March 3, 1970 J. P. KLINK ET AL 3,498,550

APPARATUS FOR FORMING, PROCESSING AND PACKAGING MULTI-STRAND ROVING

Original Filed May 14, 1965 3 Sheets-Sheet 1

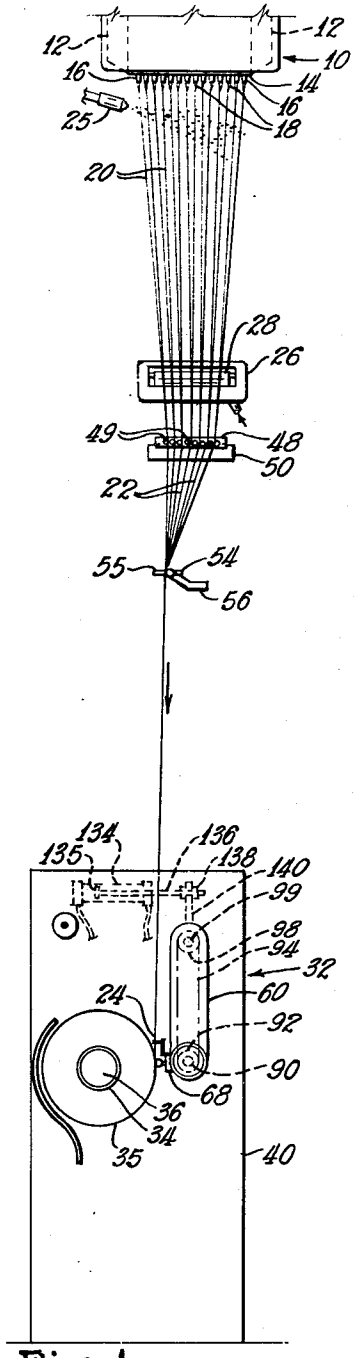


Fig. 1

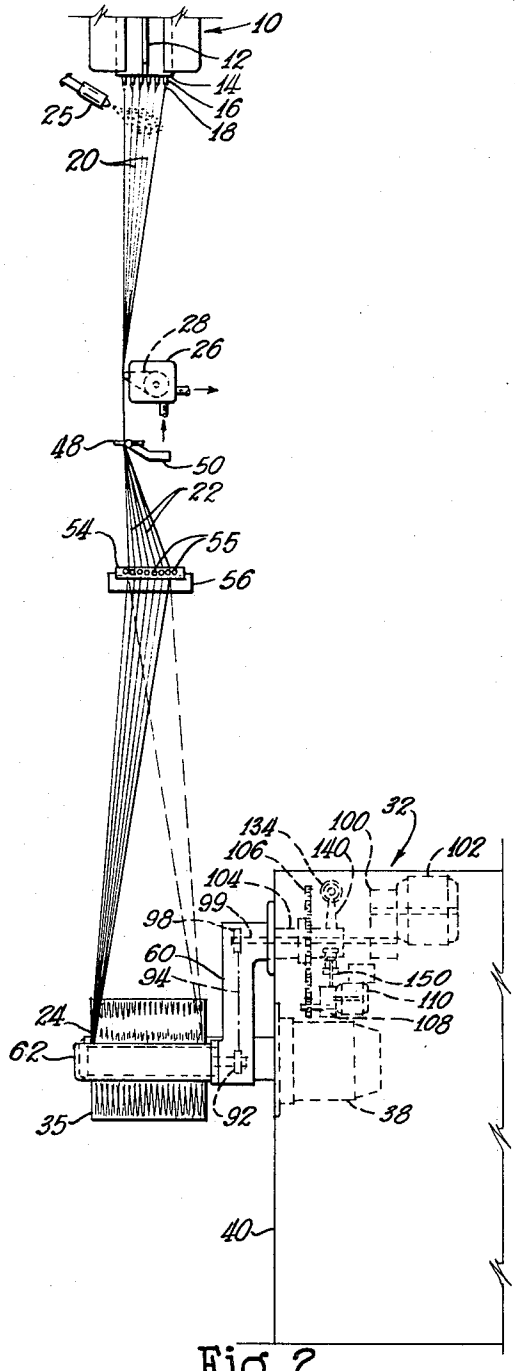


Fig. 2

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Original Filed May 14, 1965 3 Sheets-Sheet 2

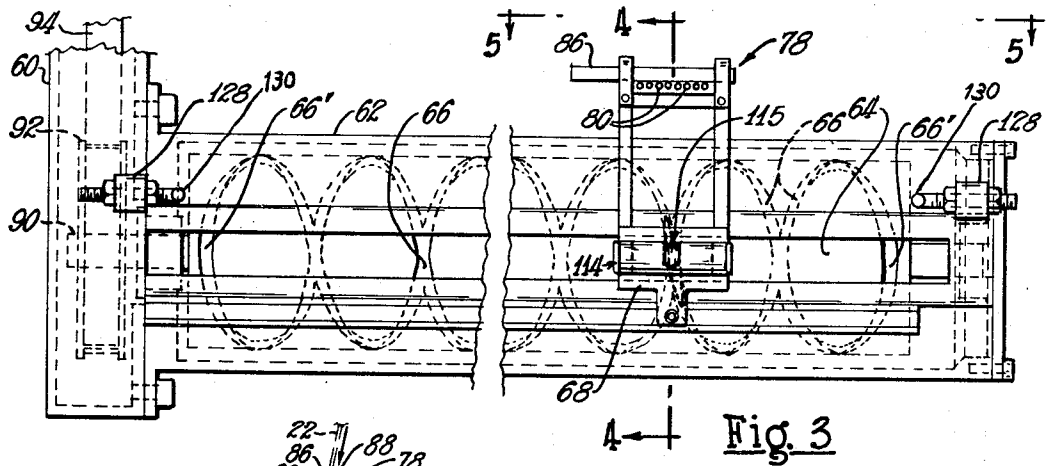


Fig. 3

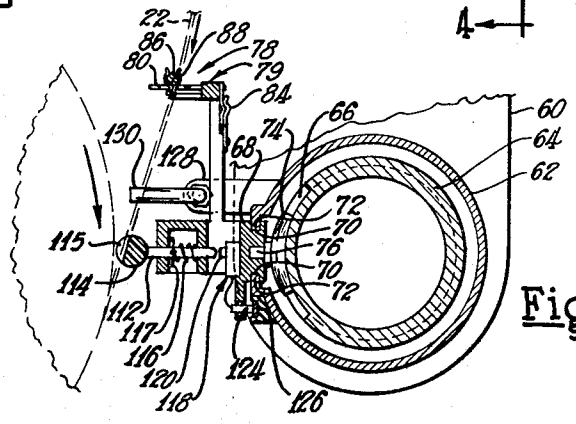


Fig. 4

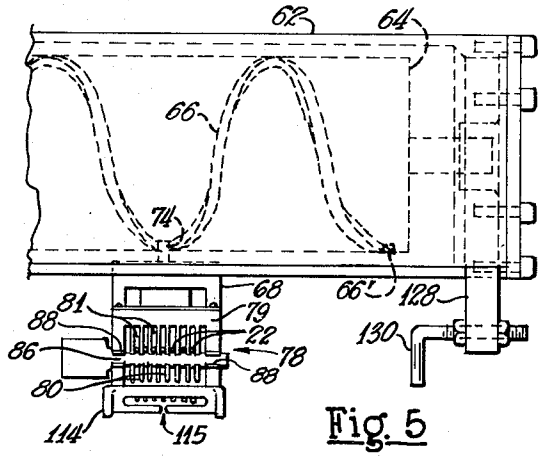


Fig. 5

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March 3, 1970 J. P. KLINK ET AL 3,498,550
APPARATUS FOR FORMING, PROCESSING AND PACKAGING MULTI-STRAND ROVING
Original Filed May 14, 1965 3 Sheets-Sheet 3

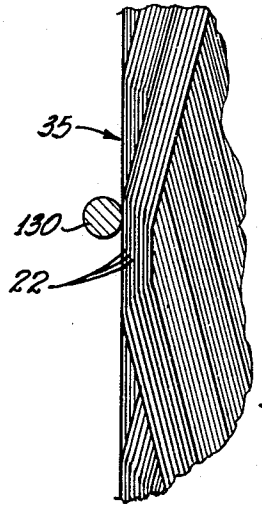


Fig. 6

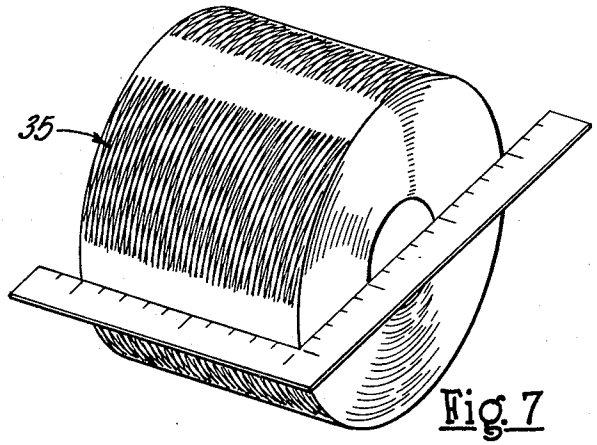


Fig. 7

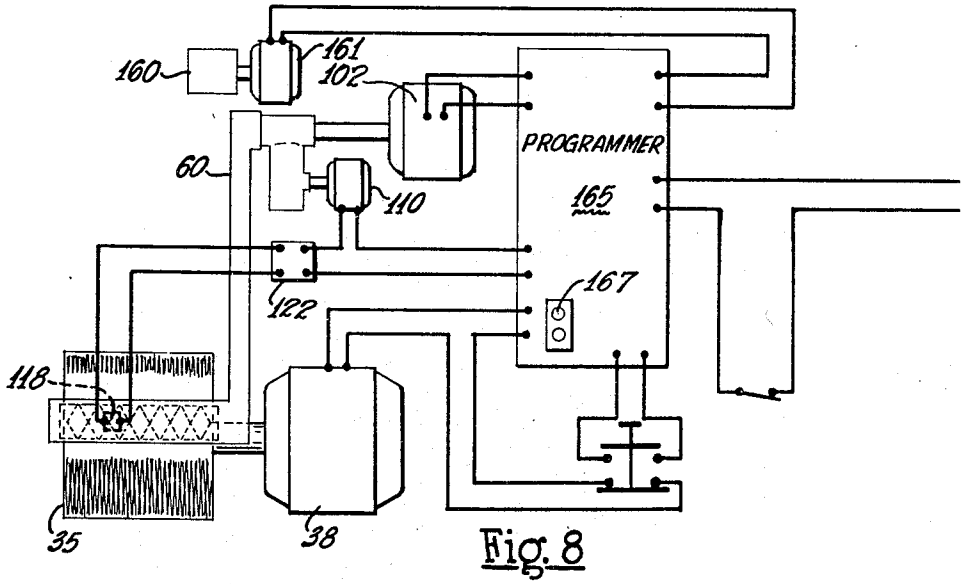


Fig. 8

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United States Patent Office 3,498,550
Patented Mar. 3, 1970

3,498,550

APPARATUS FOR FORMING, PROCESSING AND PACKAGING MULTI-STRAND ROVING

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Original application May 14, 1965, Ser. No. 455,866, now Patent No. 3,371,877, dated Mar. 5, 1968. Divided and this application Jan. 19, 1968, Ser. No. 699,209
Int. Cl. B65h 54/28
U.S. Cl. 242—18 9 Claims

ABSTRACT OF THE DISCLOSURE

This invention relates to apparatus for forming and attenuating streams of mineral material into fibers, segregating the fibers into strands and winding a multistrand roving comprising the strands into a package having its ends in parallel planes normal to the axis of the package, the apparatus including means for compacting the strands at the package ends whereby the package is of cylindrical shape throughout its length.

This is a division of our application Ser. No. 455,866 filed May 14, 1965, now Patent 3,371,877.

This invention relates to apparatus for forming heat-softenable material to filaments and forming a novel roving of the filaments and packaging the roving, and more particularly to attenuating streams of heat-softened material such as glass to filaments, forming strands of the filaments into a multi-strand roving and packaging the roving.

Endeavors have been made to produce comparatively large wound packages of roving of newly formed filaments attenuated from glass streams. Difficulties have been encountered in forming large packages by winding the roving on a winding collet. Heretofore in forming wound packages of roving or a linear group of filaments of glass, it has been a practice to employ a builder method or mechanism providing a tapered end package to prevent sloughing of the roving or linear group of filaments at the package ends, this method necessarily limiting the size of the package.

Heretofore it was deemed desirable to apply size or coating material to the filaments of the roving in order to establish some degree of integrity in the roving to facilitate further procesing. The filaments forming the roving were attenuated at high linear speeds and the filaments being acted upon by an oscillator or traverse means at such high linear speeds and at high oscillator frequencies resulted in an excessive amount of fuzz which impaired the quality of the roving as a certain amount of fuzz is necessarily embodied in the wound package. Such method of packaging could not provide a finished package with square ends normal to the axis of the package or produce a package of substantially uniform diameter throughout the length of a package.

Roving formed of a single linear group of filaments of glass have been employed as reinforcement in articles or products formed of molded resinous material or plastic and in uses where the roving is cut to short lengths for reinforcement, many of the groups of cut filaments are broken into subgroups, some having many filaments and others having only a few filaments. Such condition tends to promote nonuniformity of reinforcement in the end products.

The invention embraces a novel roving product wherein a large number of streams of glass are attenuated to continuous filaments simultaneously, and the filaments

segregated into a plurality of untwisted bundles or strands providing a multi-strand roving wherein the filaments of the strands are not adhered one to another by coating material.

An object of the invention resides in a provision of a wound package of roving comprising a plurality of strands of continuous filaments and wherein the roving is traversed during package formation to effect collection of the strands of the roving in side-by-side relation in successive layers and wherein the pattern of deposition of the roving in each layer is maintained throughout the entire package by varying and correlating the rate of movement of the traverse proportional to the increasing size of the package during its formation.

Another object of the invention resides in a sensing means which is engaged by the package of roving as the latter increases in size, the sensor effecting the operation of mechanism for moving the traverse guide means through incremental distances to maintain the traverse guide means close to the peripheral surface of the enlarging package.

Another object of the invention resides in an apparatus for winding continuous filament multiple strand roving into a package by winding the roving onto a rotating collector, the apparatus including guide means so positioned with respect to the package and the guide traversed in a manner to produce a package of substantially cylindrical shape with square ends.

Another object of the invention is the provision of a traverse means for traversing the roving during the winding of a package wherein the support means for the traverse is movable and its movement controlled with respect to the package by a package sensing means as the package increases in size so as to maintain the guide means for the roving as close as practicable to the region of collection of the roving on the package.

Another object of the invention resides in an apparatus for forming continuous attenuated filaments of heat-softenable material, such as glass, the apparatus embodying means for subdividing the filaments into strands to form a multi-strand roving employing a sensing means responsive to the enlarging package for maintaining a traverse guide for the roving in close proximity to the surface of the package through the periodic repositioning of the guide as determined by the increasing size of the package.

Another object of the invention resides in an apparatus for resetting the traverse guide for the roving at the completion of a package to a position for properly guiding the roving onto an empty collector at the start of a new package.

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 semi-diagrammatic front elevational view of an apparatus for carrying out the method of forming and packaging multi-strand roving;

FIGURE 2 is a side elevational view of the apparatus illustrated in FIGURE 1;

FIGURE 3 is an enlarged front elevational view of the package size sensor and traverse guide means for the roving;

FIGURE 4 is an enlarged cross-sectional view taken substantially on the line 4—4 of FIGURE 3;

FIGURE 5 is a top plan view of a portion of the construction shown in FIGURE 3;

FIGURE 6 is an enlarged view showing a portion of an end of a package of roving illustrating the method of compacting the roving;

FIGURE 7 is an isometric view of a complete package produced by the apparatus of the invention, and

FIGURE 8 is a schematic illustration of components of the apparatus for packaging the roving and controls therefor.

While the apparatus of the invention is particularly usable for forming filaments of heat-softened mineral material such as glass and producing multi-strand roving of the filaments and packaging the roving, it is to be understood that the apparatus may be utilized for forming and packaging roving formed of other fiber-forming materials.

Referring initially to FIGURES 1 and 2 of the drawings there is illustrated a receptacle or feeder **10** containing a supply of heat-softened glass or other filament-forming material. Where the material is glass, the feeder **10** may be connected with a forehearth (not shown) supplied with softened glass from a furnace, or the glass may be reduced to heat-softened condition in a melter or other means connected with the feeder **10**. The feeder or receptacle **10** is provided at its ends with terminal lugs **12** adapted to be connected with a source of electric energy for supplying heat to the material in the receptacle to maintain the material at the proper temperature and viscosity for forming filaments.

The floor or tip section **14** of the feeder **10** is equipped with a large number of depending projections or tips **16**, the tips having orifices therein for flowing streams **18** of the glass or other filament-forming material from the feeder. The streams are attenuated into individual continuous filaments **20**.

A feature of the invention involves forming a multi-strand roving **24** by segregating filaments **20**, attenuated directly from the glass streams **18**, into untwisted strands or bundles **22**. Each strand of the roving comprises about two hundred continuous filaments, all of the filaments of the several strands being simultaneously attenuated from streams of glass flowing from the feeder **10**. The individual filaments are of diameters of twenty hundred thousandths of an inch or more. The large number of filaments making up the strands of the roving and the size of the filaments enables attenuation at comparatively slow linear speed of about four thousand feet per minute with a slow traverse of the roving during package formation. The high throughput of glass facilitates production of the roving at low cost. The several strands comprising the roving are wound into a package.

Nozzles **25** may be provided for directing sprays of water onto the newly formed filaments. It is found that a satisfactory package may be formed of filaments of glass wherein the only material delivered onto the filaments is water from the nozzles **25**. However, it may sometimes be desirable to apply lubricants or other coating materials to the filaments for particular uses. For this purpose an applicator housing **26** supports an applicator **28** which, as shown in FIGURE 2, may be an endless belt partially immersed in coating material contained in the housing for transferring the coating material to the filaments through wiping action of the filaments engaging a film of coating material on the applicator belt **28**.

The roving **24** of a plurality of strands **22** is collected into a package **35** by a winding machine or apparatus **32**, the roving being wound onto a collector, such as a collector tube or sleeve **34**, telescoped onto a rotatable collet **36**.

The winding of the roving into a package attenuates the glass streams **18** to filaments **20**. The winding collet **36** is rotated by an electrically energizable motor **38** contained within a housing **40** of the winding machine.

The speed of the motor **38** is varied in a manner hereinafter explained to reduce the rotational speed of the winding collet **36** as the package of roving **35** increases in size so as to maintain substantially constant the linear speed of the filaments to attenuate filaments of uniform size.

The roving **24** produced by the apparatus of the invention comprises a plurality of strands **22** or groups of filaments which are collected in side-by-side relation in the package **35** in successive layers in a manner to form a square end package, as shown in FIGURE 7.

In forming the multi-strand roving, the filaments **20** drawn or attenuated from the streams **18** are subdivided or separated into strands **22** or groups of filaments shown in FIGURE 1. The filaments are oriented into groups or strands by a guide **48** resembling a comb having a plurality of projections or teeth **49** separating the strands. The strand separating means or comb **48** is mounted upon a support **50** and is preferably removable from the support to enable the operator to engage the strands in the grooves provided by the projections **49** and segregate groups of the advancing filaments into strands.

Disposed below the guide **48** and offset from the median path of the strands is a second comb or strand guide member **54** provided with teeth or projections **55** spaced to accommodate the strands **22**. The comb **54** is mounted upon a support **56** and is preferably removable to enable the operator to thread the strands between pairs of projections on the comb. The comb or strand guide **54** is disposed, as shown in FIGURES 1 and 2, to divert the strands through substantially 90°, one of the purposes being to reduce the tendency of the strands to "whip" under the influence of traverse movements thereof.

An important feature of the invention resides in the arrangement for guiding and traversing the roving as it is wound into a package wherein the traverse guide for the roving is maintained at all times close to the package in order that the strands of the roving be collected in the package in side-by-side relation and such orientation maintained during traverse of the roving throughout the package.

The invention involves the step of compacting the roving at the package ends, viz at the region of reversal of the traverse means to provide support for each preceding layer to assure the formation of a square end package eliminating a stair-step or tapering effect and consequently any tendency for the roving to slough at the package ends, the package ends being formed without lateral support. The traverse guide means for the roving is mounted by an arm **60**, shown in FIGURES 1 through 4, which is of hollow configuration to accommodate a traverse drive means.

The arm is provided with a hollow or tubular horizontal section **62** in which a traverse actuating means or member **64** is journally mounted for rotation. The member **64** is of cylindrical shape fashioned with a multiple return groove or cam **66** for reciprocating a traverse member **68**. The axis of the traverse actuator **64** is parallel with the axis of the winding collet **36**. The traverse member **68**, which may be of metal or plastic, is provided with grooves **70**, the grooves accommodating ways **72** provided on the member **62** and which are parallel with the axis of the traverse actuator **64** providing for reciprocable movement of the traverse **68** along the ways **72**.

The traverse **68** is equipped with a cam follower **74** of arcuate shape fitting in the groove **66**. The follower **74** is formed with a tenon portion **76** which is journaled for pivotal movement in the traverse member **68**, as shown in FIGURE 4, to accommodate swivel or pivotal movement of the follower **74** at the reversal regions **66'** of the multiple return groove **66**.

The traverse member is equipped with a traverse guide means **78** for the roving. The guide means **78** for the roving is inclusive of a comb **79** having spaced projections **80** which provide recesses **81**, the number of recesses being equivalent to the number of strands **22** of the roving so that each strand is accommodated in a recess **81**. The projections **80** are as thin as practicable so that the strands in the recesses **81** are in close relation, the strands

of the roving converging from the comb guide **54** to the comb-like guide **79** on the traverse block **68**.

The guide **79** is removably supported on the traverse block **68** by a clamp means **84** to enable the operator to thread the strands into the recesses **81** with the guide **78** removed from the traverse. After the operator threads the strands **22** of the roving into the recesses, the guide **79** is affixed to the traverse **68** and clamp means **84** manipulated to hold the guide **79** to the traverse **68**. In order to retain the strands in the recesses **81** a removable clamp bar **86** is disposed forwardly of and adjacent the strands and is held in such position by spring clamp means **88**.

The guide comb **79** is disposed as close as practicable to the periphery of the package of roving being formed on the collet **36** so as to effect the deposition or collection of roving on the package with the strands thereof in side-by-side relation. In winding the multi-strand roving into a package, one essential factor is to maintain the strands in side-by-side relation in order to properly form a cylindrically-shaped package.

As shown in FIGURE 3 the rotatable traverse cam **64** journaled in the horizontal section **62** of the arm **60** has a shaft portion **90** equipped with a sprocket **92** connected by a nonslipping belt **94** with a sprocket **98**, the latter being mounted on a shaft **99** which is driven through suitable transmission gearing **100** from an electrically energizable motor **102**, or connected through a nonslipping means from shaft **90** to motor **38** to positively maintain constant ratio.

The traverse guide is reciprocated at a comparatively slow speed as filament attenuation is carried on at a comparatively slow speed. These characteristics substantially eliminate abrasion or impairment of the roving by the traverse guide.

The shaft **99** extends through a hollow portion **104** of the arm **60** extending into and journaled in bearings (not shown) mounted within the winding machine housing **40**. In this manner the traversing cam **64** is rotated by the motor **102**, or through other mechanical means, independently of the relative position of the arm **60**.

The invention involves maintaining the traverse guide means close to the package and includes a sensing means responsive to the increase in size of the package for moving the traverse support arm **60** to accommodate the enlarging package while maintaining the traverse guide in substantially the same relative position close or adjacent to the periphery of the package throughout package formation.

The arrangement includes means for moving the arm **60** and the traverse guide for the roving away from the package as the package increases in size. As shown in FIGURE 2, the journal portion **104** of the arm **60** is connected by power transmission mechanism **106** including speed reducing mechanism **108** with a motor **110**. The motor **110** is of a slow speed synchronous type rotating at about 70 r.p.m. The power transmission mechanism and speed reducing gearing may be of the planetary type although any suitable mechanism may be used to effect a high ratio speed reduction between the motor **110** and the arm **60**.

The motor **110**, for shifting the position of the traverse support arm **60**, is in circuit with means for energizing and controlling the operation of the motor **110** through a sensing means responsive to increase in the size of the package of roving.

Mounted on the traverse block **68**, shown in FIGURE 4, is a relatively movable member or plunger **112** having a combined traverse guide and package size sensing means **114**. A coil spring or similar means **116** normally biases the member **112** in a left-hand direction as viewed in FIGURE 4 toward the package, a suitable stop means such as a washer **117** pinned on the plunger being provided to limit the left-hand movement of member **112** and package sensing portion **114** preferably formed of resinous material such as Micarta.

Mounted on the traverse block **68** is a microswitch **118**, the operating plunger **120** of the microswitch being aligned with the plunger or member **112**. The member **114** is provided with a T-shaped slot **115** to receive the multi-strand roving from the comb guide **79** to properly guide the roving onto the package. The slot **115** in member **114** is of a width to accommodate the several strands **22** of the roving in side-by-side relation so that the strands of the roving in the package lie in side-by-side relation.

The member **114** is adapted to be engaged by the package as the package increases in size and provides a sensor to initiate the operation of means for repositioning the arm **60** and the traverse mechanism carried thereby. The enlarging package engages the sensor and roving guide member compressing the spring **116** to engage the rod or plunger **112** with the rod or plunger **120** to close the microswitch **118** and energizes the circuit of the motor **110** to effect a very slight rotation of the arm **60** laterally away from the package.

A timer or time delay relay **122** (shown in FIGURE 8) regulates the duration of rotation of the motor **110** to move the traverse guide **78** and the sensor **114** a very slight distance away from the package in increments, each increment of movement taking place with each engagement of the sensor or member **114** with the periphery of the package of roving which is continuously increasing in diameter.

It is preferable that the package size sensor circuit be rendered operative when the sensor **114** carried by the traverse **68** is adjacent an end region of the package. The circuit through the microswitch **118** includes a spring contact member **124** which is adapted for engagement with a contact **126** mounted adjacent the region of reversal **66'** at one end of the cam **64**, the contact **126** being insulated from the horizontal section **62** of the traverse support means.

Through this arrangement the contact **124** engages the contact **126** through a short distance of traverse of the member **68** at one region of reversal of movement. Thus while a sensor **114** may at times be engaged by peripheral regions of the package being formed, the sensor **114** is rendered effective when the traverse member **68** is in a position engaging contact **124** with contact **126**. A second set of contacts (not shown) similar to contacts **124** and **126** is provided for the other current conductor connected with the microswitch **118**.

In operation of the traverse member **68** the member reciprocates full length of the cam groove **66** in one direction and at the region of reversal **66'** reverses its direction and travels uninterrupted in the opposite direction until its reversal at the opposite end of the cam groove **66**. Through this means of traverse the successive wraps or convolutions of strands of the roving are not in crossing relation but are collected in successive layers in which the convolutions of strands of roving in a layer are wound in the same direction with the wraps or convolutions of strands of the roving in adjacent layers wound in a different direction to form a wound package, the strands of the roving being collected in side-by-side relation.

The invention includes impinging the multi-strand roving at each region of reversal of the traverse guide means against an abutment or surface for compacting the strands of the roving at the package ends and axially or lengthwise of the package to promote the formation of a square edge package as shown in FIGURE 8. In winding a wound package of multi-strand roving, it has been found that the roving adjacent the package ends would normally form a package with tapered end regions and such build-up or pattern formation fosters sloughing off of roving at the package ends.

By compacting the strands of the roving axially of the package at the regions of reversal of traverse of the roving, the ends of the package are formed in parallel planes normal to the axis of the package as square ends illustrated in FIGURE 7.

Mounted on projections **128** on the horizontal section **62** of the traverse arm **60** adjacent each end of the normal distance of travel of the traverse comb guide **79** are pins or abutments **130** adjustably supported by the projections **128**, the abutments disposed in positions so that the roving impinges against the abutments adjacent the package ends.

FIGURE 6 illustrates, in enlarged detail, the compaction of the strands of the roving when impinged against an abutment or member **130** at one end of the package. From FIGURE 6 it will be seen that the strands **22** of the roving nearest the abutment **130** are compacted lengthwise of the package, preventing a tapering of the pattern of collection of the roving at the ends of the package and providing an orientation that resists sloughing of the roving at the package ends. Through this arrangement, a wound package is produced having square ends and is wound without support at the ends.

With the form of package produced by the apparatus of the invention, the package is self-supporting and upon removal of the completed package **35** and collector **34**, the collector or thin walled tube, may be collapsed and removed from the interior of the package so that the roving may be withdrawn from the inside of the package for further processing.

The arrangement includes means for moving the traverse arm **60** and traverse guide away from the package at its completion in order to facilitate removing or doffing the completed package from the collet **36**, and for resetting or repositioning the traverse guide close to an empty collector telescoped onto the winding collet **36** upon which a new package is to be formed.

Mounted within the housing **40** is a cylinder **134**, shown in broken lines in FIGURES 1 and 2, in which is disposed a piston **135** attached to a piston rod **136**, the piston rod being connected as at **138** with a member **140** secured to an extending portion **142** of the traverse arm construction **60**. The cylinder **134** is equipped with fluid conveying tubes **144** and **146** to convey fluid such as compressed air, into the cylinder to move the piston rod in either direction for moving the traverse arm portion **62** toward or away from the winding collet **36**.

Means is also provided for releasing a planetary ring of the speed reduction mechanism **108** arranged between the motor **110** and the drive shaft **99** for driving the traverse cam **64**. In the embodiment illustrated, a cylinder **150** is provided with a piston and piston rod for actuating a clutch means (not shown) for engagement and disengagement with a planetary ring of the mechanism **108** to render ineffective the planetary speed reducing mechanism between the motor **110** and the arm **60** to enable fluid under pressure such as compressed air introduced into the cylinder **134** to move the traverse arm **60** independently of the drive motor **110** and the speed reducing mechanism **108**.

A roving take-up or pull roll **160** is journaled in bearings (not shown) contained within the housing **40**, the roll being driven by a motor **161**, shown in FIGURE 8. The purpose of the roving take-up roll **160** is to effect substantially continuous attenuation of the filaments forming the roving during the period of initial start-up and during the period in which the completed package is brought to rest, removed from the collet and an empty collector placed upon the collet preparatory to forming a new package. Through this arrangement attenuation of the streams to filaments is maintained substantially continuous so as not to appreciably impair or affect the thermal conditions in the feeder **10** during transfer of the roving onto an empty collector.

The circuits and programmer for controlling the several motors to accomplish the performance of method steps in winding packages of roving are schematically illustrated in FIGURE 8. The programmer **165** is for varying the speed of the collet drive motor **38** and varying the speed of the traverse drive motor **102** and for conveying current to the traverse arm actuating motor **110**. The programmer **165** is of the character disclosed and described in Smith Patent 3,109,602 wherein the speed of the collet driving motor **38** is gradually reduced as the package of roving increases in size and the speed of the traverse drive motor **102** is gradually reduced in order to maintain uniform the pattern of orientation of the roving in the package.

These are important factors in winding a satisfactory package of roving. The rate of progressive decrease in speed of the collet motor **38** is programmed to maintain substantially constant the speed of the filaments being attenuated in order that the filaments be of uniform size, and the traverse rotor is proportionately reduced in speed to facilitate the formation of a cylindrically-shaped package of roving having square ends.

The cycle of operations and sequence of method steps in forming a roving package is as follows: During formation of a package on the rotating collet **36** the advancing strands of the roving are being traversed by the traverse guide comb **79** and the guide member **114** which are reciprocated lengthwise of the package through the drive transmited by the multiple return groove or cam **66** on the rotating traverse drive member **64** communicated to the traversed block **68** through the cam follower **74** engaged in the groove **66**.

The multi-strand roving is traversed throughout the full length of the package at each reciprocation of the traverse block **68** so that the successive wraps of roving are in wound relation as the individual strands **22** of the roving occupy the recesses **81** provided by the projections **80** of the comb-like member **79**. The several strands of the roving **24** are deposited or collected on the package in side-by-side relation, as shown in FIGURE 6.

It is essential that strand tension be maintained between the comb guide **79** and the guide bar **114** so as to maintain the strands of the roving in proper spaced relation as they are wound into the package.

As the traverse guide means **79** and **114** guide the several strands adjacent the ends of the package, the pins or abutments **130** are adjusted to positions whereby the outermost strands **22** are impinged against the abutments. This action compacts some of the strands of the roving lengthwise of the package in the manner illustrated in FIGURE 6. This compacting action on the strands of the roving at the ends of the package prevents formation of a tapered end package and promotes the formation of a cylindrically-shaped package having square ends by building up a region of compacted strands as the package ends during each reversal of the traverse guide **78**.

In order to properly guide the multiple strands of the roving into proper side-by-side relation on the package, the roving guide means should be substantially continuously maintained as close as practicable to the package. During formation, the package is progressively enlarging in diameter and the sensor arrangement for maintaining the traverse guide means close to the package functions in the following manner: When the enlarging package engages the sensor and roving guide member or bar **114**, the package moves the sensor member **114** and the supporting plunger **112** in a right-hand direction as viewed in FIGURE 4 compressing the spring **116**.

As a succeeding few layers of roving are laid on the enlarging package the plunger **112** is thus moved to engage the operative member **120** of the microswitch **118** to close the switch.

With the microswitch closed, the contact brush **124** engages the contact member **126** carried by the traverse support **62** completes a circuit through the time delay relay **122** to energize the motor **110**.

The rotation of the motor **110** through the planetary speed reducing mechanism **108** effects a slight rotation of the arm **60** about the axis of the shaft **99** in a counter-

clockwise direction, as viewed in FIGURE 1, to move the sensor member and guide **114** and the comb-like traverse guide **78** a slight distance away from the periphery of the package. The time delay relay **122**, shown in FIGURE 8, is of a character to maintain the motor **110** energized for a period of time required to move the sensor member **114** out of engagement with the package. As it is important to maintain the several strands of the roving **24** close to the region of collection on the package, the traverse support is preferably moved just sufficient to disengage the sensor bar **114** from the package surface and not more than about 1/32 of an inch from the surface.

Package winding continues with the arm **60** and section **62** in the re-adjusted position until the enlarging package again engages the sensor member **114**, compressing the spring **116** and bringing the plunger **112** into contact with the actuating element **120** of the microswitch **118**, this operation again closing the circuit of the motor **110** to again reposition the traverse support arm **60**, the sensor member **114** and the comb guide **79**.

Repetitive repositioning the traverse block **68**, roving guide and sensor means continues to the completion of the package to maintain the sensor and guide member **114** in engagement with or close to the package.

When the package is completed, the operator depresses a stop switch button **167**, de-energizing through the programmer, the collet motor **38** and the traverse drive motor **102**, and energizes the motor **161** to rotate the pull roll or standby collector roll **160**. When the stop button is actuated to de-energize the collet drive motor **38**, the motor **38** is dynamically reduced in speed by electric energy in a conventional well known method.

The actuation of the stop button **167** actuates solenoid actuated valve means (not shown) to direct compressed air to the cylinder **150** (shown in FIGURE 2) to release the planetary gearing **108** from the motor **110** and concomitantly direct compressed air to the cylinder **134**, through the tube **146**, shown in FIGURE 1, moving the piston **134** to the left, which effects counterclockwise movement of the traverse arm **60** swinging the arm to a position withdrawing the sensor member **114**, traverse member **68** and roving guide comb **78** to a maximum distance away from the completed package.

The operator then manually fractures the several strands of the roving and snubs the strands onto the rotating pull roll **160** whereby attenuation of all of the filaments is continued. With the traverse arm in retracted position, the operator doffs or removes the completed package **35** from the collet and telescopes an empty tube **34** onto the collet **36** preparatory to winding a new package.

The operator leads the advancing roving partially around the empty collector tube on the collet and depresses a foot-operated switch **170**. Depression of the switch actuates solenoid controlled valve means (not shown) to direct compressed air through tube **144** into the left-hand end of cylinder **134** to move the piston **135** in a right-hand direction to swing the traverse arm **60** in a clockwise direction to move the traverse sensor and guide member **114** close to the empty collector tube on the collet **36**. The arm **60**, on reaching its innermost position, initiates operation of valve means (not shown) to release air pressure in cylinder **150** to reestablish the drive connection of the speed reducing mechanism **108** with the motor **110**.

The operator engages the strands of the roving in the T-shaped slot in the sensor and guide member **114** while the roving is still passing partially around the collet **36** and is being wound up on the pull roll **160**. The operator removes the traverse guide comb **78** from the traverse block **68** and threads the projections of the comb **79** between pairs of strands **22** of the roving to space the strands as they are delivered onto the package. With the comb guide **79** engaged with the several strands, the operator replaces the comb guide on the traverse block **68** and locks the same in position by the clip **84**, the strands now being in side-by-side relation in the T-shaped slot **115**.

The operator releases the foot switch **170**, which energizes the motor **138** to rotate the collet **36** and simultaneously deenergizes the motor driving the pull roll **160**. As the pull roll speed is reduced, slack is formed in the strands of the roving between the collector on the collet **36** and the pull roll **160**, causing the strands of the roving to lick or adhere to the empty collector **34** to initiate winding of a new package. The snubbing of the slack strands of the roving on the empty collector **34** causes the strands to be fractured automatically between the empty collector and the pull roll **160**.

The collet motor **38** rotates the collet **36** at a speed to attenuate the streams **16** to continuous filaments of desired size. As the package increases in size, the programmer **165** progressively reduces the speed of the collet drive motor **38** so as to maintain substantially constant the linear travel of the filaments so that the filaments throughout the package are of uniform size and progressively reduces the speed of the traverse drive motor **102** to maintain the same pattern of orientation of the strands of the roving throughout the package.

During the formation of the package, at each region of the reversal of the traverse member or block **68**, the outermost strands **22** of the roving are impinged against the abutments or pins **130** to compact some of the strands lengthwise of the package, as shown in FIGURE 6.

The apparatus for forming and packaging the multifilament roving substantially eliminates the so-called catenary effect heretofore encountered in forming roving, a condition usually resulting from unequal tension of the filaments.

By partially compacting the strands of the roving at the ends of the package, the roving at such regions provides for increased density at the package ends so as to form a cylindrically-shaped package with square ends as shown in FIGURE 7. The step of compacting the strands at the package ends maintains a circular cylindrical shape to the package without any taper adjacent the ends. While the roving **24** illustrated comprises seven strands **22**, it is to be understood that the roving may be fashioned of a greater or lesser number of strands.

The package of roving wound by the apparatus of the invention has square ends, that is, the planes of the ends are in substantial parallelism. The apparatus for forming the package enables the production of comparatively large packages of roving containing upwards of ninety pounds of roving in a single package. The package of roving may be readily processed through a drying operation or the package impregnated with coating material if desired. In withdrawing the roving from the package the several strands forming the roving are withdrawn simultaneously. The apparatus for guiding the strands of the roving onto the package by guide means disposed close to the package enables its formation wherein the strands are under control of the traverse guide to effect an unvarying pattern of orientation of the strands in each layer of roving in the package to promote uniform tension throughout the package.

The use of the apparatus of the invention results in a novel roving of strands of glass filaments wherein the filaments are directly attenuated from glass streams and the multi-strand roving collected in comparatively large packages and at low cost.

We claim:

1. Apparatus for packaging a group of linear bundles of fibers comprising, in combination, support means, a rotatable collector journaled on the support means upon which the group of bundles of fibers is wound into a package, means for rotating the collector, traverse means engaging the group of bundles of fibers with the bundles in side-by-side relation, means for reciprocating the traverse means lengthwise of the package to distribute

the group of bundles of fibers in successive layers in the package with the bundles in each layer in side-by-side noncrossing relation, means responsive to the enlarging package for moving the traverse means to maintain the traverse means close to but out of contact with the periphery of the package throughout the formation of the package, and abutment means adjacent the ends of the package engageable with bundles of fibers of the group to compact the bundles at the package ends.

2. The combination according to claim 1 wherein the traverse means includes a member having projections engaging the bundles of fibers for maintaining the bundles in side-by-side relation.

3. Apparatus for packaging a group of linear bundles of fibers comprising, in combination, support means, a rotatable collector journaled on the support means upon which the group of bundles of fibers is wound into a package, means for rotating the collector, a traverse member engaging the group of bundles of fibers with the bundles in side-by-side relation, means movably mounted on the support means carrying the traverse member, motive means for moving the traverse member carrying means, means for reciprocating the traverse member lengthwise of the package to distribute the group of bundles of fibers in successive layers in the package with the bundles in side-by-side relation, switch means actuated by the package for controlling said motive means for moving the traverse member carrying means to maintain the traverse member in predetermined relation to the periphery of the package throughout the formation of the package, and abutment means adjacent the ends of the package engageable with bundles of fibers of the group to compact the bundles at the package ends

4. Apparatus for packaging roving of strands of fibers comprising, in combination, support means, a rotatable collector journaled on the support means upon which the roving is wound into a package, means for rotating the collector, a traverse member having means for maintaining the strands of fibers in side-by-side relation, relatively movable means mounted by the support means carrying said traverse member, means for reciprocating the traverse member lengthwise of the package to distribute the roving in the package, means responsive to the enlarging package for periodically moving the traverse member carrying means to maintain the traverse member in substantially the same position relative to the periphery of the package throughout the formation of the package, and abutment means adjacent the ends of the package engageable with strands of fibers of the roving to compact the strands at the package ends.

5. Apparatus for packaging roving of strands of fibers comprising, in combination, a support, a rotatable collector journaled on the support upon which the roving of strands is wound in a package, means for rotating the collector, a traverse member, means journally mounted on the support and carrying the traverse member, motive means for moving said traverse member carrying means, guide means supported by the traverse member having projections for maintaining the strands of the roving in side-by-side relation, means for reciprocating the traverse member and guide lengthwise of the package whereby the strands of the roving are collected in the package in side-by-side relation, control means responsive to the enlarging package for initiating periodic operation of said motive means for successively repositioning the traverse member and guide means to maintain the guide means in substantially the same position relative to the periphery of the package throughout the formation of the package, and abutment means adjacent the ends of the package engageable with strands of fibers of the roving to compact the strands at the package ends.

6. Apparatus for packaging roving of strands of glass fibers comprising, in combination, a support, a rotatable collector journaled on the support upon which the roving of strands is wound in a package, means for rotating the collector, a traverse supporting member movably mounted on the support, a traverse member reciprocably mounted on the traverse supporting member, guide means carried by the traverse member having projections maintaining the strands in side-by-side relation, means for reciprocating the traverse member and guide lengthwise of the package whereby the strands of the roving are collected in the package in side-by-side relation, a package sensor bar supported by the traverse member for engagement with the periphery of the package, means actuated by the sensor bar upon enlargement of the package for successively moving the traverse supporting member to reposition the traverse member through successive increments to maintain the guide means and sensor bar in substantially the same positions relative to the periphery of the package throughout formation of the package, and abutment means adjacent the ends of the package engageable with strands of fibers of the roving to compact the strands at the package ends.

7. Apparatus for forming and packaging multi-strand roving of strands of continuous filaments comprising, in combination, means for feeding a plurality of streams of heat-softened glass to be attenuated to continuous glass filaments, means separting the filaments into strands to form a multi-strand roving, a support, a rotatable collector journaled on the support, means for rotating the collector to wind the roving thereon and attenuate the streams to filaments, traverse guide means disposed close to the package for guiding the roving onto the package to maintain the strands of the roving in side-by-side relation in the package, a traverse guide support means carried by the support, means traversing the guide means lengthwise of the guide support means and the collector to distribute the roving in successive layers of equal length to form a wound package, and means adjacent the ends of the package engageable with the strands of the roving to compact the strands at the package ends.

8. Apparatus for forming and packaging multi-strand roving of continuous filaments of glass comprising, in combination, means for feeding a plurality of streams of heat-softened glass to be attenuated to continuous filaments, means separating the filaments into strands to form a multi-strand roving, a support, a rotatable collector journaled on the support, means for rotating the collector to wind the roving thereon and attenuate the streams to filaments, a traverse block reciprocably mounted on a member carried by the support, guide means supported by the traverse block and disposed close to the package for guiding the roving onto the package to maintain the strands of the roving in side-by-side relation in the package, means traversing the guide means lengthwise of the collector to distribute the roving in successive layers of equal length to form a wound package, means adjacent the ends of the package engageable with the strands of the roving to compact the strands at the package ends, and means actuated by pressure of the enlarging package on the guide means for effecting movement of the member supporting the traverse block to move the guide means radially of the package for maintaining the guide means close to the package throughout the formation of the package.

9. Apparatus for forming and packaging multi-strand roving of strands of continuous filaments comprising, in combination, means for feeding a plurality of streams of heat-softened glass to be attenuated to continuous filaments, means separating the filaments into a plurality of strands, support means, a rotatable collector journaled on the support means, means for rotating the collector to wind the strands of the roving thereon and attenuate the streams to filaments, an arm movably mounted on the support means, a traverse member reciprocably mounted by the arm, guide means carried by the traverse member disposed close to the package for guiding the roving onto the package to maintain the strands of the roving in side-by-side relation in the package, means on said traverse

member separating the strands, means traversing the guide means lengthwise of the collector to distribute the roving in successive layers of equal length to form a wound package, said guide means providing means for sensing increase in size of the package during its formation, and means actuated by pressure of the package on the guide means for effecting movement of said arm to move the guide means radially of the package in small increments to maintain the guide means close to the package throughout the formation of the package.

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