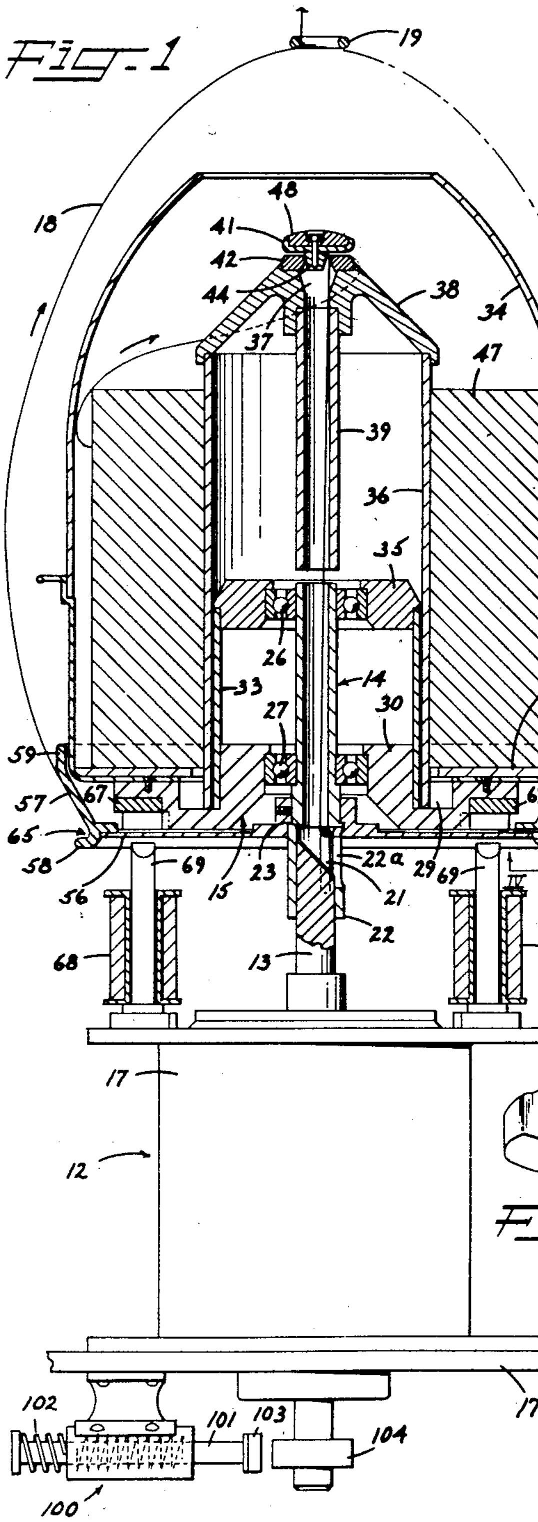
July 10, 1951 I. S. ROBERTS 2,559,735

STRAND TWISTING MACHINE

Filed Dec. 16, 1947 4 Sheets-Sheet 1

Fig. 1



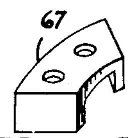


Fig. 2

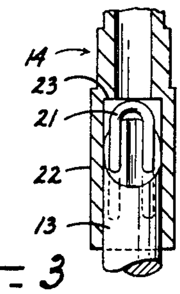


Fig. 3

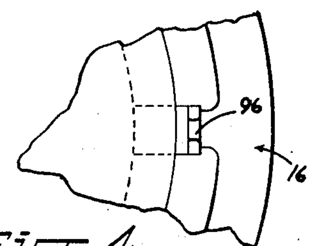


Fig. 4

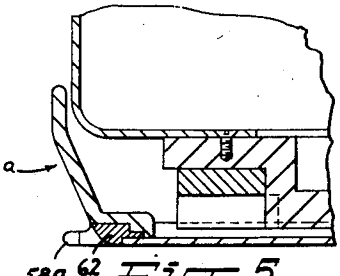


Fig. 5

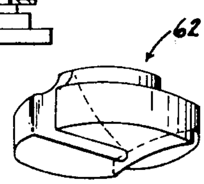
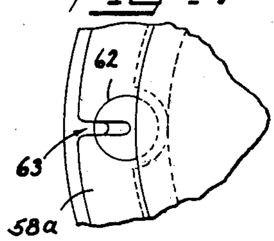


Fig. 6

Fig. 7



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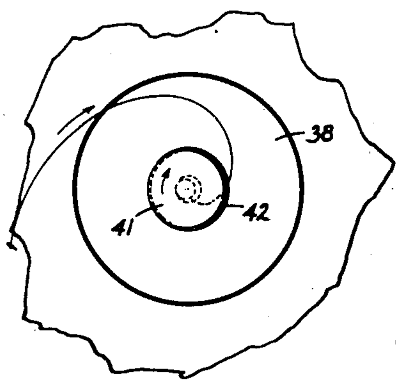

Fig. 11

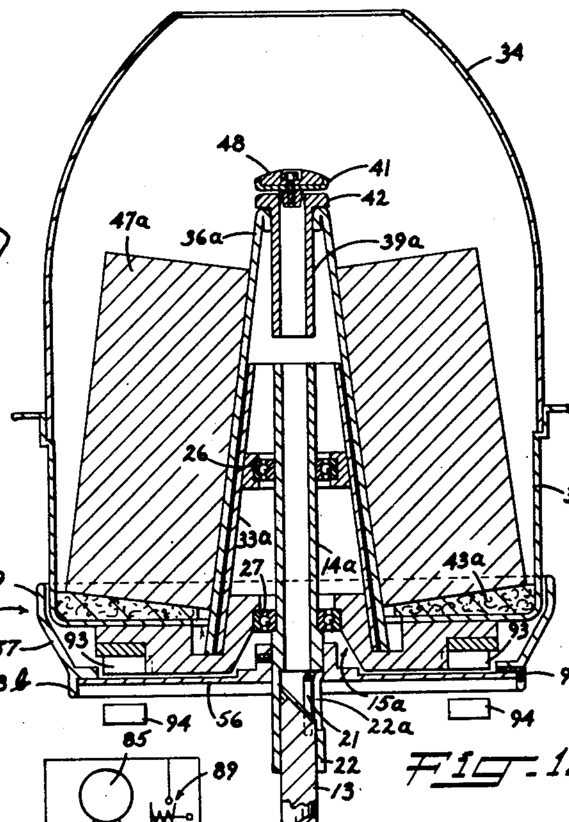

Fig. 12

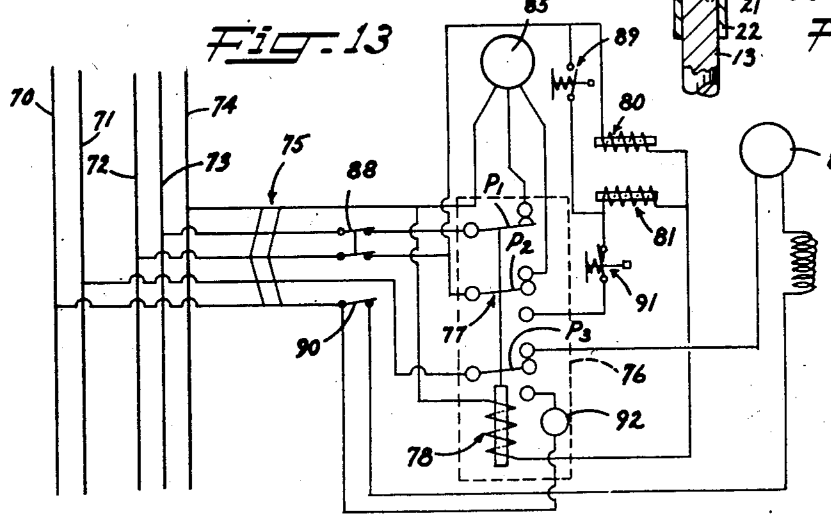

Fig. 13

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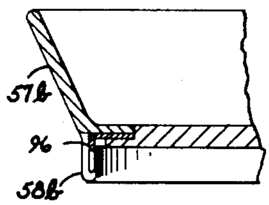

Fig. 8

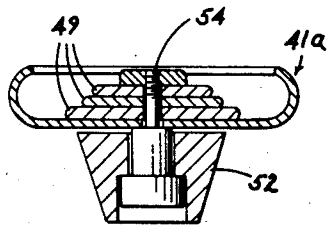

Fig. 9

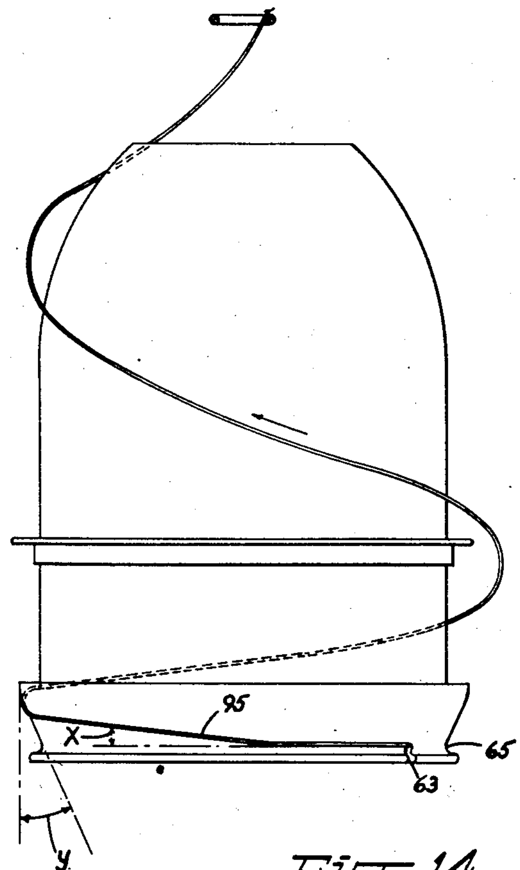

Fig. 14

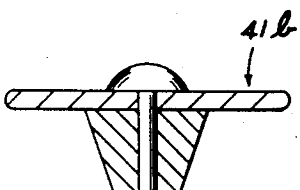

Fig. 10

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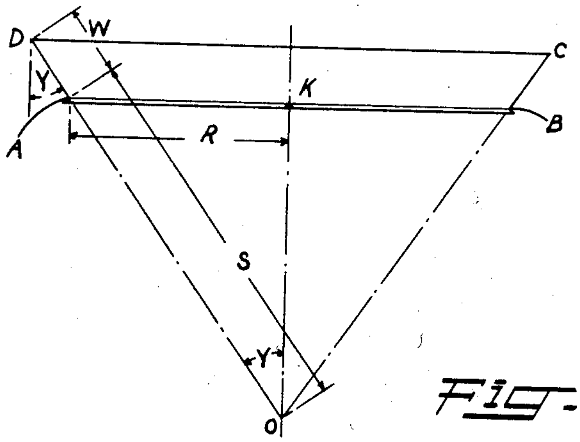

Fig. 15

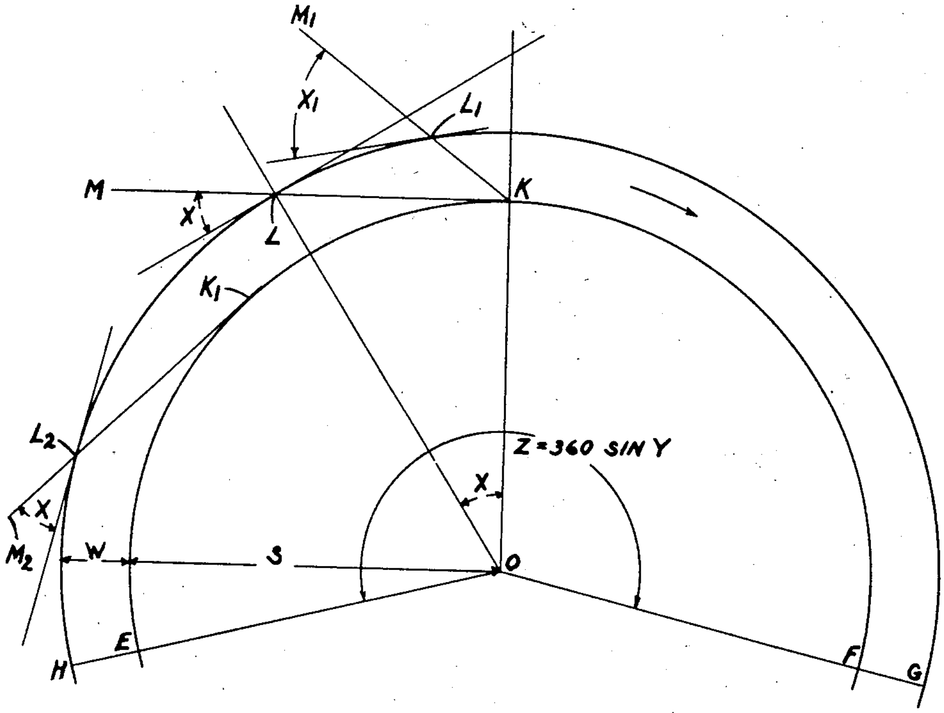

Fig. 16

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UNITED STATES PATENT OFFICE

2,559,735

STRAND TWISTING MACHINE

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Application December 16, 1947, Serial No. 791,963

7 Claims. (Cl. 57—58)

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This invention relates to yarn or thread twisting machinery such as a two-for-one twister and particularly to devices for controlling yarn or thread tension during a twisting operation.

In a typical two-for-one twisting operation, a strand such as a thread, cord, ply or yarn is pulled from a supply package through the twister and is wound about the spindle of a package winding machine. More explicitly, untwisted or partially twisted yarn is supplied from a supply package, such as a bobbin, cake, or cheese held in place on the twister by a holder mounted on the twister spindle but held from rotating during the twisting operation. Yarn is drawn from the non-rotating supply package into one end of the rapidly rotating hollow twister spindle, then withdrawn at another point by a flyer and delivered to a rotating eccentric position. As the spindle is rotated, the yarn which progressively passes between the flyer and an overhead ring guide is acted upon by forces which cause it to follow a spiral path. This spiral path revolves about the axis to form an apparent balloon outline which is usually referred to as a "balloon." From the overhead ring guide, the yarn passes to the package winding machine.

In adapting twisting machines of this type to the processing of large packages, large stable balloons must be formed to provide space for package holders of sufficient size. Other factors being constant, the shape of the balloon and the volume enclosed by it are determined by the tension in the strand; a high strand tension produces a narrow balloon with a relatively large mean helix angle while a low strand tension produces a wide balloon with a relatively small mean helix angle. Thus, to secure a balloon which will encompass a large supply package, as well as to avoid overstraining the yarn, it is desirable that the twisting be conducted at low strand tension. However, low strand tensions are more difficult to maintain than high strand tensions since variations in absolute tension values have relatively larger percentage effects. Also, the small helix angle balloon resulting from low strand tension is relatively unstable since the strand length in the balloon is greater. It is therefore readily apparent that provision must be made for precise tension control if large supply packages are to be twisted on a machine of this type. The present invention provides means for securing this precise tension control.

The problem of balloon shape control and the operation of the present invention can be more fully understood through consideration of the forces which act on the strand as it revolves about

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the spindle axis in passing between the flyer and the ring guide and which, in combination, cause it to assume a certain definite shape. There are four such forces to be considered, i. e., the draft which is imposed on the strand by the take-up means, centrifugal force, wind resistance to peripheral motion, and the retarding force which is applied to the strand at or before the flyer by frictional resistance or other means. A fifth force, wind resistance to motion lengthwise of the strand, is negligible and the draft may therefore be considered to be equal to the retarding force and both of them to be equal to the tension in the strand. The centrifugal force on the strand is a function of spindle speed, mean balloon diameter, balloon height, strand denier and strand moisture content and the wind resistance to peripheral motion is a function of spindle speed, air humidity, mean balloon diameter, balloon height, degree of twist being applied and strand denier, filament count, filament structure, material density, finish and original twist. However, all of these factors except balloon diameter may be readily maintained substantially constant and the balloon diameter becomes fixed when the strand tension is made fixed. If, for a given system of the general character described, the above mentioned factors, with the exception of strand tension and balloon diameter, are maintained constant and the strand tension is decreased a definite small amount by reducing the retarding force, the balloon diameter will increase and its mean helix angle will decrease until a new balance of forces is obtained and a new stable balloon shape is secured. This decrease in balloon helix angle with decrease in strand tension has an important bearing upon the invention as explained later.

An important object is to provide a two-stage tensioning device for a two-for-one twister which produces greater uniformity in yarn tension and improved balloon characteristics. As objects ancillary thereto, a simple and inexpensive device is provided for initially tensioning the yarn before or as it enters the hollow twister spindle; to accomplish second stage tensioning, a flyer of particular design for producing desired frictional effects is also provided. It is an object also to accomplish tensioning of yarn or thread during the twisting with a minimum of disturbance to the yarn structure or filament arrangement. It is also an object to provide an electrical means for effecting emergency stopping of twisting machinery. Another object is to provide the above means while maintaining standard design features and capacity for large packages. Another object is to utilize electromagnetic means which both prevents rotation of the package holder or, when failing in that function, actuates the electrical means for effecting emergency stops. Other objects, features, and advantages will be apparent from the drawings and the following description thereof.

In the drawings illustrative of the invention,

Figure 1 is a side elevation partly in section of a two-for-one twisting machine embodying the invention;

Figure 2 is a perspective view of a magnetically sensitive cleat used in the machine of Figure 1;

Figure 3 is a fragmentary vertical view partly in section at right angles with the view of Figure 1 of the upper end of the driving shaft;

Figure 4 is a fragmentary bottom view of the flyer of Figure 1 showing a yarn guide in place;

Figure 5 is a fragmentary vertical section of a modified package holder and the flyer with a modified yarn guide insert in place;

Figure 6 is a perspective view of the yarn guide insert of Figures 5 and 7;

Figure 7 is a bottom view of the flyer and yarn guide insert shown in Figure 5;

Figure 8 shows a portion of a modified flyer in section;

Figure 9 is a transverse sectional view of the members of a modified form of initial tensioning device;

Figure 10 illustrates a variation of the device shown in Figure 9;

Figure 11 is a top view of an initial tensioning device;

Figure 12 is a side elevation in section of another embodiment of the invention;

Figure 13 is an electrical circuit diagram of the invention;

Figure 14 is a partial elevation of a twisting machine and illustrates a helical yarn path.

Figure 15 is a profile in a vertical plane of the strand-guiding portion of a flyer; and

Figure 16 shows the area of the strand-guiding flyer portion of Figure 15 developed in a plane.

Referring now to Figure 1, a two-for-one twisting machine is shown comprising as its principal parts, a driving means such as an electric motor 12, a drive shaft 13, a hollow tubular, shaft 14, a package holder 15, and a flyer 16. A ring-guide 19 is supported rigidly above the machine by means not shown. Since the various parts of the machine are supported either by the driving means housing 17 or the shaft 13, the machine may receive its principal support at the driving means housing 17 by supporting means such as the platform or rail 17*a*. The upper end of the drive shaft 13 terminates in a groove oblique to its axis. The hollow spindle shaft 14 has an enlarged portion 22 which fits tightly over the upper end of shaft 13. The shaft 13 is drilled axially from the portion of the grooved surface nearest the driving means to accommodate the two ends of a U-shaped member 21 as shown in Figures 1 and 3. Spindle shaft 14 has an enlarged lower portion 22 which provides close-fitting and limited telescopic relation with the shaft 13 on the interior and forms an exterior shoulder 23 whereby the axial position of the flyer 16 is determined. Shaft 14 is at least long enough to provide stable support of the package holder 15 at the bearings 26 and 27. The enlarged portion 22 of shaft 14 is provided with an opening 22*a* aligned with the closed end of U-shaped member 21 so that yarn or thread may be introduced into the top end of shaft 14 and discharged beneath the flyer 16.

The holder 15 comprises a base portion 30 acting as a hub about the bearing 27, a lower cylindrical shell member 31 having a flange extending inwardly from its lower portion and secured thereby to the top surface, of base portion 30, an upper hub member 35 for bearing 26, and a cylindrical sleeve 33 connecting the base portion 30 and the hub member 35. The shell member 31 is provided with a chrome plated and polished outer flange 32 about its top portion for minimizing frictional contact and abrasion of the strand with the supply holder assembly during starting and stopping of the twisting machine. To prevent the material being twisted from coming into contact with a supply package 47 or with the yarn being drawn therefrom, a domed or conical cover such as the shell member 34 is supported on a horizontal surface 40 formed by an annular recess along the inner surface in the top portion of member 31. So that strands on the bottom portion of the supply package do not become damaged and so that the supply package is prevented from easily rotating about the smooth metal surface of the bottom of the shell member 31, an annular flat cushion 43 of felt or other soft protective material is placed within the member 31 at the package supporting surface. A supply package of yarn, or other filamentary or textile material is ordinarily furnished on a rigid core of standard design such as the cylindrical member 36 of Figure 1. As both ends of the core generally extend beyond the yarn package, an annular recess 29 may be provided in the base portion 30 below the annular package-supporting surface of the member 31 to receive the lower end of the core 36. To the upper protruding end of core 36 is fitted a conical or domed cap 38 having an axial passageway 37. In order to control or restrict the path of yarn passing into the shaft 14 and to facilitate lacing-up the passageway of cap 38 may be extended by a cylindrical member 39.

An essential feature of the invention now to be described is the tensioning device, comprising plates 41 and 42 mounted atop the cap 38, which prevents tangling of the yarn as it passes through the rotating spindle 14 and imparts to the yarn part of the total tension necessary to form a stable balloon-shape such as that indicated by numeral 18 in Figure 1. The shape of cap 38 is critically important; if it is too tall, the yarn will wrap around it and snub; if it is too short, the yarn tends to snub at the edges of the supply package. The slope of the side of the cap is then chosen so that the yarn spirals about the cap and slides smoothly and upwardly into the bite of tension plates 41 and 42. A cap having a slope of approximately 45 degrees has been found quite satisfactory although to meet specific conditions, slopes from 30 to 60 degrees with the horizontal are quite practical. Plate 42 has an annular upper yarn engaging surface and a central bore or passageway; it is firmly fastened to the cap 38 over the cap passageway 37. If desired, the plate 42 and the cap 38 may be formed as a one piece structure. Plate 41 has a lower yarn engaging surface substantially meeting the yarn engaging surface of plate 42 and has a stem 44, preferably tapered, extending therefrom, of smaller diameter than the passageway of plate 42. A stem diameter approximately 0.80 that of the passageway diameter is quite satisfactory although stem diameters in the range of 0.10 to 0.95 that of the passageway diameter may also be used. In operation, yarn is drawn from a supply package **47** and through the tensioning device horizontally between the plates **41** and **42**. While the yarn is between the mating surfaces of the plates, its longitudinal speed is from five to ten times greater than its sidewise speed depending upon the diameter of the supply package. One result thereof is a helical yarn path between plates as shown in Figure 11 which revolves once about the plate **42** for each wrap removed from the supply package. Another result is to slowly rotate the plate **41** in the direction indicated in Figure 11 and to move it laterally so that the stem **44** rides around the wall of the passageway of the plate **42** always at a point opposite the yarn path to provide a crescent-shaped clearance space at a preferred point for yarn travel to the spindle shaft **14**. This manner of operation prevents the yarn from being pinched between the stem **44** and the plate **42** and from being subjected to tension variations due to spindle vibration.

The weight of the plate **41** is chosen to produce a desired tension in the yarn. Weight variation may be obtained by means of inserts of a type such as insert **48** shown in Figures 1 and 12, or small plate like discs **49** shown in Figure 9, or separate differently weighted plate units such as unit **41*b*** of Figure 10; a further feature embodied in the unit **41*a*** of Figure 9 is the anti-friction element **52** which may rotate freely about a bolt **54** to reduce friction and wear on the stem and to produce, a tensioning device less sensitive to spindle vibration. The bolt **54** holds the entire assembly together. Plate **41** and variations thereof and including attachments thereto as shown in Figures 9 and 10 are designed so that the top of the assembly does not offer obstruction to any loops of yarn which might occasionally jump over it when irregularities occur in operation.

The tension plates **41** and **42** may be of an abrasion resistant material such as a vitreous ceramic material including that known by the trade-name Alsimag, a sintered powdered tungsten carbide including that known by the trade-name Carboloy, chrome-plated steel or tungsten alloy. The mating surfaces should be ground and should have rounded corners to provide a smooth path for the yarn to and from the tension control region. The mating surfaces should also be substantially horizontal and plane. Preferable proportions are approximately as shown; if the outside diameter of the plates is too large, the yarn wraps around the entrance groove formed at the peripheries of the mating surfaces; if the outside diameter is too small, mating surfaces are too narrow and unit pressure on the yarn becomes too great for preferred operation. Line contact between plates **41** and **42** should be used only to control very light tensions. Figure 12 illustrates the use of the invention wherein the supply package holder **15*a*** is designed for supporting a yarn package having frusto-conical outer and inner surfaces. The upper diameter of a package insert **36*a*** is such that the initial tensioning device plates **41** and **42** are supported directly on the insert **36*a***. A tubular yarn guide **39*a*** is attached directly to plate **42**. Similar members in Figures 1 and 12 are indicated by the same reference numerals; parts having similar function in the two figures but modified structure are indicated by the same reference numeral except that the letter "*a*" is added to the numeral of Figure 12.

Another important feature of this invention is a flyer, such as one shown in Figures 1, 4, 5, 7, 8, and 12, designed particularly for the second stage of tensioning in cooperation with the first stage device described hereinbefore. The flyer **16** comprises a hub portion secured to the shaft **14**, a disc portion **56** which is preferably of an electrically non-conducting material, and a frusto-conical rim section **57** having a flange **58**, **58*a***, or **58*b***, contiguous with its smaller diameter end and an approximately cylindrical flange **59** contiguous with its larger diameter end.

As shown in Figures 1, 5, and 12, the cylindrical portion **59** is preferably of greater inside diameter than element **31** of the package holder so that during starting and stopping of the flyer, the yarn remains clear of the surface of the package holder assembly, or otherwise the yarn may be broken, abraded or tangled about the twister. The rim section of flyer **16** is slotted, as shown in Figures 1, 4, and 12, for receiving a strand-guiding insert **96** of abrasion resistant material, at the region where the strand passes through a right-angle or nearly right-angle turn onto the thread-guiding portion of the flyer rim. A modified flyer **16*a*** with flange **58*a*** is slotted and drilled as shown in Figures 5 and 7 to accommodate a yarn-guiding insert **62** shown removed in Figure 6. The insert **62**, shown in place in Figures 5 and 7, completes a thread-guiding slot **63**. The insert **96** or **62** is formed from an abrasion-resisting material such as a sintered powdered tungsten carbide including that known by the trade-name Carboloy, a tungsten steel, or a chrome-plated steel. In operation, the yarn is led from the spindle **14** around a right angle turn formed by the U-shaped insert **21**, along the underneath of disc portion **56**, and through the strand-guiding insert **96** of flyer **16** onto the outer frusto-conical surface of the rim section.

The operation of the flyer to control yarn tension can best be understood from consideration of the behavior and path of the yarn upon the outer surface of the flyer. Figure 15 shows the outline of a center-line section of the frusto-conical portion **57** and flange **58** of the flyer. Angle Y is the generating angle of the conical surface. In Figure 16, outline EKFGLH is a development of the outside surface of portion **57**. The arrow indicates the direction of rotation and point K represents the notch **63** where the yarn first contacts the face **57**. Line EKF represents the flange **58** and may be considered as a partition extending upward from the plane of the paper for limiting the path of the yarn. The yarn, as it leaves the notch, takes a direction which is determined by the combined effect of all the forces acting upon it while in the balloon. The path of the yarn in the balloon is helical and, due to the fact that the length of yarn exposed to wind resistance progressively decreases as the yarn approaches the guide ring, the helix angle of the balloon progressively increases as shown in Figure 14. For a particular combination of operational values such as spindle speed, yarn character and yarn tension, there is a definite balance of forces on the yarn, a definite balloon shape and a definite angle of departure or initial helix angle between the path of the yarn as it leaves the flyer surface and a tangent to the periphery of the flyer at this point. This is angle X_1 in Figure 16. Since the shape of the balloon can be varied by changing the yarn tension, as explained before, the value of angle X_1 and the position of the point of departure L_1 can be varied in the same manner. As the yarn tension decreases, wind resistance decreases angle X and carries point L_1 to the left in Figure 16 until a point L is reached. If the point of departure is carried beyond L, as to L_2, the yarn wraps around flange **58** along line FKE from K to K_1 and angle X remains unchanged. This wrapping continues until the frictional resistance between the yarn and the surface of the flyer increases the yarn tension to a point where there is no further tendency for angle X to decrease in value and therefore no further tendency toward wrapping. Thus the tension in the yarn automatically assumes a balance with the other forces on the yarn to secure a definite and constant value of angle X and a definite and constant balloon shape. Also, if the factors such as spindle speed and yarn character which control these other forces remain constant, as they normally will during a given twisting operation, the yarn tension in the balloon will automatically remain constant if the initial tension in the yarn as it reaches the flyer does not exceed the control value.

A study of Figures 15 and 16 will show that a definite relationship exists between angle X and the generating angle Y of the frusto-conical control surface of the flyer. This relationship can be expressed by the formula

$$\cos X = \frac{R}{R + W \sin Y}$$

where R is the radius of the flyer at the notch and W is the width of the face of the flyer surface. Z is the angle in Fig. 16 between the radii extending from the ends of the conical surface EKFGLH of the flyer, and S represents the slope height from the smaller diameter of the conical surface of the flyer to the vertex of the cone DOC of Fig. 15 containing the conical surface **57**. The derivation of the formula is as follows:

$2\pi R = 2\pi S \frac{Z}{360}$ = the circumference of the smaller edge of the thread-guiding portion of Figure 15.

$$\frac{Z}{360} = \frac{R}{S} = \sin Y$$

or Z=360 sin Y; also

$$S = \frac{R}{\sin Y}$$

$$\frac{S}{S+W} = \cos X$$

or, substituting

$$\frac{R}{\sin Y} \text{ for } S,\ \cos X = \frac{R}{R + W \sin Y}$$

This formula neglects the curvature of yarn path KL due to wind resistance and also neglects the effect of the deflection of the yarn by the rim of the flyer when point M is below the plane of the paper but it is sufficiently accurate for use to select values of R, W and Y to provide an X angle value which corresponds to an experimentally determined acceptable balloon shape and acceptable yarn tension. In practice, the value of the Y angle must be high enough in combination with set values of R and W, so that the resultant effect of wind resistance and centrifugal force upon any yarn to be handled by the twister will not throw the yarn clear of the flyer at L. If this should happen, the control functions of the flyer would become inoperative. At the other extreme, the Y value should never be high enough so that the balancing balloon tension will overstrain the yarn. In between these extremes, there is sufficient latitude so that a certain flyer shape operating at a certain speed may be used with a reasonable variety of yarns. However, for an extreme change in yarn, such as from 150 denier to 1100 denier, Y or W, or the spindle speed must be changed (in this case, Y or W is increased or the spindle speed is decreased), if a controlled X angle and a controlled and acceptable yarn tension is to be obtained. Y values will, in practically all cases, fall within the range of 25 to 65 degrees.

The line AD in Figure 15 of surface portion **57** should preferably be straight as shown but may be made slightly concave or convex without losing its ability to control angle X. In the practice of this invention, a flyer having a yarn controlling surface sloping approximately 35 degrees with the axis and rotated at 6600 R. P. M. produced a stable balloon form with 150 denier yarn drawn at 110 meters per minute. The yarn tension above the ring guide was approximately 22 grams. The plate weight in the initial tensioning device (plate **41**) was 10 grams. Yarn tension measured at a point between the ring guide and the take-up showed a variation under 0.5 gram.

A further important feature of this invention is the means provided for preventing turning of the package supply holder while the spindle rotates. This means comprises (1) magnetic means or magnetically sensitive elements such as steel cleats **67** shown fastened in an annular recess provided in the bottom surface of the base portion **30** of the package supply holder, and (2) an equal number of electromagnets **68** with pole pieces **69** arranged in a similar pattern about the spindle axis closely spaced to the lower side flyer disc portion **56** and mounted on the motor housing **12** or other rigidly supported member related to the twisting machine. The relation of the magnetic cleats **67** to electromagnets **68** is such that as the holder **15** is rotated through one revolution, the cleats **67** are aligned with the pole pieces **69** of corresponding electromagnets in at least one position. So that the magnetic forces between adjacent pole pieces and cleats are not adversely affected when the coils of the electromagnets are energized, and to prevent the induction of eddy currents, the disc portion **56** of the flyer and the base portion **30** of the package holder are formed from non-electrically conductive materials, such as thermosetting or thermoplastic resinous compositions, resin impregnated paper or fabrics, or the electromagnets **68** may be of the single coil or the double-coil type. The double-coil type having a U-shaped core is most effective since both of its poles terminate in a region immediately beneath the flyer. The shape of cleats **67** is most appropriate for electromagnets having a U-shaped core.

When the electromagnets **68** are energized and in alignment with elements **67**, magnetic aligning forces are produced therebetween which overcome the torque produced from frictional forces generated in bearings **26** and **27** during spindle rotation. An effective holding means for a twister package holder is thus provided.

The holding means just described serves another important function of the invention, namely, as a means for actuating an electrical control system for emergency stopping of the twisting and the packaging machinery. In ordinary operation the package holder is held from turning; however, it may be forced out of its normal alignment with the electromagnets by application of sufficient torque; for example, bearing seizure in bearings 26 and 27 would rotate the holder. In the event adhering, tangled, or knotted yarn on the supply package resists unwrapping therefrom, a tension is immediately produced in the yarn extending from the package to the twisting spindle which tends to or succeeds in rotating the holder out of alignment with the electromagnets. When misalignment occurs, a change of impedance is produced in the electrical circuit which energizes the coils of the electromagnets, and causes an increase in current flow which may be used to instantaneously energize other electrical apparatus.

Referring to Figure 13, a circuit diagram is shown in which power is supplied to a twisting machine and a package winding device electrically controlled according to this invention from a 110 volt, 60 cycle alternating current supply comprising lines 70 and 71, and a 60 volt, 3 phase alternating current supply comprising lines 72, 73, 74 through a common five terminal plug or switch 75. The area circumscribed by a dotted line 76 indicates a 3-pole over-current relay with a thirty-two volt coil 78. The relay contains a three-pole switch 77, the separate poles of which are indicated as P_1, P_2, and P_3. In a position hereinafter designated as "on-power," P_1, and P_2 close a 3-phase power circuit to a twister motor 85 and P_3 closes a two phase power circuit to a take-up means motor 84. In a position hereinafter designated as "off-power," P_1 has become functionless, P_2 closes a circuit energizing a solenoid braking coil 81 and P_3 closes a circuit which lights a signal 92. Holding coil 80 is used to designate the sum of the coils in the electromagnets 68. The solenoid coil 81 operates a plunger 101 of a braking assembly 100 in opposition to spring 102 (Figure 1) and presses the brake shoe 103 against a brake drum 104 on shaft 13.

The circuit diagram in Figure 13 is shown for normal operation with both motors 85 and 84 running. Assuming the plug 75, and switches 88 and 90 open, the starting procedure for the twisting machine is as follows: insert plug 75 and close switch 88. If the magnetic elements 67 of the holder 16 are not aligned with the pole pieces 69, the impedance of holding coil 80 is low enough that the current in the relay coil 78 trips the relay switch 77 to the off-power position and places the solenoid brake coil 81 in parallel with coil 80 so that, even if the pole pieces and electromagnets are now aligned, the impedance of that part of the circuit would still be low enough to maintain the relay in the off-power position. If the holder and electromagnets were aligned when the switch 88 is closed, the impedance of coil 80 would be high, the switch 71 would assume on-power position, and the twister motor 85 would start. To stop the twister motor 85, switch 89 is momentarily closed to place coil 81 in parallel with holding coil 80; with the impedance of the circuit containing coil 78 reduced, the relay switch 77 trips.

To start the twister and the package winder simultaneously, switches 90 and 88 are closed with the relay 76 in tripped position, the supply package holder is rotated for alignment of cleats 67 with the electromagnets, yarn is laced through the twister and the package winding machine, and switch 91 is momentarily opened to cut the solenoid coil 81 out of parallel with coil 80 so as to increase the impedance of the circuit containing coil 78; the relay switch 77 is thereby returned to its normal position wherein two of its poles, P_1 and P_2, close the power circuit to the three-phase twister motor 85 and the other pole P_3 closes the circuit to the winding motor 84. If it should be desired to run the winding motor 84 without the twister motor 85, close switch 90 and leave switch 88 open.

For normal stopping, push switch 89; coil 81 is thus energized and actuates the solenoid brake while also reducing the impedance; the relay trips, interrupting the power circuits to the motors 84 and 85 and closing the circuits to coil 81 and the light 92. In the case of emergency, i. e., stopping due to bearing seizure, yarn tangling, or other cause, the supply package holder starts to rotate, and is pulled out of alignment with the electromagnets; impedances of the electromagnet coils decrease and the relay is tripped. Figure 12 shows the location of permanent magnets 93 and 94 which can be used instead of cleats 67 and electromagnets 68 as an alternative means for maintaining the alignment of package holder support 15 and motor 17.

The invention described provides, in addition to the emergency stopping features, a tensioning control system which promotes unusual stability in yarn tension during a twisting operation. Variation in yarn tension may be readily limited to 0.5 gram and even less in a machine in good mechanical condition. Such control over yarn is particularly beneficial when twisting yarn furnished in large size packages since small fluctuations in yarn tension when forming large balloons at low yarn tension tend to cause relatively large changes in balloon shape. While the process for twisting fine denier, low tensile strength yarns is more benefited by the tensioning features of the invention, the twisting of all types of yarns, threads, strands and cords is improved because of the stability imparted to the balloon and the resultant benefits of increased supply package space, and uniformity in the twisted product.

While preferred embodiments of the invention have been shown, it is to be understood that changes and variations may be made without departing from the spirit and scope of the invention as defined by the appended claims.

I claim:

1. A two-for-one twisting machine comprising a spindle, electrical means for driving the spindle, a flyer fixed on the spindle, a supply package holder mounted on the spindle and rotatable relative thereto and provided with magnetic means, stationary electromagnetic coil means spaced with respect to the holder on the opposite side of the flyer for cooperating inductively with said magnetic means for maintaining the holder stationary, a tensioning device supported by the supply package holder, an electrically operated braking means for the spindle, electrical means electrically connected with the coil means and responsive to variations in the impedance of the coil means resulting from changes in the spacing between the magnetic means and the coil means for simultaneously operating the braking means and stopping the flow of electrical current to the driving means upon a predetermined change of said impedance, and an alternating current source for energizing the electromagnetic coil means and the electrical means.

2. A twisting machine comprising a driving shaft having a grooved oblique surface at one end, a guiding member having a strand-guiding

portion spaced above the groove and extending transversely of the direction of slope of the oblique surface, a hollow extension for the driving shaft interiorly recessed to permit telescopic relationship therewith having an opening in radial alignment with the portion of the oblique surface below the strand-guiding portion.

3. A two-for-one twisting machine comprising a spindle, electrical means for driving the spindle, a flyer fixed on the spindle, a supply package holder mounted on the spindle and rotatable relative thereto and provided with magnetic means, stationary electromagnetic coil means spaced with respect to the holder on the opposite side of the flyer for cooperating inductively with said magnetic means for maintaining the holder stationary, electrical means electrically connected with the coil means and responsive to variations in the impedance of the coil means resulting from changes in the spacing between the magnetic means and the coil means for simultaneously operating the braking means and stopping the flow of electrical current to the driving means upon a predetermined change of said impedance, and an alternating current source for energizing the electromagnetic coil means and the electrical means.

4. A two-for-one twisting machine comprising a driving shaft having an oblique surface at one end, electrical means for driving the shaft, a guiding member having a strand-guiding portion spaced above the oblique surface and extending transversely of the direction of slope of the oblique surface, a hollow extension for the driving shaft interiorly recessed to permit telescopic relationship therewith having an opening in radial alignment with the portion of the oblique surface below the strand-guiding portion of the guiding member, a flyer fixed to the hollow extension, a supply package holder mounted on the hollow extension and rotatable relative thereto, and provided with magnetic means, stationary electromagnetic coil means spaced with respect to the holder on the opposite side of the flyer for cooperating inductively with said magnetic means for maintaining the holder stationary, an electrically operated braking means for the flyer, and electrical means electrically connected with the coil means, and responsive to variations in the impedance resulting from changes in the spacing between the magnetic means and the coil means for simultaneously operating the braking means and stopping the flow of electrical current to the driving means upon a predetermined change of said impedance, and an alternating current source for energizing the electromagnetic coil means and the electrical means.

5. A twisting machine comprising a driving shaft having an oblique surface at one end, a driving means toward the other end thereof, a U-shaped thread-guiding element attached to the end of the driving shaft within a portion of the oblique surface nearest the driving means with the thread-guiding surface of the member aligned transversely of the direction of slope of the oblique surface, a hollow shaft telescopically and non-rotatably attached by an enlarged end portion to the driving shaft with the interior wall of the section of smaller diameter overhanging the closed end of the U-shaped thread-guiding element, and the hollow shaft having an opening in radial alignment with the closed portion of the U-shaped member.

6. A two-for-one twisting machine comprising a spindle, electrical means for driving the spindle, a flyer fixed on the spindle, a supply package holder mounted on the spindle and rotatable thereto and provided with magnetic means, stationary electromagnetic coil means spaced with respect to the holder on the opposite side of the flyer for cooperating inductively with said magnetic means for maintaining the holder stationary, solenoid operated braking means for the spindle, an electromagnetic coil electrically connected with the coil means, and responsive to changes in impedance of the stationary electromagnetic coil means resulting from changes in the spacing between the magnetic means and the coil means for mechanically operating the multipole switch whereby the solenoid braking means is operated and the flow of electrical current to the driving means is stopped upon a predetermined change of said impedance, and an alternating current source for energizing the electromagnetic coil means and the electrical means.

7. A two-for-one twisting machine in working relationship with an electrically driven take-up device comprising a spindle, electrical means for driving the spindle, a flyer fixed on the spindle, a supply package holder mounted on the spindle and rotatable relative thereto and provided with magnetic means, stationary electromagnetic coil means spaced with respect to the holder on the opposite side of the flyer for cooperating inductively with said magnetic means for maintaining the holder stationary, a solenoid operated braking means for the flyer, an electromagnetic coil electrically connected with the coil means and responsive to changes in impedance of the stationary electromagnetic coil means resulting from changes in the spacing between the magnetic means and the coil means for mechanically operating a multi-pole switch whereby the solenoid braking means is operated and the flow of electrical current to the driving means and the take-up means is stopped upon a predetermined change of said impedance, and an alternating current source for energizing the electromagnetic coil means and the electrical means.

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