attachments have been evolved in an attempt to deliver such spooled or reeled yarn in an untwisted condition. Even these devices which have been at least partially successful have the disadvantage that, on starting, the yarn is frequently overstretched and broken. Further, when the machines are stopped or the yarn breaks, there is the equally great danger of overrun and tangling, and the still greater risk of breaking the yarn at the next starting. These conditions are particularly hazardous on knitting machines such as flat knitting machines, which characteristically have a high-frequency start-stop yarn demand; and contain circular knitting machines which employ highly sensitive tension devices to control instant stopping and high starting speeds of machines.

One of the more recently evolved unwinding attachments is an electronically controlled spool unwinder which has dynamic braking and infinite take-off speeds within the knitting machine speed range. However, this apparatus is costly and delicate, and requires technical maintenance which is not normally available in the average mill.

This invention solves the foregoing unwinding problems and overcomes the foregoing disadvantages of the prior art by providing apparatus for winding yarn packets in which a predetermined twist is continually induced in the yarn during its winding on the core or quill of the cone or other form which the packet takes. In particular, each turn of the yarn about the axis of the packet is impressed with a longitudinal twist in the same direction in which the yarn is to be unwound from the packet, and which is thus opposite to the twist imparted by overend withdrawal. Thus, as the yarn is unwound by overend withdrawal from the packet, the induced twist will counteract the imparted twist and the unwound yarn will be in a flat, untwisted condition. My invention further includes a novel tensioning means which is effective to control the winding tension so that the induced twists will not be crushed during the winding operation or subsequent storage and thereby permanently crease the yarn. The tensioning means is additionally effective to permit a continuous, induced twist to be drawn through it without bunching into spaced twists, as would occur with conventional tensioning apparatus employing conventional thread guides and frictional tension plates or grooves. Therefore, by winding a packet according to my invention, it is possible to provide overend take-off with its attendant advantages, and at the same time to eliminate the need of using the previously evolved, expensive and frequently unsatisfactory unwinding attachments.

It is to be understood that, unless the flat yarn is relatively non-plastic, resilient, and crease-resistant, and/or is to be stored or held in process for only a relatively short time in the form of a packet having the yarn laid thereon with the above described twist, the foregoing step of providing a continual twist which is the reverse of that imparted by overend withdrawal of the yarn will not alone solve the twist problems heretofore inherent in flat yarns if the yarn is laid in the packet in conventional patterns by conventional winding or coning machines. Indeed, use of conventional winding or coning equipment after imparting the aforesaid reverse twist can seriously increase the twisting if due and careful allowances are not made for the tendency of a twisted flat yarn to crease during storage. Thus, if continually twisted flat yarn is permitted to acquire creases during storage in a packet form, overend withdrawal from the packet will frequently double the appearance of twists in the yarns as it appears in the fabric. One set of twists is due to the creasing of the reverse twist induced in the yarn during coning or otherwise packeting the yarn and which will not pull out in

overend withdrawal from the packet. The other set of twists results from the normal twist imparted to a yarn by overend withdrawal; these latter twists usually establish themselves between the creases resulting from the induced twist.

The foregoing highly undesirable circumstance of multiplying the appearance of twist presents a dilemma for which conventional coning equipment and winding patterns offer no solution. The reason for the dilemma is this: Heretofore it has been necessary to packet the yarn with so-called "hard-spots," that is, loci in the packet (usually at the "corners" at least) where each turn of yarn crosses over an adjacent turn or otherwise firmly binds against an adjacent turn; otherwise the packet will be unstable and successive circumferential strata will slough off the packet to produce hopeless tangles and snarls. In fact, standard coning machines are purposely provided with so-called hardening bars or the equivalent to wind the yarn on the cone to the high spots which build up and, thus, insure the creation of stabilizing hard spots. Yet these hard spots in a conventional packet necessarily tend to crease a twisted flat yarn wound thereon.

According to my invention, the packet may be wound under relatively low tension, while at the same time sloughing-off is prevented. This is accomplished by winding the yarn in layers of constantly varying traverse lengths. For example, the winding pattern may be one in which the layers vary from long-to-short-to-long lengths, this pattern being repeated until the packet is fully formed. Preferably, the number of turns in each layer is constant with the turns being more widely spaced apart in a long layer than in a short layer, thereby binding in the turns of the short layer. By winding in this manner so that the short layers have superposed and supporting long layers, sloughing-off of the coils, as well as hard spots, is minimized. Moreover, since the coils are not laid edge-to-edge, it is possible to eliminate the conventional hardening bar or driving roll which tends to crush the pre-twisted yarn. Packets wound in this fashion will assume a variation of the so-called "pineapple" shapes, that is, the sides of the packets are approximately conical in the area where all layers, long and short, coincide and build up to the maximum diameter. The ends, however, curve gradually inwardly to the core as the axially longer layers or coils overlap and bind in the shorter layers, these ends of the packet are characterized by being no harder than other areas of the packet. Thus, yarn wound in a packet according to this invention is not only under substantially equal tension throughout but is also under substantially equal compression from adjacent layers throughout the packet.

An object of this invention is the provision of apparatus for inducing a calculated twist into yarn being wound into a packet, and for winding the yarn under a predetermined and controllable tension and pattern so that the twists in the yarn will not be crushed.

Another object is the provision of apparatus for forming a stable, soft yarn packet in which hard spots are eliminated and which is not subject to sloughing-off and the uniquely formed packet produced thereby.

Still another object is the provision of apparatus for winding flat, monofilament yarn into a packet which can be unwound by overend take-off with the yarn in a flat condition.

A further object of the invention is the provision of a uniquely wound packet having substantially equal coil compression and density and the apparatus for winding the same.

Other objects and advantages of the invention will become apparent when the same is considered in connection with the following detailed description and the accompanying drawings wherein:

FIGURE 1 is a schematic side elevation of a winding apparatus embodying the invention.

FIGURE 2 is a front elevation of the apparatus shown in FIG. 1.

FIGURE 3 is a sectional view taken along the line 3—3 of FIG. 2 showing a portion of the tensioning means of the winding apparatus.

FIGURE 4 is a sectional view taken along the line 4—4 of FIG. 2 showing the traverse arm of the winding apparatus in different positions.

FIGURE 5 is an elevational view of a "pineapple" packet which can be wound with a winding apparatus embodying the invention.

FIGURE 6 is a diagrammatic showing of the projected path of travel taken by the traverse arm when winding a packet such as shown in FIG. 5.

FIGURE 7 is a fragmentary view of an exemplary flat yarn which can be wound into a packet with a winding apparatus embodying the invention.

Referring now to the drawings, the winding apparatus comprising the invention will be seen to consist generally of a yarn supply station **10**, a yarn tensioning means **11**, and a winding station **12**.

The yarn supply station **10** includes a U-shaped yoke **18** which is mounted on a hollow shaft **19**. This yoke is rotated by means of a driven gear **20** which is fastened to the yoke and which meshes with a drive gear **21** carried on a shaft **22** (see FIG. 2). A sprocket **23** is also keyed to the shaft **22** and is driven by a chain **24**.

A yarn supply spool **30** is mounted within the yoke **18** for rotation about the spool axis by a spindle means consisting of opposed pins **32** extending through opposite arms of the yoke. At least one of the pins **32** is retractable so that the supply spool can be conveniently mounted and unmounted. Yarn **33** is led from the supply spool **30** to a guide sheave **34** from which the yarn **33** then passes to the tensioning means **11** and thence to the winding station **12**. The throat or surface of the sheave **34** is tangent to the axis of the yoke shaft **19** to center the take-off of the yarn **33** from the spool **30** as the yarn traverses the axial length of the spool during take-off. As shown most clearly in FIG. 1, the axis of rotation of the spool **30** is perpendicular to axis of the yoke shaft **19** and, thus, to the general line of take-off of the flat yarn **33**. Therefore, by continually rotating the yoke **18** as the yarn **33** is drawn off the spool **30**, a twist is continuously induced in the yarn as it is drawn from the supply spool upon which the yarn is wound in a flat condition, usually with one turn abutting an adjacent turn on the spool.

The yoke **18** also has mounted therein a variable braking means for controlling the speed of rotation of the supply spool **30**. As shown, this braking means consists of a leaf spring **38** fastened at one end to an inner wall of the yoke, and which is sprung or pre-set to have its free end firmly engaged against a flange of the supply spool. A brake-control rod **39**, reciprocal in the hollow shaft **19**, has its inner end extending through an aperture in the spring **38**, the inner end of the rod being provided with a nut **39** or other suitable spring abutment means. When the rod **39** is moved to the right, as viewed in FIG. 1, it will either partially or wholly disengage the free end of the spring from the spool flange to permit freer unreeling of the yarn from the supply spool. Conversely, when the rod **39** is allowed to move to the left, the free end of the brake spring **38** will press against the spool flange with increasing pressure to either slow down or stop the rotation of the supply spool.

The tensioning means **11** interposed between the supply station **10** and the winding station **12** serves the function of accurately controlling the tension under which the yarn is wound, and contributes to the winding of a packet of substantially uniform density and coil compression. The tensioning means **11**, is operatively connected to the variable braking means for the supply spool, and thus serves the additional function of preventing back-

lash and tangling of the yarn if for some reason the yarn should break.

In the form illustrated, the tensioning means includes a bell crank 45 carried on a pivot 46, the bell crank being suitably biased by a spring, weight, elastic band, or the like. On one end of the bell crank arm 47 is mounted a freely rotatable floating sheave 48, while, in this embodiment, a suitable adjustable biasing means 49, an elastic band, is connected between the fixed frame of the machine and the other arm 50 of the bell crank. A link 51 is pivotally connected at each end between an intermediate point of the bell crank arm 50 and a lever 52 mounted for oscillation on a pivot 53. The outer end of the brake-control rod 39 is pivotally fastened to the end of the lever 52 opposite the connecting link 51.

The yarn 33 passes from the guide sheave 34 over a sheave 54 around the floating sheave 48 and thence back over a sheave 55 (see FIG. 2) to the winding station 12. The sheaves 54 and 55 are coaxially mounted for free rotation on a fixed sheave pin 56 carried by frame of the machine. As indicated in FIG. 1, the floating sheave 48 lies below the sheaves 54 and 55 and is constantly urged away from them by the biased action of the bell crank. When the tension in the yarn 33 tends to exceed the tension established by the balance of the bias means 49 and the spring brake 38, the floating pinion 48 will be drawn upwardly and the bell crank rocked about the pivot 46. The resultant clockwise motion of the bell crank serves to pull the connecting link 51 to the left which in turn actuates the lever 52 in the same direction as the bell crank. The motion of lever 52 will pull the rod 39 to the right thereby lessening the pressure of the free end spring 38 on the supply spool flange to reduce the drag of the brake on the spool and, thereby, relieve the tension on the yarn. Conversely, if the yarn tension should suddenly slacken, the bell crank and lever will rock counterclockwise and the spring will firmly engage the spool flange to restore tension. If the yarn 33 should ever break, the consequent full engagement of the variable brake means with the spool flange will stop the spool and prevent any overrun which would result in back-lash and tangling.

It is to be noted that the successive sheaves 34, 54, 48, and 55 over which must pass the flat yarn 33 twisted by the supply station are in form of so-called lantern pinions comprising spaced pins carried between a pair of disks. Lantern pinions are particularly well suited for the purposes of my invention since they will feed along the continuous twist in the yarn without bunching it into spaced twists such as would occur with conventional tensioning constructions which employ thread guides and frictional plates or grooves. I do not wish to limit my invention to the use of lantern pinions, however, since sheaves with soft felted or rubber yarn-contacting surfaces may also perform satisfactorily, although they have a relatively short life because of the rapid cutting and wear of rubber or felt surfaces by the relatively sharp edges of the twisted flat yarn.

The winding station 12 is basically comprised of a conventional coning machine 60 of the so-called "Universal" type with certain novel improvements which will be hereinafter described in detail. These improvements enable the coning machine to form a packet of the flat, twisted yarn, and to wind the packet in a unique and beneficial winding pattern.

The coning machine 60 includes a winding shaft 61 which is connected by a belt 62 to a suitable motor means (not shown). In the preferred form of construction, the winding shaft has an outboard end 65 upon which can be mounted the packet core 63. The other end of shaft 61 carries a sprocket 64 about which is entrained the endless chain 24 driving the sprocket 23. The sprockets 23 and 64 are of equal size, as are the gears 20 and 21, so that the yoke 18 and the shaft 61 will be turned at a one-to-one ratio and consequently produce a complete 360° twist in the yarn for every 360° wrap of yarn laid down in forming the packet. It will also be observed that because of the interposition of the driving gear 21 the yoke and winding shaft will turn in opposite directions.

The yarn is laid down on the core by a traverse arm 69 which carries a yarn guide 70 and guide pulley 71, both of these latter elements forming a yarn guide means. The traverse arm is spaced above the outboard end 65 of the winding shaft and lies in a substantially horizontal plane. One end of the arm is pivotally mounted on a vertical pivot carried by the frame of the machine so that the guide pulley 71 can be oscillated along substantially the full length of the outboard end of the winding shaft, while the free end of the traverse arm has a slot 72.

The oscillatory motion of the traverse arm is produced by movement of a finger 73 which projects upwardly through the slot 72. The finger 73 is reciprocated along the outboard end of the winding shaft by an attached rod 74 slidably mounted in a rocker plate 75. Reciprocatory movement is imparted to the rod 74 by a wabble cam 76 which has a peripheral cam groove 77 in which rides a cam follower 78 attached to the end of arm 74. Preferably the wabble cam is shaped to impart a constant throw to the rod. The wabble cam is keyed to a shaft 83 which is parallel to and spaced below the winding shaft 61. A suitable gear train, generally indicated by reference numeral 79, interconnects shafts 61 and 83.

For reasons to be discussed in more detail, it has been found desirable to provide a means for constantly varying the arc through which the traverse arm oscillates, and this is achieved by moving the finger 73 toward and away from the pivoted end of the traverse arm at the same time the traverse arm is being oscillated over the length of the core or partially formed packet.

As illustrated, the rocker plate 75, which carries the throw rod 74, is journalled on the outer end of the shaft 83 so that it can be oscillated toward and away from the pivoted end of the traverse arm. The rocker plate is rocked about the shaft 83 by a reciprocating link 89 which is pivotally connected to the weighted arm 90 which, in turn, is integrally joined to the rocker plate and extends below the shaft 83. The reciprocating link 89 has a forked end forming legs 91, and is guided for movement to-and-fro by a roller 92 which is received between the legs. Movement is imparted to the link 89 by a cam 93 which contacts a cam follower 94 carried by the link 89. A gear-head motor 95 is provided for driving the cam at the desired rate of speed.

In operation, the yarn is drawn from the yarn supply spool 30 and is passed through the tensioning means 11 which applies the proper tension to the yarn by controlling the speed of unreeling through the variable braking means. This tension can be changed at will simply by adjusting the tension exerted by the biasing means 49. As the yarn is drawn from the spool 30. the rotating yoke 18 will induce a gradual and continuous twist in the flat yarn.

The flat and gradually twisted yarn is led from the tensioning means through the yarn guide 70 and the guide pulley 71 at which time the yarn is laid down in concentric layers or strata on the core 63 by the oscillatory action of the traverse arm 69. Since the winding shaft 61 is rotating in a direction opposite to the rotational direction of the yoke 18, the yarn has an induced twist which is opposite to the direction in which the packet is being wound. Stated in another way, the yarn will have an induced twist in the same direction as that in which the packet will be unwound. The direction of rotation of the yoke and packet can be best appreciated by referring to FIG. 2. Thus, because of the induced reverse twist which is impressed on the yarn at the supply station 12, the 360° twist imparted to the yarn by each wrap of the yarn around the cone through an overend

take-off from the packet will be precisely counteracted by the 1:1 ratio of rotation of the yoke **18** and shaft **61**.

The continual movement of the finger **73** toward and away from the pivoted end of the traverse arm **69** continually varies the arc through which the traverse arm oscillates and will, thus, constantly change the axial length of each strata or layer of yarn on the packet. This action is most clearly observable in FIGS. 2 and 4. It will be apparent that the motion of finger, in effect, shortens and lengthens the traverse arm depending on whether the finger is moved toward or away from the pivoted end of the arm, respectively. Since the throw of the rod **74**, and, hence, of the finger **73** is constant, the traverse arm will be moved through its greatest arc and will lay down the longest strata of yarn on packet when the finger is closest to the pivoted end of the traverse arm. This position of the finger and the resultant arc is indicated at A in FIG. 4. Conversely, when the finger is farthest away from the pivoted end of the traverse arm, the arm will move through its smallest arc and will lay down the shortest strata of yarn. This position of the finger and the resultant arc is indicated at B in FIG. 4. From the foregoing description it will be apparent that the pattern of strata lengths, as well as the shape of the packet itself, can be easily varied by changing the configuration of the cam **93** and/or varying the speed of the cam driving motor with respect to the motor driving the belt **62**. The shaft which drives the cam **93** may, of course, be driven by the same motor which drives the belt **62**, in which event, it is usually desirable to interpose a speed change means between the motor and one of the drives for the cam **93** or the belt **62**.

In the illustrated embodiment, the cam **93** is generally heart-shaped, and results in what is termed a "pineapple" packet, the packet being designated by reference numeral **100** in FIG. 5. As shown, the packet has substantially straight sides **101** and slightly tapered and rounded ends **102**.

The winding pattern of the packet can be best explained in connection with FIG. 6 which shows the projected path of travel taken by the traverse arm **69** during the winding operation. It will be observed that the arcuate path of travel taken by the arm as it builds the packet continually varies between the maximum arc A and the minimum arc B. As a consequence, the arm lays down the yarn in succeeding layers or strata which have constantly varying traverse lengths along the axial length of the core, and with no two succeeding strata having the same length. This winding pattern, wherein the strata vary from long-to-short-to-long lengths is repeated over and over until the packet is completed with long and short strata lengths interspersed as the packet is built up.

This distinct winding pattern has two main advantages. The first advantage is in connection with the winding of flat yarns such as indicated by reference numeral **103** in FIG. 6, this yarn consisting of a strip of metal foil **106** sandwiched between layers **104** and **105** of fiber, usually a plastic material. It will be apparent to those skilled in the art that, if a twist were induced in such a yarn, and the yarn were wound by conventional winding procedures in which the coils were laid down edge-to-edge under relatively high tension, the induced twists would be crushed and the yarn creased. As explained above, these creases are caused not only by the tension in the yarn, but by the hard spots which, primarily, occur at the ends of the packet where the yarn is doubled back on itself to form succeeding layers. However, by winding in such a manner that the yarn coils are not laid down edge-to-edge and the succeeding strata vary in length, the hard spots occurring in conventional packets are largely eliminated. Also, the decreasing distance between the yarn guide pulley **71** and the actual winding surface of the packet serves to make an appreciable difference between the lengths of strata which otherwise might be presumed to be equal because they were laid while the arm **69** is swung through precisely the same arc. Moreover, the tendency of the concentric yarn strata to slough-off is greatly minimized since the longer strata lengths lock the shorter strata against slippage. This will be evident by referring to FIG. 5 in which is diagrammatically shown a long strata A_1 and a short strata B_1. It will be observed that the lengths B_1, as well as the major portion of the lengths A_1, are parallel to the sides **101** of the packet. The ends of strata A_1, however, bend over the ends of strata B_1 to form the tapered and somewhat rounded packet ends **102**. Thus the ends of strata A_1 lock the shorter strata B_1 against the core and prevent them from sloughing-off and tangling. Because of this locking action, the relatively high tension, as well as the hard spots, in conventionally wound packets can be eliminated and still produce a stable packet.

While this invention has been described with particularity in the winding of flat yarns, especially with respect to metallic yarns slit from laminated films enclosing a metallic inner layer, and presently finds its greatest utility in coning, quilling, or otherwise packeting such yarns so that they may be withdrawn over the end of the cores on which they are wound and delivered therefrom in as flat a condition as they are wound on the usual supply spools for such yarns, it is to be understood that this invention is not limited in its entirety to flat yarns. For example, certain round spun staple yarns incorporating thermoplastic fibers and/or impregnated with thermosetting resins are heat-set to stabilize the twist therein. These heat-set yarns and certain monofilament yarns (regardless of cross-section) can become very spring-like when twisted and thus tend to snarl in weaving or knitting due to the build-up of twists imparted by overend withdrawal from a packet. Employement of the method and mechanism of this invention to induce a gradual continuous reverse twist to such yarns during packeting permits a stable packet to be wound while permitting the yarns to be delivered therefrom in a highly desirable untwisted condition. Also, it is highly desirable for optimum performance of certain highly twisted round elastic crepe yarns to maintain a precisely fixed number of twists per unit of length. Such precise twisting cannot be maintained by merely relying on the overend withdrawal from the cone to produce the final desired number of twists per inch; since the number of twists in any yarns imparted by overend withdrawal of a yarn from a cone is equal to the number of circumferential wraps or turns of the yarn about the cone, overend withdrawal from a cone will not produce an equal number of twists per foot due to the increasing circumferential length of the wraps as the cone builds up and the diameter of the cone periphery increases. It is the object of the conventional "pineapple" cone to offset this effect of the increasing diameter of the cone periphery as the cone builds up by shortening the axial lengths of the successive helices of yarn wrapped on the cone, but by this invention that problem is simply circumvented. It is to be noted that the 1:1 ratio of the spool yoke and cone winding shaft induces of 360° twist in the yarn per wrap around the cone regardless of whether the length of yarn in a given wrap is long or short. Thus, just as flat yarn wound on a cone according to this invention is delivered in a flat condition when taken off over the end of the cone, round yarn wound on a supply spool with a precise number of twists per inch can be taken off over the end of a cone with an equally precise twist in the yarn.

Although all major sub-assemblies of a yarn-packeting machine made according to this invention coact in the specific embodiment shown for winding flat yarns, it is not to be understood that one or more sub-assemblies and the packet produced thereby may not possess separate utility. Thus, for example, with or without the yarn-twisting supply station shown in the specific embodiment and with the yarn tension control shown or other satisfactory tension control, the yarn winding station can

wind a round yarn into a packet having a minimum of "hard spots," i.e., substantially equal compression and density of the yarn throughout the packet. It has long been recognized that a frequent cause of streaking and color bars in yarns dyed by so-called package dyeing—in which the dye is forced into a packet of yarn wound on a hollow perforated core—is caused by the uneven "take" of the dye where adjacent turns of the yarn are relatively compressed at the "hard spots" built into the packet for stabilizing the packet. Thus, by package dyeing any yarns otherwise suitable for package dyeing and wound into a packet of the construction shown, with relatively low tension and even compression throughout the packet, the dye bath may be relatively quickly and uniformly flushed through the packet; by minimizing "hard spots" in the packet, a frequent cause of unlevel package dyeing is minimized. Of course, if the yarn is to be wound for package dyeing, the core of the packet is usually a suitable cylindrical perforate tube, rather than the conical core shown in the specific embodiment, also, the packet on such a core may take the form of cylinder with gently rounded ends rather than the "pineapple" cone form shown.

It is, therefore, apparent that this invention is not to be limited, in whole or part, to the aspects specifically shown in the particular embodiment disclosed but only by the appended claims and that one skilled in the art may modify, adapt, or alter, either in form or utility, the specific embodiment disclosed without departing from the scope or spirit of this invention as set forth in the following claims.

What is claimed is:

1. In a winding apparatus of the type described comprising a supply station for supplying yarn to a winding station, said supply station including spool mounting means, means for rotating the spool mounting means about an axis perpendicular to the axis of said spool mounting means, and braking means operatively connected to said spool mounting means; tensioning means, said tensioning means establishing a path of travel between said supply station and said winding station, means for simultaneously varying said path of travel and actuating said braking means to impart tension to yarn along said path of travel; said winding station including a winding shaft, motor means for rotating said winding shaft, drive means connecting said winding shaft to said means for rotating the spool mounting means, said winding shaft and means for rotating the spool mounting means turning in opposite directions and at the same speed, a pivoted traverse arm for laying down yarn on a packet core mounted on said winding shaft, and means for alternately increasing and decreasing the laying stroke of said traverse arm and for simultaneously oscillating its free end with a constant stroke, whereby yarn passing from said supply station will have a continuous twist impressed thereon in a direction opposite to that in which the yarn is being wound, and whereby the yarn will be laid down in increasing and decreasing traverse lengths along the packet core by the action of imparting a constant throw to the arm and simultaneously changing its laying stroke.

2. Yarn winding apparatus for winding flat yarn comprising a yarn supply station, said yarn supply station including a rotatable yoke having means for mounting a yarn supply spool for free rotation about the spool axis, and braking means connected to said yoke for controlling the speed of rotation of the spool; tensioning means including means to receive yarn from said supply station and guide it to a yarn winding station comprising at least two rotatable sheaves, means mounting said sheaves for relative movement with respect to each other to vary the length of yarn traveling from said supply station to said winding station, and biasing means acting on said sheave mounting means to move said sheaves away from each other; feed-back means correlating relative movement of said sheaves to said yarn supply station comprising means connecting said sheave mounting means to said braking means whereby said braking means will be actuated by relative movement of said sheaves; and a yarn winding station comprising a rotatable winding shaft, motor means connected to said winding shaft, drive means connecting said winding shaft to said yoke of the supply station for rotating said yoke at the same speed and in an opposite direction to said winding shaft, a traverse arm above one end of said winding shaft including yarn guide means for receiving yarn from said tensioning means, means pivotally mounting one end of the traverse arm so that the other end can be swung in an arcuate path with the yarn guide means axially traversing a portion of said one end of the winding shaft, a slot in said other end of the traverse arm, an upstanding finger projecting through said slot, means mounting said finger for movement along the axis of said one end of the winding shaft, means for reciprocating the finger with a constant throw, means for simultaneously changing the length of said traverse arm, whereby yarn will be wound on a packet core mounted on said one end of the winding shaft in a direction opposite to the continuous twist induced on the yarn by the rotating yoke, and whereby said yarn will be laid down on the packet core in concentric strata having constantly varying traverse lengths by simultaneously changing the length of the traverse arm and oscillating it with a constant throw.

3. Yarn winding apparatus for winding flat yarn comprising a yarn supply station, said yarn supply station including a rotatable yoke having means for mounting a yarn supply spool for free rotation about the spool axis, and braking means mounted in said yoke for controlling the speed of rotation of the spool; tensioning means including means to receive yarn from said supply station and guide it to a yarn winding station comprising first and third rotatable sheaves coaxially mounted, and a second sheave, means to move said first and third sheaves and said second sheave with respect to each other to vary the length of yarn traveling from said supply station to said winding station comprising a bell crank, said second sheave being rotatably mounted on an arm of said bell crank, and biasing means acting on the other arm of said bell crank to move said second sheave away from said first and third sheaves; feed-back means correlating relative movement of said sheaves to said yarn supply station comprising a lever arm pivotally mounted between its ends, a connecting link having one end pivotally fastened to said other arm of the bell crank, and a brake actuating means connected to said brake means and to the other end of said lever arm whereby said brake means will be actuated by relative movement of said sheaves; and a yarn winding station comprising a rotatable winding shaft, motor means connected to said winding shaft, drive means connecting said winding shaft to said yoke of the supply station for rotating said yoke at the same speed and in an opposite direction to said winding shaft, said winding shaft having an outboard end adapted to have a packet core mounted thereon, a traverse arm above the outboard end of said winding shaft including yarn guide means for receiving yarn from said third sheave, means pivotally mounting one end of the traverse arm so that the other end can be swung in an arcuate path with the yarn guide means traversing substantially the entire axial length of the outboard end of the winding shaft, a slot in said other end of the traverse arm, a second rotatable shaft parallel to and spaced below said winding shaft, drive means connecting the winding shaft to said second shaft, a rocker plate journalled on said second shaft, a rod mounted in said rocker plate for reciprocatory movement parallel to the winding shaft, an upstanding finger on one end of the rod, said finger projecting through the slot in the traverse arm, a cam follower on the other end of the rod, a constant-throw wabble cam on said second shaft, said wabble cam and cam follower being opera-

tively connected so that the rod will be reciprocated with a constant stroke, an integral extension on the rocker plate extending below the second shaft, a link fastened at one end to said extension, a cam follower on the other end of said link, a cam operatively engaged with said cam follower for oscillating said rocker plate toward and away from the pivoted end of the traverse arm, and a motor for turning said cam, whereby yarn will be wound on a packet core mounted on the outboard end of the winding shaft in a direction opposite to the continuous twist induced on the yarn by the rotating yoke, and whereby said yarn will be laid down on the packet core in concentric strata having constantly varying traverse lengths by the simultaneous action of the oscillating traverse arm and the rocking movement of said finger toward and away from the pivoted end of said traverse arm.

4. Yarn winding apparatus for winding flat yarn comprising a yarn supply station, said yarn supply station including a rotatable yoke, spindle means in the arms of said yoke for mounting a yarn supply spool for free rotation about the spool axis, and variable braking means mounted in said yoke for controlling the speed of rotation of a spool carried by the spindle means; tensioning means for receiving yarn from said yarn supply station, said tensioning means including means to receive yarn from said supply station and guide it to a yarn winding station comprising first and third rotatable lantern pinions coaxially mounted, and a second lantern pinion, means to move said first and third lantern pinions and said second lantern pinion with respect to each other to vary the length of yarn traveling from said supply station to said winding station comprising a bell crank, said second lantern pinion being rotatably mounted on an arm of said bell crank, and biasing means acting on the other arm of said bell crank to impart tension to said yarn passing from said supply station to said winding station through coaction with said variable braking means; feedback means correlating said tension means to said yarn supply station comprising a lever arm pivotally mounted between its ends, a connecting link having one end pivotally fastened to an end of said lever arm and having its other end pivotally fastened to said other arm of said bell crank, and a brake actuating means connected to said variable brake means and to the other end of said lever arm whereby said brake means will be actuated by movement of said second pinion and bell crank; and a yarn winding station comprising a horizontal, rotatable winding shaft, motor means connected to said winding shaft, drive means connecting said winding shaft to said yoke of the supply station for rotating said yoke at the same speed and in an opposite direction to said winding shaft, said winding shaft having an outboard end adapted to have a packet core mounted thereon, a substantially horizontal traverse arm above the outboard end of said winding shaft, yarn guide means on said traverse arm for receiving yarn from said third lantern pinion, means pivotally mounting one end of the traverse arm so that the other end can be swung in a horizontal, arcuate path with the yarn guide means traversing substantially the entire axial length of the outboard end of the winding shaft, a slot in said other end of the traverse arm, a second rotatable shaft parallel to and spaced below said winding shaft, gear means connecting the winding shaft to said second shaft, a rocker plate journalled on said second shaft, said rocker plate extending along substantially the full length of the outboard end of the winding shaft, a rod mounted in said rocker plate for reciprocatory movement parallel to the winding shaft, an upstanding finger on one end of the rod, said finger projecting through the slot in the traverse arm, a cam follower on the other end of the rod, a constant-throw wabble cam on said second shaft, said wabble cam and cam follower being operatively connected so that the rod will be reciprocated with a constant stroke, an integral extension on the rocker plate extending below the second shaft, a link fastened at one end to said extension, a cam follower on the other end of said link, a cam operatively engaged with said cam follower for oscillating said rocker plate toward and away from the pivoted end of the traverse arm, and a motor for turning said cam, whereby yarn will be wound on a packet core mounted on the outboard end of the winding shaft in a direction opposite to the continuous twist impressed on the yarn by the rotating yoke, and whereby said yarn will be laid down on the packet core in concentric strata having constantly varying traverse lengths by the simultaneous action of the oscillating traverse arm and the rocking movement of said finger toward and away from the pivoted end of said traverse arm.

5. Yarn winding apparatus for winding flat yarn comprising a yarn supply station, said yarn supply station including a rotatable yoke having means for mounting a yarn supply spool for free rotation about the spool axis, and braking means mounted in said yoke for controlling the speed of rotation of the spool; tensioning means including means to receive yarn from said supply station and guide it to a yarn winding station comprising first and third rotatable sheaves coaxially mounted, and a second sheave, means to move said first and third sheaves and said second sheave with respect to each other to vary the length of yarn traveling from said supply station to said winding station comprising a bell crank, said second sheave being rotatably mounted on an arm of said bell crank, and biasing means acting on the other arm of said bell crank to move said second sheave away from said first and third sheaves; feed-back means correlating relative movement of said sheaves to said yarn supply station comprising means connecting said bell crank to said braking means; and a yarn winding station comprising a winding shaft, motor means for rotating said winding shaft, drive means connecting said winding shaft to said yoke for rotating said yoke at the same speed as said winding shaft and in an opposite direction, and means for winding yarn from said tensioning means on a packet core mounted on said winding shaft in a direction opposite to the twist impressed on the yarn by said rotatable yoke.

6. Yarn winding apparatus for winding flat yarn comprising a yarn supply station, said yarn supply station including a rotatable yoke, spindle means in the arms of said yoke for mounting a yarn supply spool for free rotation about the spool axis, and variable braking means mounted in said yoke for controlling the speed of rotation of a spool carried by the spindle means; tensioning means for receiving yarn from said yarn supply station, said tensioning means including means to receive yarn from said supply station and guide it to a yarn winding station comprising first and third rotatable lantern pinions coaxially mounted, and a second lantern pinion, means to move said first and third lantern pinions and said second lantern pinion with respect to each other to vary the length of yarn traveling from said supply station to said winding station comprising a bell crank, said second lantern pinion being rotatably mounted on an arm of said bell crank, and biasing means acting on the other arm of said bell crank to impart tension to said yarn passing from said supply station to said winding station through coaction with said variable braking means, feedback means correlating said tension means to said yarn supply station comprising a lever arm pivotally mounted between its ends, a connecting link having one end pivotally fastened to an end of said lever arm and having its other end pivotally fastened to said other arm of said bell crank, and a brake actuating means connected to said variable braking means and to the other end of said lever arm whereby said braking means will be actuated by movement of said second pinion and bell crank; and a yarn winding station comprising a winding shaft, motor means for rotating said winding shaft, drive means connecting said winding shaft to said yoke for rotating

said yoke at the same speed as said winding shaft and in an opposite direction, and means for winding yarn from said tensioning means on a packet core mounted on said winding shaft in a direction opposite to the twist impressed on the yarn by said rotatable yoke.

7. Yarn winding apparatus for winding flat yarn comprising a yarn supply station for supplying yarn to a winding station, said yarn supply station including a rotatable yoke having means for mounting a yarn supply spool for free rotation about the spool axis, and braking means mounted in said yoke for controlling the speed of rotation of the spool; tensioning means, said tensioning means establishing a path of travel between said supply station and said winding station, means for simultaneously varying said path of travel and actuating said brake means to impart tension to yarn along said path of travel; and a yarn winding station comprising a rotatable winding shaft, motor means connected to said winding shaft, drive means connecting said winding shaft to said yoke of the supply station for rotating said yoke at the same speed and in an opposite direction to said winding shaft, said winding shaft having an outboard end adapted to have a packet core mounted thereon, a traverse arm above the outboard end of said winding shaft including yarn guide means for receiving yarn from said tensioning means, means pivotally mounting one end of the traverse arm so that the other end can be swung in an arcuate path with the yarn guide means traversing substantially the entire axial length of the outboard end of the winding shaft, a slot in said other end of the traverse arm, a second rotatable shaft parallel to and spaced below said winding shaft, drive means connecting the winding shaft to said second shaft, a rocker plate journalled on said second shaft, a rod mounted in said rocker plate for reciprocatory movement parallel to the winding shaft, an upstanding finger on one end of the rod, said finger projecting through the slot in the traverse arm, a cam follower on the other end of the rod, a constant-throw wabble cam on said second shaft, said wabble cam and cam follower being operatively connected so that the rod will be reciprocated with a constant stroke, an integral extension on the rocker plate extending below the second shaft, a link fastened at one end to said extension, a cam follower on the other end of said link, a cam operatively engaged with said cam follower for oscillating said rocker plate toward and away from the pivoted end of the traverse arm, and a motor for turning same cam, whereby yarn will be wound on a packet core mounted on the outboard end of the winding shaft in a direction opposite to the continuous twist induced on the yarn by the rotating yoke, and whereby said yarn will be laid down on the packet core in concentric strata having constantly varying traverse lengths by the simultaneous action of the oscillating traverse arm and the rocking movement of said finger toward and away from the pivoted end of said traverse arm.

8. Yarn winding apparatus for winding flat yarn comprising a yarn supply station for supplying yarn to a winding station, said yarn supply station including a rotatable yoke, spindle means in the arms of said yoke for mounting a yarn supply spool for free rotation about the spool axis, and variable braking means mounted in said yoke for controlling the speed of rotation of a spool carried by the spindle means; tensioning means for receiving yarn from said yarn supply station, said tensioning means establishing a path of travel between said supply station and said winding station, means for simultaneously varying said path of travel and actuating said brake means to impart tension to yarn along said path of travel; and a yarn winding station comprising a horizontal, rotatable winding shaft, motor means connected to said winding shaft, drive means connecting said winding shaft to said yoke of the supply station for rotating said yoke at the same speed and in an opposite direction to said winding shaft, said winding shaft having an outboard end adapted to have a packet core mounted thereon, a substantially horizontal traverse arm above the outboard end of said winding shaft, yarn guide means on said traverse arm for receiving yarn from said tensioning means, means pivotally mounting one end of the traverse arm so that the other end can be swung in a horizontal, arcuate path with the yarn guide means traversing substantially the entire axial length of the outboard end of the winding shaft, a slot in said other end of the traverse arm, a second rotatable shaft parallel to and spaced below said winding shaft, gear means connecting the winding shaft to said second shaft, a rocker plate journalled on said second shaft, said rocker plate extending along substantially the full length of the outboard end of the winding shaft, a rod mounted in said rocker plate for reciprocatory movement parallel to the winding shaft, an upstanding finger on one end of the rod, said finger projecting through the slot in the traverse arm, a cam follower on the other end of the rod, a constant-throw wabble cam on said second shaft, said wabble cam and cam follower being operatively connected so that the rod will be reciprocated with a constant stroke, an integral extension on the rocker plate extending below the second shaft, a link fastened at one end to said extension, a cam follower on the other end of said link, a cam operatively engaged with said cam follower for oscillating said rocker plate toward and away from the pivoted end of the traverse arm, and a motor for turning said cam, whereby yarn will be wound on a packet core mounted on the outboard end of the winding shaft in a direction opposite to the continuous twist induced on the yarn by the rotating yoke, and whereby said yarn will be laid down on the packet core in concentric strata having constantly varying lengths by the simultaneous action of the oscillating traverse arm and the rocking movement of said finger toward and away from the pivoted end of said traverse arm.

9. In yarn winding apparatus of the type described comprising a yarn supply station, said yarn supply station including a spool mounting means, yoke means holding said spool mounting means, and braking means operatively connected to said spool mounting means; tensioning means including means to receive yarn from said supply station and guide it to a yarn winding station comprising at least two rotatable sheaves, means mounting said sheaves for relative movement with respect to each other to vary the length of yarn traveling from said supply station to said winding station, and biasing means acting on said sheave mounting means to move said sheaves away from each other; feed-back means correlating relative movement of said sheaves to said yarn supply station comprising means connecting said sheave mounting means to said braking means, whereby said braking means will be actuated by relative movement of said sheaves; and a yarn winding station comprising a horizontal, rotatable winding shaft, motor means connected to said winding shaft, drive means connecting said winding shaft to said yoke of the supply station for rotating said yoke at the same speed and in an opposite direction to said winding shaft, said winding shaft having an outboard end adapted to have a packet core mounted thereon, a substantially horizontal traverse arm above the outboard end of said winding shaft, yarn guide means on said traverse arm for receiving yarn from said tensioning means, means pivotally mounting one end of the traverse arm so that the other end can be swung in a horizontal, arcuate path with the yarn guide means traversing substantially the entire axial length of the outboard end of the winding shaft, a slot in said other end of the traverse arm, a second rotatable shaft parallel to and spaced below said winding shaft, gear means connecting the winding shaft to said second shaft, a rocket plate journalled on said second shaft, said rocker plate extending along substantially the full length of the out-

board end of the winding shaft, a rod mounted in said rocker plate for reciprocatory movement parallel to the winding shaft, an upstanding finger on one end of the rod, said finger projecting through the slot in the traverse arm, a cam follower on the other end of the rod, a constant-throw wabble cam on said second shaft, said wabble cam and cam follower being operatively connected so that the rod will be reciprocated with a constant stroke, an integral extension on the rocker plate extending below the second shaft, a link fastened at one end to said extension, a cam follower on the other end of said link, a cam operatively engaged with said cam follower for oscillating said rocker plate toward and away from the pivoted end of the traverse arm, and a motor for turning said cam, whereby yarn will be wound on a packet core mounted on the outboard end of the winding shaft in a direction opposite to the continuous twist impressed on the yarn by the rotating yoke means, and whereby said yarn will be laid down on the packet core in concentric strata having constantly varying traverse lengths by the simultaneous action of the oscillating traverse arm and the rocking movement of said finger toward and away from the pivoted end of said traverse arm.

10. Yarn winding apparatus for winding flat yarn comprising a yarn supply station, said yarn supply station including spool mounting means, rotatable yoke means holding said spool mounting means, and braking means operatively connected to said spool mounting means, tensioning means including means to receive yarn from said supply station and guide it to a yarn winding station comprising first and third rotatable sheaves coaxially mounted, and a second sheave, means to move said first and third sheaves and said second sheave with respect to each other to vary the length of yarn traveling from said supply station to said winding station comprising a bell crank, said second sheave being rotatably mounted on an arm of said bell crank, and biasing means acting on the other arm of said bell crank to move said second sheave away from said first and third sheaves; feed-back means correlating relative movement of said sheaves to said yarn supply station comprising a lever arm pivotally mounted between its ends, a connecting link having one end pivotally fastened to an end of said lever arm and having its other end pivotally fastened to said other arm of the bell crank, and a brake actuating means connected to said braking means and to the other end of said lever arm whereby said brake means will be actuated by relative movement of said sheaves; and a yarn winding station comprising a rotatable winding shaft, motor means connected to said winding shaft, drive means connecting said winding shaft to said yoke means of the supply station for rotating said yoke means at the same speed and in an opposite direction to said winding shaft, said winding shaft having an outboard end adapted to have a packet core mounted thereon, a traverse arm above the outboard end of said winding shaft including yarn guide means for receiving yarn from said third sheave, means pivotally mounting one end of the traverse arm so that the other end can be swung in an arcuate path with the yarn guide means traversing substantially the entire axial length of the outboard end of the winding shaft, a slot in said other end of the traverse arm, a second rotatable shaft parallel to and spaced below said winding shaft, drive means connecting the winding shaft to said second shaft, a rocker plate journalled on said second shaft, a rod mounted in said rocker plate for reciprocatory movement parallel to the winding shaft, an upstanding finger on one end of the rod, said finger projecting through the slot in the traverse arm, a cam follower on the other end of the rod, a constant-throw wabble cam on said second shaft, said wabble cam and cam follower being operatively connected so that the rod will be reciprocated with a constant stroke, an integral extension on the rocker plate extending below the second shaft, a link fastened at one end to said extension, a cam follower on the other end of said link, a cam operatively engaged with said cam follower for oscillating said rocker plate toward and away from the pivoted end of the traverse arm, and a motor for turning said cam, whereby yarn will be wound on a packet core mounted on the outboard end of the winding shaft in a direction opposite to the continuous twist induced on the yarn by the rotating yoke means, and whereby said yarn will be laid down on the packet core in concentric strata having constantly varying traverse lengths by the simultaneous action of the oscillating traverse arm and the rocking movement of said finger toward and away from the pivoted end of said traverse arm.

11. Yarn winding apparatus for winding flat yarn comprising a yarn supply station, said yarn supply station including spool mounting means, means for rotating said spool mounting means about an axis perpendicular to the spool mounting means axis, and braking means operatively connected to the spool mounting means; tensioning means for receiving yarn from said yarn supply station, said tensioning means including means to receive yarn from said supply station and guide it to a yarn winding station comprising first and third rotatable lantern pinions coaxially mounted, and a second lantern pinion, means to move said first and third lantern pinions and said second lantern pinion with respect to each other to vary the length of yarn traveling from said supply station to said winding station comprising a bell crank, said second lantern being rotatably mounted on an arm of said bell crank, and biasing means acting on the other arm of said bell crank to impart tension to said yarn passing from said supply station to said winding station through coaction with said variable braking means; feed-back means correlating said tension means to said yarn supply station comprising a lever arm pivotally mounted between its ends, a connecting link having one end pivotally fastened to said other arm of the bell crank, and a brake actuating means connected to said braking means and to the other end of said lever arm whereby said braking means will be actuated by movement of said second pinion and bell crank; and a yarn winding station comprising a horizontal, rotatable winding shaft, motor means connected to said winding shaft, drive means connecting said winding shaft to said means for rotating said spool mounting means for rotating said shaft and said means for rotating said spool mounting means at the same speed and in opposite directions, said winding shaft having an outboard end adapted to have a packet core mounted thereon, a substantially horizontal traverse arm above the outboard end of said winding shaft, yarn guide means on said traverse arm for receiving yarn from said third lantern pinion, means pivotally mounting one end of the traverse arm so that the other end can be swung in a horizontal, arcuate path with the yarn guide means traversing substantially the entire axial length of the outboard end of the winding shaft, a slot in said other end of the traverse arm, a second rotatable shaft parallel to and spaced below said winding shaft, gear means connecting the winding shaft to said second shaft, a rocker plate journalled on said second shaft, said rocker plate extending along substantially the full length of the outboard end of the winding shaft, a rod mounted in said rocker plate for reciprocatory movement parallel to the winding shaft, an upstanding finger on one end of the rod, said finger projecting through the slot in the traverse arm, a cam follower on the other end of the rod, a constant-throw wabble cam on said second shaft, said wabble cam and cam follower being operatively connected so that the rod will be reciprocated with a constant stroke, an integral extension on the rocker plate extending below the second shaft, a link fastened at one end to said extension, a cam follower on the other end of said link, a cam operatively engaged with said cam follower for oscillating said rocker plate toward and away from the pivoted end of the traverse arm, and a motor for turning said cam, whereby yarn will be wound on a packet core mounted on the out-

board end of the winding shaft in a direction opposite to the continuous twist induced on the yarn by the rotating spool mounting means, and whereby said yarn will be laid down on the packet core in concentric strata having constantly varying lengths by the simultaneous action of the oscillating traverse arm and the rocking movement of said finger toward and away from the pivoted end of said traverse arm.

12. In a winding apparatus of the type described, an improved winding means comprising a winding shaft, motor means for rotating said winding shaft, a pivoted traverse arm for laying down yarn on a packet core mounted on one end of said winding shaft, means for imparting a constant throw to the free end of the traverse arm whereby said free end is moved in an arcuate path which traverses the axial length of a portion of said one end of said winding shaft, and means for alternately increasing and decreasing the laying stroke of said traverse arm during its arcuate travel, whereby the yarn will be laid down in varying traverse lengths along the packet core by the action of imparting a constant throw to the arm and simultaneously changing its length.

13. In an apparatus for winding yarn, an improved winding means comprising a rotatable winding shaft, motor means connected to said winding shaft, said winding shaft having an outboard end adapted to have a packet core mounted thereon, a traverse arm above the outboard end of said winding shaft including yarn guide means for receiving yarn from a yarn supply, means pivotally mounting one end of the traverse arm so that the other end can be swung in an arcuate path with the yarn guide means traversing substantially the entire axial length of the outboard end of the winding shaft, a slot in said other end of the traverse arm, a second rotatable shaft parallel to and spaced below said winding shaft, drive means connecting the winding shaft to said second shaft, a rocker plate journalled on said second shaft, a rod mounted in said rocker plate for reciprocatory movement parallel to the winding shaft, an upstanding finger on one end of the rod, said finger projecting through the slot in the traverse arm, a cam follower on the other end of the rod, a constant-throw wabble cam on said second shaft, said wabble cam and cam follower being operatively connected so that the rod will be reciprocated with a constant stroke, an integral extension on the rocker plate extending below the second shaft, a link fastened at one end to said extension, a cam follower on the other end of said link, a cam operatively engaged with said cam follower for oscillating said rocker plate toward and away from the pivoted end of the traverse arm, and a motor for turning said cam, whereby said yarn will be laid down on the packet core in concentric strata having constantly varying traverse lengths by the simultaneous action of the oscillating traverse arm and the rocking movement of said finger toward and away from the pivoted end of said traverse arm.

14. In an apparatus for winding yarn, an improved winding means comprising a horizontal, rotatable winding shaft, motor means connected to said winding shaft, said winding shaft having an outboard end adapted to have a packet core mounted thereon, a substantially horizontal traverse arm above the outboard end of said winding shaft, yarn guide means on said traverse arm for receiving yarn from a yarn supply, means pivotally mounting one end of the traverse arm so that the other end can be swung in a horizontal, arcuate path with the yarn guide means traversing substantially the entire axial length of the outboard end of the winding shaft, a slot in said other end of the traverse arm, a second rotatable shaft parallel to and spaced below said winding shaft, gear means connecting the winding shaft to said second shaft, a rocker plate journalled on said second shaft, said rocker plate extending along substantially the full length of the outboard end of the winding shaft, a rod mounted in said rocker plate for reciprocatory movement parallel to the winding shaft, an upstanding finger on one end of the rod, said finger projecting through the slot in the traverse arm, a cam follower on the other end of the rod, a constant-throw wabble cam on said second shaft, said wabble cam and cam follower being operatively connected so that the rod will be reciprocated with a constant stroke, an integral extension on the rocker plate extending below the second shaft, a link fastened at one end to said extension, a cam follower on the other end of said link, a cam operatively engaged with said cam follower for oscillating said rocker plate toward and away from the pivoted end of the traverse arm, and a motor for turning said cam, whereby yarn will be wound on a packet core mounted on the outboard end of the winding shaft in strata having constantly varying lengths by the simultaneous action of the oscillating traverse arm and the rocking movement of said finger toward and away from the pivoted end of said traverse arm.

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