Jan. 2, 1968 J. P. KLINK ET AL 3,361,375

METHOD AND APPARATUS FOR PACKAGING STRAND MATERIAL

Filed April 18, 1966 5 Sheets-Sheet 1

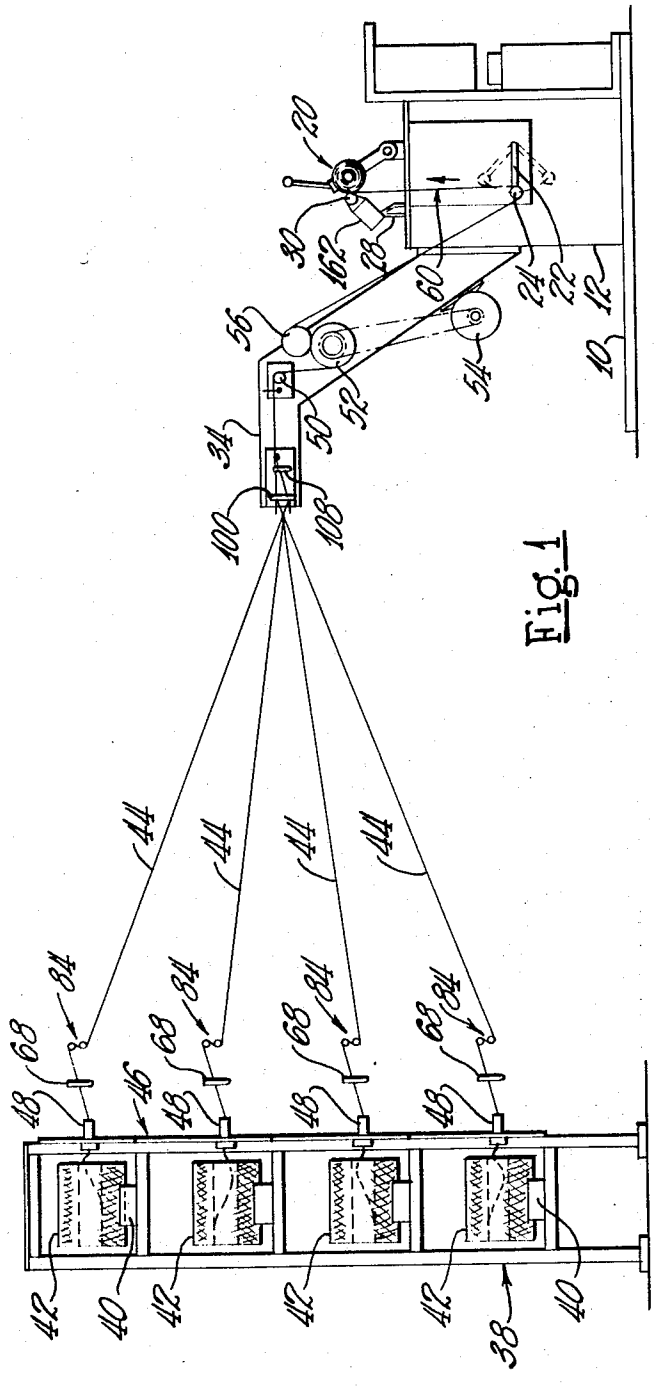


Fig. 1

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METHOD AND APPARATUS FOR PACKAGING STRAND MATERIAL

Filed April 18, 1966 5 Sheets-Sheet 2

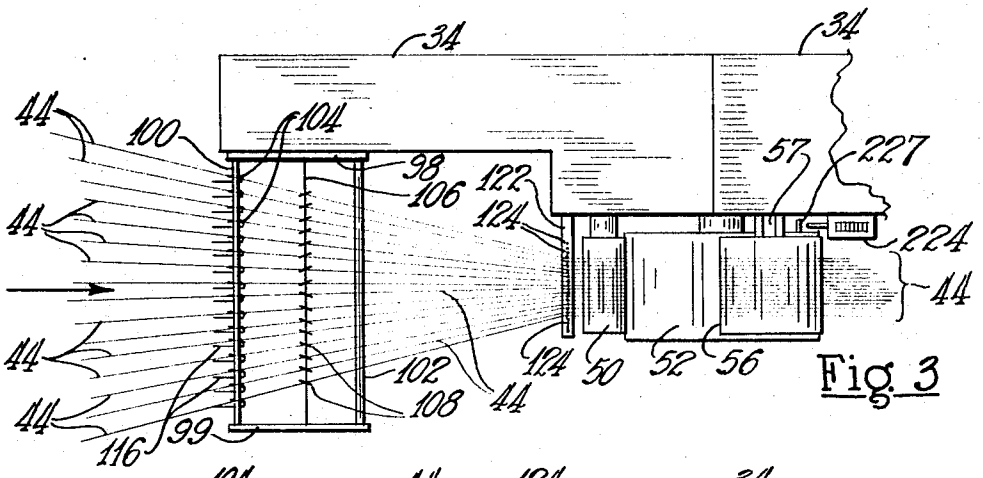


Fig. 3

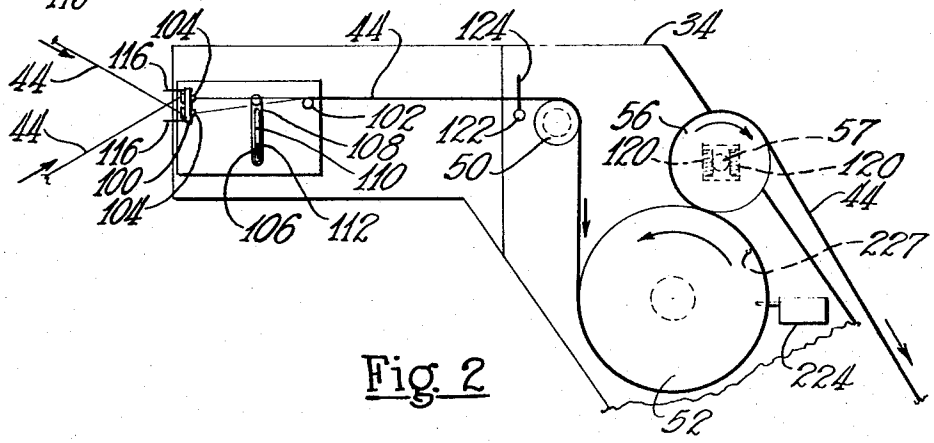


Fig. 2

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METHOD AND APPARATUS FOR PACKAGING STRAND MATERIAL

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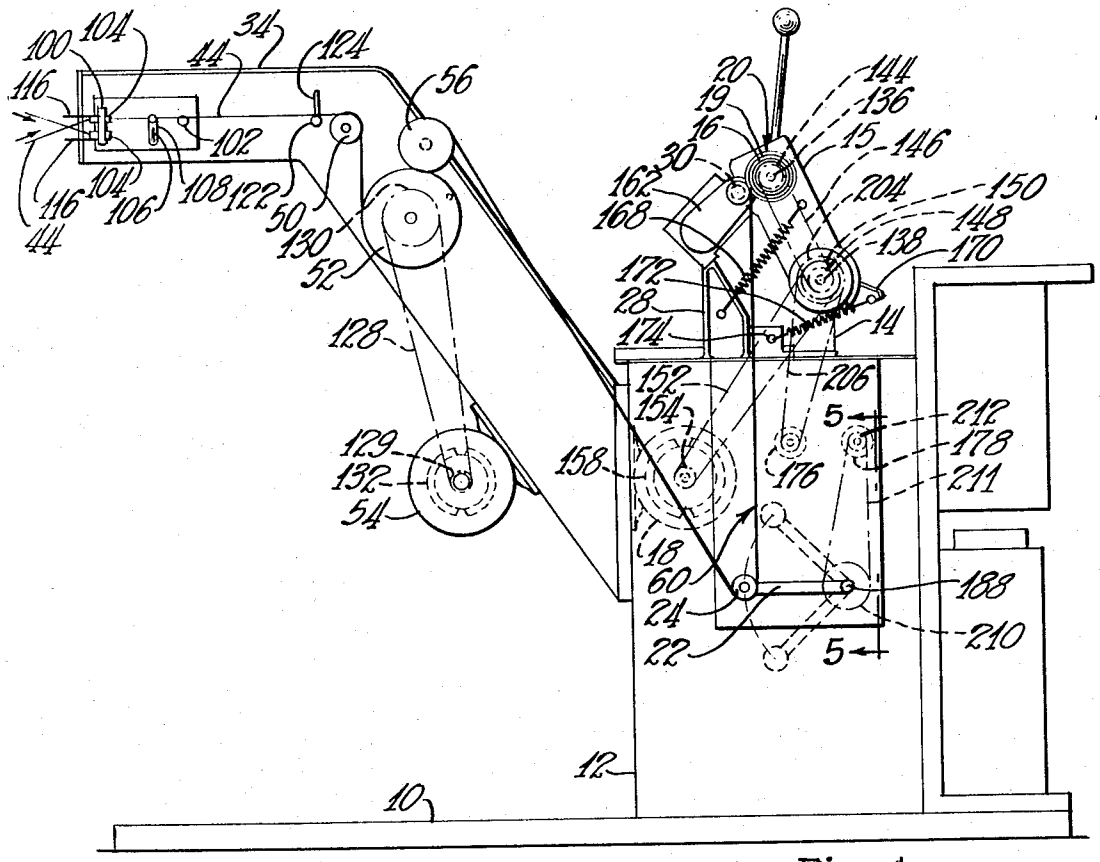


Fig. 4

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METHOD AND APPARATUS FOR PACKAGING STRAND MATERIAL

Filed April 18, 1966 5 Sheets-Sheet 4

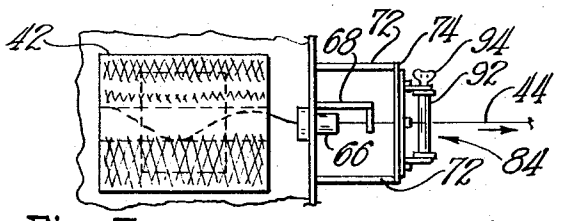


Fig. 7

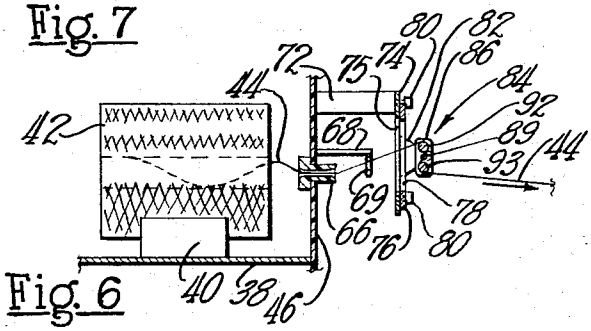


Fig. 6

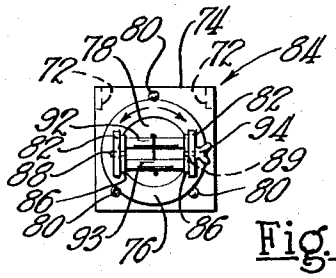


Fig. 8

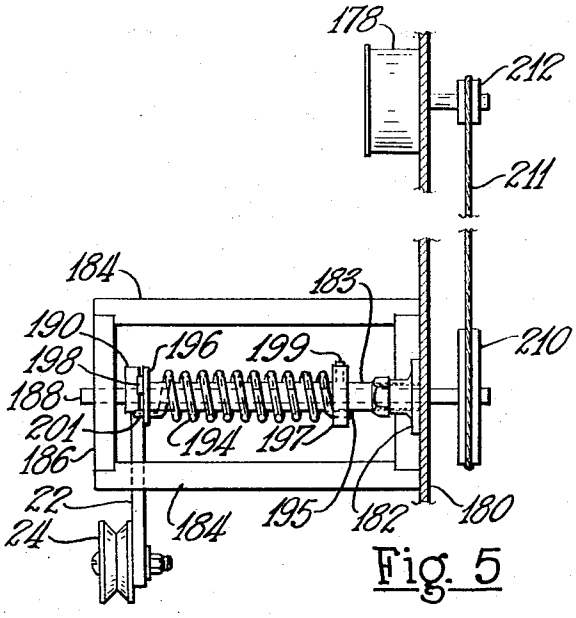


Fig. 5

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METHOD AND APPARATUS FOR PACKAGING STRAND MATERIAL

Filed April 18, 1966 5 Sheets-Sheet 5

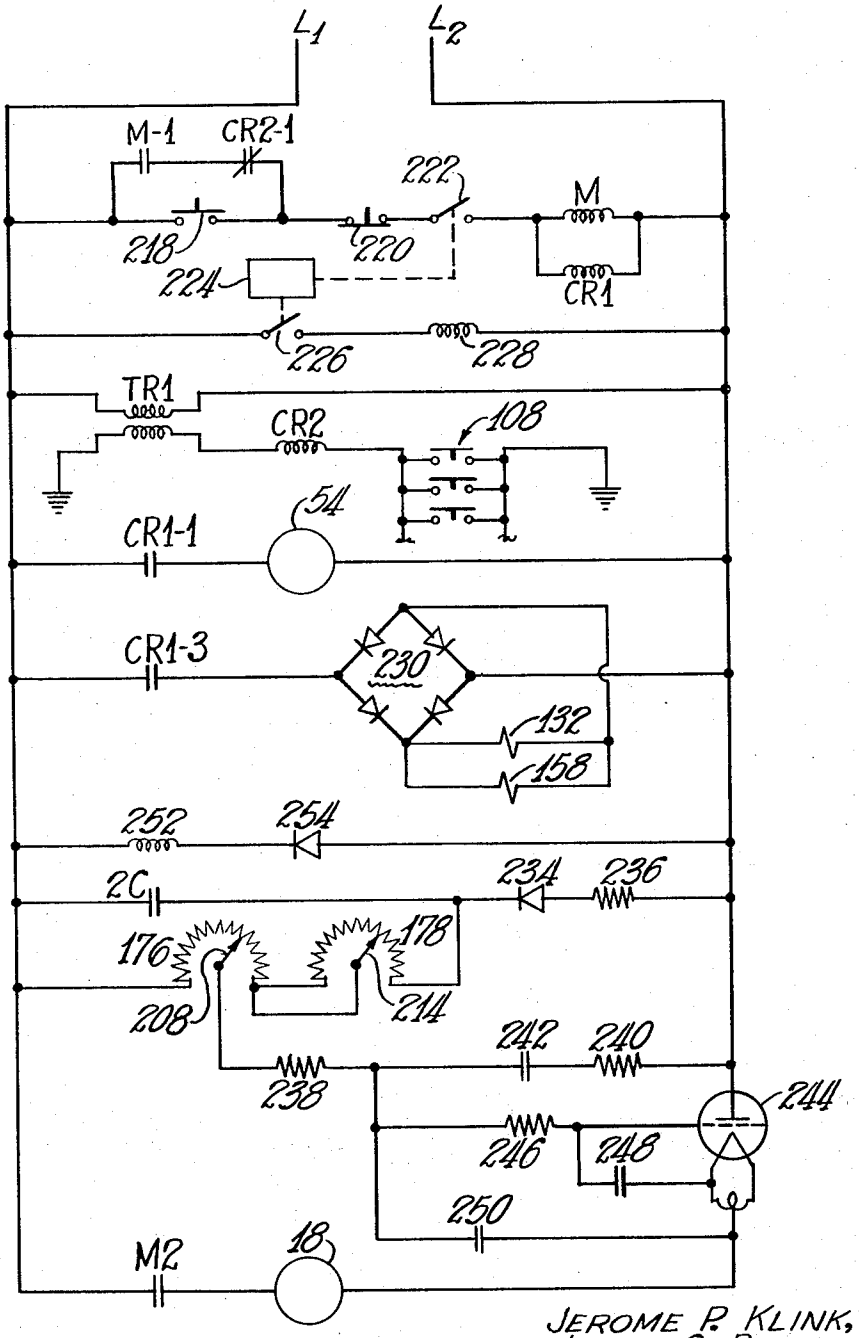


Fig. 9

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United States Patent Office 3,361,375 Patented Jan. 2, 1968

3,361,375

METHOD AND APPARATUS FOR PACKAGING STRAND MATERIAL

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Filed Apr. 18, 1966, Ser. No. 543,247
20 Claims. (Cl. 242—42)

This invention relates to a method of and apparatus for packaging filamentary materials, such as strands, rovings and the like, and more especially to a method of and apparatus for combining strand, rovings and the like of glass filaments into a composite linear product or roving and winding the composite product or roving into a package.

It has been a practice to produce a composite roving product by withdrawing strands or rovings from creel supplies thereof and converging the strands or rovings into a group and winding the group on a rotatable packaging tube or collector. It is found that the composite linear product or roving packaged in this fashion when withdrawn from the package exhibits multiple catenaries or a separation of the strands or rovings in the composite product which impair further processing of the product as well as to reduce the strength characteristics of the composite product.

This condition ensues because of unequal tensions of the individual strands or rovings during the winding of the group of strands or rovings into a composite roving or product. This condition of the product is usually referred to as "catenary" and exemplifies a looseness or slack of one or more strands or rovings in the composite group because the unequal tensions establish minute differences in length of the individual strands or rovings making up the composite product. Subsequent processing of composite rovings having catenaries fosters breakage of individual filaments resulting in a high fuzz level and reduced strength characteristics of the product.

The present invention embraces a method of combining groups or bundles of filaments, strands or rovings into a composite group or roving and packaging the composite group or roving by winding in a manner assuring equal tension of the individual strands or rovings in the group to eliminate the presence of catenaries in the group.

Another object of the invention resides in a method of combining strands or rovings, especially strands or rovings of glass filaments, into a composite product or roving in a manner wherein each of the strands or rovings making up the product is subjected to equal tension as they are collected into a composite roving or product whereby the strength characteristics of the composite product are greatly improved.

Another object of the invention resides in a method of withdrawing strands or rovings from a creel at equal linear speeds whereby to produce a product wherein the strands or rovings are of equal lengths.

Another object of the invention resides in an apparatus for processing and packaging a group of strands or rovings, particularly strands or rovings of glass filaments, into a composite roving, the apparatus embodying means for establishing equal tension in each strand or roving prior to collection of the group into a wound package.

Another object of the invention resides in an apparatus wherein the tension of a composite linear product of strands or rovings is maintained substantially constant during winding of the product in a package whereby the tension in the package is maintained constant throughout the package irrespective of the size of the package.

Another object of the invention resides in an apparatus for combining strands or rovings into a composite linear product or roving embodying an arrangement for interrupting winding or collection of the product in the event of malfunction or breakage of a strand or roving to thereby automatically avoid packaging a substandard product.

Another object of the invention is the provision of a winding apparatus embodying a positive feed means for multiple strands or rovings supplied from a creel to the winding mechanism to assure equal tension in individual strands or rovings advanced to the winder in combination with means modifying or modulating the speed of the packaging collector as the package increases in size and continuously and concomitantly modulating the speed of the collector under the influence of tension in the group of rovings or strands or composite roving being packaged to establish uniform tension throughout the package.

Another object of the invention resides in a method of and apparatus for winding a group or bundle of strands or rovings into a composite roving or product at comparatively high speeds and thereby reduce the cost of packaging.

Another object of the invention resides in an apparatus adaptable for combining a small or a large number of strand or roving ends into a composite roving or product and winding the product into a package wherein the strands or rovings in the product are under uniform tension and hence of equal length substantially eliminating catenaries.

Further objects and advantages are within the scope of this invention such as relate to the arrangement, operation and function of the related elements of the structure, to various details of construction and to combinations of parts, elements per se, and to economies of manufacture and numerous other features as will be apparent from a consideration of the specification and drawing of a form of the invention, which may be preferred, in which:

FIGURE 1 is a schematic elevational view of one form of apparatus for carrying out the method of the invention;

FIGURE 2 is an elevational view of means for feeding individual strands or rovings in spaced relation preparatory to collecting them in a composite roving or product;

FIGURE 3 is a top plan view of the arrangement illustrated in FIGURE 2;

FIGURE 4 is an enlarged elevational view of the strand or roving feed means and winding apparatus shown in FIGURE 1;

FIGURE 5 is a sectional view taken substantially on the line 5—5 of FIGURE 4;

FIGURE 6 is an enlarged vertical sectional view illustrating a roving or strand tension control at the region of withdrawal from a supply package;

FIGURE 7 is a top plan view of the arrangement shown in FIGURE 4;

FIGURE 8 is an end view of the arrangement shown in FIGURE 4; and

FIGURE 9 is a schematic diagram of the circuit and electrical components of the apparatus.

While the method and apparatus of the invention are particularly usable for packaging a composite roving or end product comprising multiple strands for rovings formed of filaments of glass, it is to be understood that the method and arrangement may be utilized wherever it is desired to maintain equal tension in linear bodies assembled into a composite product.

Referring to the drawings in detail and initially to FIGURE 1, there is illustrated a form of apparatus of the invention for combining strands of rovings supplied from packages on a creel into a single bundle, group or

composite roving and winding same into a package. The apparatus is inclusive of a base 10 on which is mounted a housing or frame structure 12 which supports or encloses operating components and control means therefor. The housing 12 is provided with an upwardly extending frame portion 14 on which a winding head 15 is mounted, a winding mandrel 16 being journaled on the head being driven by an electrically energizable motor 18, the mandrel mounting a collector or thin-walled tube 19 upon which the composite roving or end product is collected into a wound package 20.

Pivotally mounted by means carried by the housing 12 is a tension control arm 22 having at its distal end a roving guide means or member 24 mounted on the tension control arm 22. In the apparatus illustrated the roll 24 is fashioned with a peripheral groove to converge the strands or rovings into a single group or composite roving preparatory to winding the composite roving or end product into the package 20. Also mounted on the housing is a member 28 which supports a rotatable traverse means 30 which reciprocates a guide lengthwise of the package and its supporting mandrel 16 and is engaged by the group or bundle of strands or roving making up the composite roving end product 60.

The traverse means or guide 30 is reciprocated throughout the full length of the package 20 to guide the composite roving onto the package to form a square end package. The traverse 30 is reciprocated by means (not shown) driven by the motor 18 to establish the proper speed ratio of reciprocation of the traverse 30 with respect to the mandrel driving motor 18 to maintain the pattern of collection of the roving constant throughout the package as package increases in size. The traverse guide 30 is maintained close to the package throughout the entire winding of the package, the pivotally supported head 15 accommodating the increasing size of the package.

The composite roving 60 comprises a plurality of individual strands or rovings supplied packages mounted on a creel frame. As shown in FIGURE 1, there is provided a package support means or creel frame 38 having a plurality of cradles 40 providing mounting means for packages 42 of strands or rovings 44 to be combined into the composite roving 60. While FIGURE 1 illustrates the frame 38 as supporting packages in vertically spaced relation, it is to be understood that the creel frame 38 extends transversely and is adapted to support several vertical tiers of strand or roving supply packages in adjacent relation.

The creel frame 38 is equipped with a thread board 46 provided with openings accommodating guide bushings 48, there being a guide bushing for each strand or roving 44.

Suitable tension devices for adjusting the tension in each strand or roving will be hereinafter described. The arrangement includes means for simultaneously withdrawing and feeding a plurality of strands or rovings from the packages mounted upon the creel frame 38.

Journally supported upon a supplemental frame structure 34 is an idler roll 50 for guiding the individual strands or rovings 44 toward a strand or roving feed or pull roll 52 driven by a motor 54 at a substantially constant speed. The strands or rovings 44 engage the pull roll or feed roll 52 and a cooperating nip roll 56, and are advanced to the guide member or grooved roll 24 carried by the pivotally supported tension arm 22. The guide 24 provides a gathering means for converging the strands or rovings 44 into the single roving 60 which is a composite of the several rovings or strands.

It is essential to maintain the same tension in each of the strands or rovings processed by the method of the invention in order to eliminate caternary. One form of construction for establishing initial tension in each of the strands or rovings 44 is shown in FIGURES 6 through 8. The thread board 46, supported by the creel frame 38, is equipped with a guide bushing 66 adjacent each package 42 of strand or roving through which the strand or roving 44 is drawn by the pull or feed roll 52.

Mounted adjacent each of the guide bushings 66 is a member 68 preferably of phenolic resin and fabric laminate commercially known as Micarta, each member 68 provided with a slot 69 through which the strand or roving 44 is threaded to properly direct the strand or roving to the tensioning means. A support means 72, secured to the thread board 46, is provided with a plate 74 fashioned with a circular opening 75. Disposed contiguous with a surface of the plate 74 is an annular disc-like member 76 fashioned with a circular opening 78. Disposed adjacent the periphery of the annular member 76 are threaded members or screws 80 threaded into openings in the plate 74.

The screws 80 are disposed close to the periphery of the plate 76 whereby the heads of the screws overlap a major surface of the plate and secure the annular member 76 to the plate 74. The screws 80 may be released and the annular member 76 rotated to adjust the position of the annular member 76 with respect to the plate 74. Extending from the annular member 76 are spaced brackets 82. Disposed between the brackets is an adjustable tensioning means 84 comprising spaced plates 86 pivotally supported by trunnions 88 and 89 as shown in FIGURE 8. Disposed between and connecting the plates 86 are rods 92 and 93, preferably glass rods disposed in spaced parallel relation.

The plates 86 and the rods 92 and 93 carried thereby provide an adjustable tensioning unit 84 which may be rotated about the axes of the trunnions 88 and 89 to regulate the tension in the roving or strand 44 as it is withdrawn from a package.

The trunnion 89 has a threaded portion adapted to receive a winged nut 94 for locking the tension unit or device 84 in a desired adjusted position. As hereinbefore mentioned the creel frame 38 extends transversely and supports additional groups of roving or strand packages in vertically stacked relation. The rovings 44 from the several packages are converged to an extent whereby the rovings are in laterally spaced relation as shown in FIGURE 3 in advance of their engagement with a feed roll system.

The feed roll system is adapted to advance the several individual strands or rovings 44 in spaced relation at a constant speed to establish and maintain uniform tension in all of the rovings or strands. Disposed forwardly of the creel support 38 and mounted on the supplemental frame 34 is a strand or roving guide means comprising spaced plates or members 98 and 99, the member 98 being fixedly secured to the frame 34. The plates 98 and 99 are joined together and held in spaced relation by a guide bushing support bar or member 100 and a rod 102, as shown in FIGURES 2 and 3.

The bar 100 is provided with a plurality of openings, guide bushings 104 being disposed in the openings for guiding the strands or rovings 44. Extending between the plates 98 and 99 and spaced from the guide bar 100 and rod 102 is a second bar 106. Disposed along the bar 106 are drop members or drop wires 108, each having an elongated slot 110 accommodating the bar 106.

Each of the members 108 is fashioned with a guide eye to accommodate a roving 44. The bar 106 is provided at its upper edge region with an insulated conductor 112 extending lengthwise of the bar.

Each of the drop members or drop wires 108 is held in elevated position as shown in FIGURE 2 by tension of the roving threaded through the guide eye in the drop member. When a roving is broken, the member 108 normally supported thereby falls by gravity whereby the upper end of the slot 110 engages the conductor 112 to complete a circuit through a relay CR2, shown in FIGURE 9, to interrupt the circuits of the winding motor 18 and feed roll motor 54 and initiate the operation of braking mechanism for the feed roll and winder motors to

instantly interrupt advancement of all of the strands or rovings 44. Upon splicing the broken roving, the tension on the roving returns the adjacent member 108 to its elevated position to restore conditions to normal for continuing a winding operation.

The guide bar 100 is equipped with a plurality of projections 116 which may be in the form of spring wires extending from the bar 100 toward the advanced rovings 44. The projections 116 are disposed close to the bushings 104 supported by the bar 100 and are for the purpose of engaging a loop or snag in a strand or roving 44 to prevent the defective strand or roving from advancing to the feed mechanism.

When a loop or snag in a strand or roving is impaled or caught on a projection, the strand or roving is broken by the sudden increase in tension and the winding operation automatically stopped by the falling of the adjacent drop member or drop wire 108 to energize a relay CR2, illustrated in FIGURE 9 to interrupt the operation of the feeding and winding apparatus.

One of the features of the invention is the positive feeding of the individual strands or rovings 44 simultaneously by orientation of the individual rovings in a pattern whereby they are fed or advanced by feed rolls at a constant linear rate. The driven feed roll 52 is journally supported in suitable bearings mounted in the supplemental frame 34, the pressure or nip roll 56 being biased into engagement with the strands or rovings 44 moving partially around the feed roll 52 and the pressure roll 56.

Springs 120 are effective on the shaft 57 supporting the pressure roll 56 to prevent any slippage of the rovings or strands 44 relative to the feed and pressure rolls 54 and 56. As particularly shown in FIGURE 3, the individual rovings or strands 44 are arranged in uniformly spaced relation as they engage the idler roll 50. Disposed adjacent the roll 50 is a comb bar 122 provided with spaced teeth or projections 124, the projections serving to maintain the rovings or strands 44 in uniformly spaced transverse relation or pattern preparatory to their engagement with the idler roll 50.

The feed roll motor 54 drives the feed roll 52 by a driving chain 128 engaging sprockets 129 and 130 on the motor shaft and feed roll shaft respectively. The motor 54 is equipped with an electrically actuated brake 132 which is actuated in a manner hereinafter described. Through the above-described arrangement each roving or strand 44 is positively advanced at the same linear speed.

The shaft 136 mounting the winding mandrel 16 is journally mounted for rotation in bearings carried by the pivotally supported head 15. A sprocket 144 on the mandrel shaft 136 is connected by a driving chain 146 with a sprocket 148 mounted on the shaft 138. Also mounted on the shaft 138 is a sprocket 150 connected by a driving chain 152 with a sprocket 154 securely mounted on the shaft of the motor 18. The motor 18 is equipped with an electric brake 158 for stopping the winding operation in the event of breakage of a strand or roving 44. The motor 18 drives the winding mandrel 16 through the media of the chains 146 and 152 and associated sprockets. Through this arrangement the head 15 is adapted to pivot about the axis of the shaft 138 as the package 20 of roving 60 increases in size.

The roving 60 is traversed lengthwise of the mandrel 18 by conventional traverse means in order to distribute the roving lengthwise of the mandrel and collector tube 19 in forming the package.

The traverse shaft 160 is of conventional construction provided with a double reverse cam groove for reciprocating a traverse guide member or guide eye (not shown) through which the composite roving 60 is threaded to guide the roving onto the collector or packaging tube 19. The rotatable traverse means or traverse roll 30 is journaled in and enclosed by a housing 162, the traverse being driven by the motor 18 through conventional drive means (not shown).

The mandrel supporting head 15 is biased by spring pressure in a counterclockwise direction as viewed in FIGURE 4 to maintain the surface of the package of roving being formed in contact with the traverse roll 30. The biasing means is inclusive of a first contractile spring 168 disposed between the head 15 and the bracket 28, as shown in FIGURE 4. A bracket 170 is adjustably carried by the head 15, the means of adjustment not being shown as it is conventional. A second contractile spring 172 is connected with the bracket 170 and with a stationary anchor member 174 mounted on the frame of the winding machine.

This arrangement of spring biasing means for a roving winding head is conventional, two springs 168 and 172 being employed to compensate for variable factors such as the initial weight of the head 15 and mandrel, the increase in package weight as the package increases in size and the decrease in the force vector as the head 15 is pivoted in a clockwise direction toward a vertical position through the axis of the shaft 138 providing the pivotal support for the head.

The pressure and weight biasing compensation of the springs 168 and 172 providing for these variable factors is attained by adjusting the relative position of the bracket 170 with respect to the winding head 15.

The motor 18 is of a character energized by direct current in which the speed is progressively reduced as the package 20 of roving increases in size during a winding operation. As hereinafter described in connection with the circuit diagram of FIGURE 9, the means for reducing the speed of the motor 18 is initiated and controlled by potentiometers 176 and 178. The group of rovings or strands 44 leaving the roll 56 are converged to a composite roving 60 by the grooved guide member 24 mounted upon the movable tension arm 22.

The arm 22 is under spring pressure tending to bias the arm for movement about its support in a counterclockwise direction as viewed in FIGURE 4 to maintain continuous tension on the roving 60. The mounting of the arm 22 is illustrated in FIGURE 5. Secured to a plate 180 which is mounted on the housing 12 is a bracket 182 to which is secured a tubular cylindrical member 183. Extending forwardly of the plate 180 are support members 184 connected at their outer ends by a bar or member 186. Journally supported in the tubular member 182 and an opening in the member 186 is a shaft 188. The arm 22 is engaged by a member 190 which is secured to the shaft 188.

The member 183 provides a support for a coil spring 194. Journally mounted upon the shaft 188 is a member 196 having a lug 198 adapted for engagement with member 190 secured to the arm 22. One end 195 of the spring 194 is anchored to a collar 197 which is secured to member 183 by a setscrew 199. The collar may be adjusted relative to the member 183 to adjust the tension of the spring 194. The other end 201 of the spring 194 adjacent the member 196 is engaged with the member 196. The spring 194 is tensioned in a direction to bias the arm 22 in a counterclockwise direction as viewed in FIGURE 4.

Tension of the spring 194 is transmitted to the arm through member 196 to constantly maintain tension on the rovings or strands 44 passing around the guide member 24 and the composite roving 60 comprising the converged group of rovings or strands 44.

An important feature of the invention is the maintenance of uniformly constant tension on the composite roving 60 during the entire period of winding the same on the collector 19 on the mandrel 16. Mounted upon the shaft 138 supporting the head 15 is a drum 204 which is connected to the arm 208 of the potentiometer 176, shown in FIGURE 9, by a flexible wire belt 206. Through the medium of the wire belt 206 the relative pivotal movement of the head 15 in a clockwise direction as viewed in FIGURE 4 caused by the increasing size of the roving

package 20 effects progressive movement of the arm 208 of the potentiometer 176 to progressively reduce speed of the motor driving the mandrel 16 and package collector 19 as the package increases in size.

The second potentiometer 178 is in series with the potentiometer 176 as shown in the circuit diagram of FIGURE 9. The shaft 188, supporting the tension arm 22, is provided with a pulley 210 connected by a flexible wire belt 211 with a pulley 212 mounting the potentiometer arm 214 of the potentiometer 178. The potentiometer 178 is sensitive to minute pivotal movements of the tension control arm 22 and supplements the potentiometer 176 to vary the speed of the package winding motor 18 to continuously vary the motor speed to compensate for relative movements of the tension control arm 22 which movements occur by reason of the traverse of the composite roving lengthwise of the package, the traversing of the roving 60 at the package surface causing continuous change in the angularity of the roving between the guide member 24 on the arm 22 and the traverse guide eye.

The continuous change in angularity of the roving results in a continuously varying movement of the arm 22 and a corresponding varying movement of the potentiometer arm 214 to effect a continuously changing adjustment of the potentiometer 178 to vary the speed of the winding motor 18 as hereinafter explained.

The circuit diagram, shown in FIGURE 9, illustrates the specific components of the apparatus and controls therefor. In the operation of the apparatus, the individual rovings or strands 44 derived from the supply packages 42 are respectively threaded through the guide bushings 48 in the thread board 46 and through the tensioning devices 84 illustrated in FIGURES 6 through 8, and generally converged whereby each of the rovings or strands 44 is threaded through a guide bushing 104 in the guide member 100, shown in FIGURES 3 and 4.

Each individual tension device 84 is adjusted to secure uniform tension in each of the rovings or strands 44 and each tension device adjusted by rotating the mounting plate 76 to provide the proper angle of convergence for a strand or roving 44 and the locking screws 80 drawn up to hold each mounting plate 76 in adjusted position. The strands 44 threaded through the guide bushings 104 are threaded through guide eyes in the tension sensing bars or drop wires 108, thence over the bar 102 and each roving threaded between adjacent teeth 124 of a comb 122 so that the several rovings are in equally spaced relation and in the same plane as they engage the idler roll 50.

The advancing rovings or strands 44 in spaced relation engage the driven feed roll 52 and the pressure or nip roll 56, the rovings being converged into a composite group or composite roving by the gathering shoe or guide member 24 mounted at the distal end of the tension arm 22. The winding of the group of rovings or composite roving 60 is initiated by the operator manually threading the composite roving through the traverse guide eye associated with the traverse means 30 and manually winding a few turns of the roving on the collector or packaging tube 19 carried by the mandrel 16, after which the operator closes the starting switch 218, shown in FIGURE 9.

Conventional alternating current is provided from a supply through conductors L1 and L2, shown in FIGURE 9. A stop switch 220 is in series relation with the starting switch 218. The relay CR1 controls the operation of the feed roll motor 54 through contact CR1–1.

The solenoid of the control M energizes a holding relay M1 and energizes the winding mandrel drive motor through contact M2. A switch 222 controlled by the yardage counter 224 interrupts the circuit to stop the winding operation when a predetermined yardage is wound in the package. With reference to FIGURE 3, the yardage counter 224 is equipped with a pulsing switch 226 actuated by means 227 associated with or carried by the feed roll 52, the switch being of conventional construction, preferably of the electronic type for integrating the yardage accumulating in the package 20. The counter coil 228 for the pulsing switch 226 is shown in FIGURE 9.

The primary of a transformer TR1 is connected across the supply lines L1, L2. The transformer TR1 provides reduced voltage for the circuit of the drop members or drop wires 108 for interrupting operation of the winding apparatus when any one of the rovings or strands 44 is broken. The relay CR2 is provided with a contact CR2–1 in circuit with the control relays CR1 and M to interrupt the energization of both the roving winder motor 18 and the feed roll motor 54 upon energization of the relay CR2 when one of the members or drop wires 108 completes a circuit through the secondary of the transformer TR1.

The braking means 132 for the feed roll motor 54 and the braking means for the brake 158 of the motor 18 driving the winding mandrel are of the solenoid operated, contracting shoe type of conventional construction adapted to be actuated by direct current.

As shown in FIGURE 9, a rectifier 230 is provided for supplying direct current to the braking means 132 and 158. The relay contact CR1–3 is intercalated in the circuit of the rectifier 230 and is actuated to energize the motor braking means 132 and 158 when the relay CR2 interrupts the motor circuits through the contactors CR–1 and CR2–1.

The winding motor 18 is operated by direct current and a compensator means embodied in the control circuit for the motor 18 to vary the motor speed for establishing constant tension on the composite roving 60 being fed to the collector on the winding mandrel and maintaining uniform linear speed of the roving as the package 20 increases in size. The compensator includes the potentiometers 176 and 178 arranged in series relation and in circuit with a rectifier 234, a resistance 236 being connected in the rectifier circuit. A condenser 2C is connected across the potentiometer circuit. The circuit connected with the potentiometer arm 208 includes resistances 238 and 240 and a condenser 242 connected with the anode of a triode control tube or thyratron 244.

A third resistance 246 is connected between the potentiometers and the grid of the thyratron 244. A condenser 248 is shunted between the anode and the grid and a condenser 250 connected between the anode and the resistance 238. A shunt field 252 for the motor 18 is in series with a rectifier 254.

Through this circuit the motor 18 is operated by direct current and its speed is modulated or progressively reduced as the package 20 increases in size through the voltage divider position provided by the potentiometers 176 and 178.

The arrangement provides for substantially constant tension throughout the entire winding operation in forming a package. The position of the potentiometer arm 208 is progressively moved in one direction as it is actuated or controlled by the relative position of the head 15 carrying the winding mandrel 16. As the roving package increases in size, the potentiometer arm 208 is progressively moved and, through the thyratron control 244, progressively reduces the speed of the package winding motor 18 as the package of roving increases in size.

The arm 214 of the highly sensitive potentiometer 178 is controlled by the relative position of the tension arm 22 carrying the guide member 24 for the roving 60, the potentiometer 178 supplementing the potentiometer 176 to maintain substantially constant the tension in the composite roving at all times during the package winding operation. The arm 22 is continuously oscillating during a winding operation due to the changing angularity of the roving 60 between the winding region on the package and the roving guide member 24 due to the traversing of the composite roving lengthwise of the package during package winding. Movements of the tension arm 22 are transmitted to the potentiometer 178 to continuously modulate the speed of the winding motor 18.

Through the maintenance of substantially constant tension in the composite roving as it is wound into a package and the maintenance of constant feed rate of individual rovings or strands **44** and maintenance of constant tension thereof prior to their convergence into the composite roving **60**, there is no tendency for catenary formation of individual rovings or strands in the composite roving **60** and catenary thereby substantially eliminated in packaging the roving.

Should one of the strands or rovings **44** be broken, the drop member **108** normally supported thereby is released because of failure of tension in the broken roving or strand and falls by gravity, completing a circuit through the relay contacts CR2 and CR2-1 to interrupt the circuit to both the motors **18** and **54** and energize the brake mechanisms **132** and **158** to immediately stop the winding operation. When the package is completed, the counter-controlled switch **220** is automatically opened to de-energize the circuits of the motors **18** and **54**. After the completion of the package, the operator doffs the package from the mandrel **16**, telescopes an empty tube or collector **19** on the mandrel and winding of the composite roving **60** begun on the empty tube in the manner hereinbefore described.

It is apparent that, within the scope of the invention, modifications and different arrangements may be made other than as herein disclosed, and the present disclosure is illustrative merely, the invention comprehending all variations thereof.

We claim:

1. The method of packaging roving including engaging a plurality of individual rovings with a movable surface with the rovings arranged in side-by-side relation on the surface, establishing tension in each of the rovings, moving the surface to advance the rovings at substantially constant speed, converging the individual rovings into a composite roving, winding the composite roving upon a rotating collector into a package, and maintaining substantially constant the tension in the composite roving during formation of the package.

2. The method according to claim **1** wherein the individual rovings are bundles of filaments of glass.

3. The method of packaging filamentary material including engaging individual groups of filamentary material with a feed roll with the individual groups arranged in side-by-side relation on the feed roll, rotating the feed roll to advance the groups from supply packages at substantially constant speed, regulating the tension in each group, converging the groups into a single bundle, winding the bundle upon a rotating collector into a package, and maintaining constant the tension in the bundle during formation of the package.

4. The method of packaging filamentary material including engaging individual groups of filamentary material with a movable surface, moving the surface to advance the groups at a substantially constant speed, combining the advancing groups into a single bundle, winding the bundle upon a rotating collector into a package, and modulating the speed of the rotating collector for maintaining substantially constant the tension in the bundle during formation of the package.

5. The method according to claim **4** including the steps of establishing tension in each of the groups advancing toward the movable surface, and regulating the tension in each group.

6. The method of winding groups of filamentary material into a package including engaging the groups of filamentary material with tension establishing surfaces individual to each group, spacing the individual groups in a common plane, engaging the groups while in spaced relation with a feed roll, rotating the feed roll to advance all of the groups simultaneously, converging the groups into a single bundle, winding the bundle on a rotating collector into a package applying pressure on the bundle at the region of convergence of the groups to establish tension in the bundle, and modulating the speed of rotation of the collector to maintain constant the tension in the bundle.

7. The method of forming and packaging a composite roving from individual rovings from supply packages including the steps of engaging each of the individual rovings with a feed roll with the rovings arranged in side-by-side relation on the feed roll, rotating the feed roll by a constant speed motor to advance all of the rovings simultaneously, engaging the advancing rovings with a movable gathering means to converge the rovings into a single composite roving, rotating a collector by a variable speed motor, winding the composite roving on the collector, applying pressure on the gathering means to establish tension in the composite roving, and modulating the speed of the variable speed motor to wind the composite roving on the collector at a constant linear speed.

8. The method according to claim **7** including the steps of traversing the composite roving to distribute the roving lengthwise of the package, and further modulating the speed of the variable speed motor under the influence of movements of the gathering means during traversing of the the composite roving to maintain substantially constant the tension in the composite roving.

9. The method according to claim **7** including sensing the tension in each individual roving in advance of its engagement with the feed roll, and de-energizing the motors upon failure of tension in an individual roving.

10. The method according to claim **7** including the steps of continuously integrating by a counter the yardage being wound in the package, and de-energizing the motors under the influence of the counter when a predetermined amount of yardage is wound into the package.

11. Apparatus for packaging composite roving comprising a plurality of individual rovings including, in combination, support means, a winding collet mounted for rotation on the support means upon which the composite roving is wound into a package, traverse means for traversing the composite roving lengthwise of the package, feed means for withdrawing simultaneously a plurality of individual rovings from supplies thereof and delivering them to the winding collet, means for driving the feed means, means between the feed roll and winding collet for engaging and converging the individual rovings delivered from the feed means into a composite roving, motive means for driving the winding collet and traverse means, and a member influenced by tension in the rovings adapted to modulate the speed of the motive means for maintaining constant the tension in the composite roving being wound in the package.

12. Apparatus for packaging composite roving including, in combination, support means, a winding head movably mounted on the support means, a winding mandrel journaled on said head on which the composite roving is wound into a package, motive means for rotating the mandrel, a feed roll journaled on the support means, means for rotating the feed roll, means for guiding a plurality of individual rovings in spaced relation from a supply into engagement with the feed roll, a relatively movable member disposed between the feed roll and mandrel engaging and converging the individual rovings into a composite roving, means for modulating the speed of the motive means as the package on the mandrel increases in size, and means controlled by movement of said member for further modulating the speed of the motive means for maintaining substantially constant the tension in the individual rovings and the composite roving.

13. Apparatus for packaging filamentary material including, in combination, support means, a rotable winding collet journally mounted by the support means on which the material is wound into a package, motive means for rotating the collet, a movable member mounted by the support means, means for guiding a plurality of individual groups of filamentary material into engagement with the movable member with the groups in side-by-side relation

on the movable member, means for moving the movable member to advance the groups of filamentary material to said collet, a gathering means disposed between the movable member and the winding collet engaging and converging the advancing groups into a single bundle, means for traversing the bundle to distribute the bundle lengthwise of the package during formation of the package, means for effecting relative movement between the winding collet and the traverse means as the package increases in size, and means responsive to movement of the gathering means for modulating the speed of the motive means for the collet.

14. Apparatus for packaging filamentary material including, in combination, support means, a winding head mounted by the support means, a winding collet journaled on said head, a variable speed motor for rotating the collet, a feed roll, a motor for rotating the feed roll at a substantially constant speed, means for guiding a plurality of individual groups of filamentary material into engagement with the feed roll whereby the groups are advanced to said collet by the feed roll, a movably mounted gathering means engaging and converging the advancing groups into a single bundle, the single bundle adapted to be collected into a package on the winding collet, traverse means for distributing the bundle lengthwise of the package, said winding head and said traverse means being arranged for relative movement to accommodate increase in the size of the package during package formation, and a compensator intercalated in the circuit of the variable speed collet drive motor arranged to vary a voltage divider position for modulating the speed of the collet drive motor to maintain substantially constant the tension in the bundle.

15. The combination according to claim **14** wherein the compensator includes a first potentiometer influenced by relative movement between the traverse means and the winding head as the package increases in size, and a second potentiometer controlled by the movably mounted gathering means.

16. The combination according to claim **14** including a relatively movable tension sensing member for each individual group, each tension sensing member being normally maintained in a predetermined position by tension in the adjacent group, and switch means in the circuit of the feed roll and collet drive motors influenced by movement of a tension sensing member upon tension failure of a group to de-energize said motors.

17. The combination according to claim **16** including electrically energizable braking means for said motors set into operation when said feed roll and collet motors are de-energized.

18. The combination according to claim **16** including a plurality of pins disposed adjacent the guide means for the individual groups adapted to snag imperfect groups and effect fracture thereof to thereby initiate movement of a tension sensing member for de-energizing said feed roll and collet drive motors.

19. Apparatus for packaging composite roving comprising a plurality of individual rovings including, in combination, support means, a winding collet journally mounted by the support means upon which composite roving is wound into a package, means for rotating the collet, a feed roll journally mounted by the support means, means for rotating the feed roll, means for guiding individual rovings from supply packages thereof into engagement with the feed roll, tension establishing means for each of said individual rovings disposed between the supply package and the feed roll, each of said tension establishing means being adjustable for regulating tension in each of the individual rovings, a gathering means between said feed roll and collet for engaging and converging the individual rovings into a composite roving, and means regulating the speed of the collet rotating means for maintaining substantially constant the tension in the composite roving.

20. The combination according to claim **19** wherein each tension establishing means includes a pair of members engaging an individual roving, means for adjusting the relative position of said members about one axis with respect to the roving for modifying the tension in the roving, said pair of members being adjustable about a second axis normal to the first axis for varying the angularity of the rectilinear path of the roving moving away from the tension establishing means.

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