Dec. 20, 1966 R. E. SMITH ETAL 3,292,871

APPARATUS FOR FORMING AND COLLECTING FILAMENTS

Filed Nov. 18, 1963 2 Sheets-Sheet 1

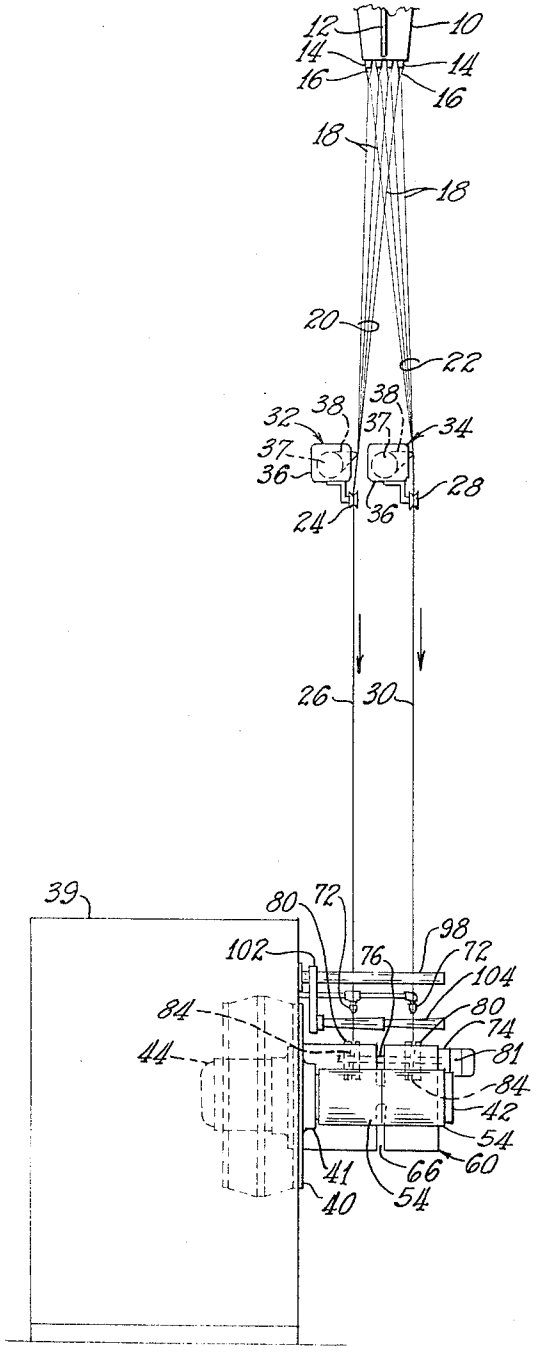

Fig. 1

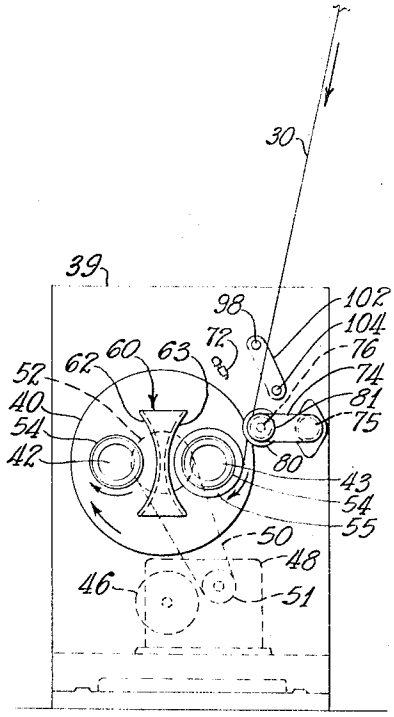

Fig. 2

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Filed Nov. 18, 1963 2 Sheets-Sheet 2

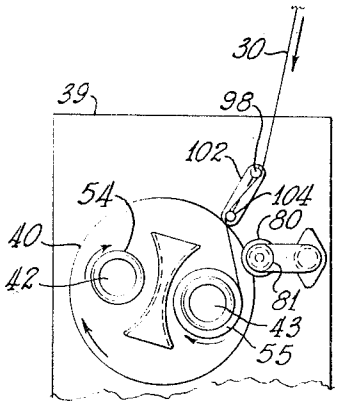

Fig. 3

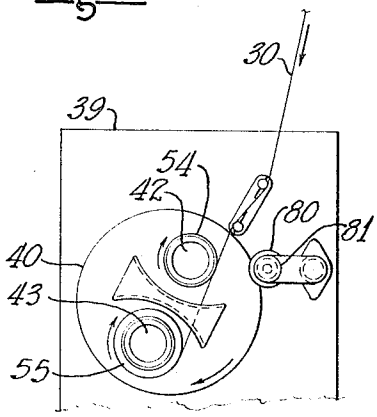

Fig. 4

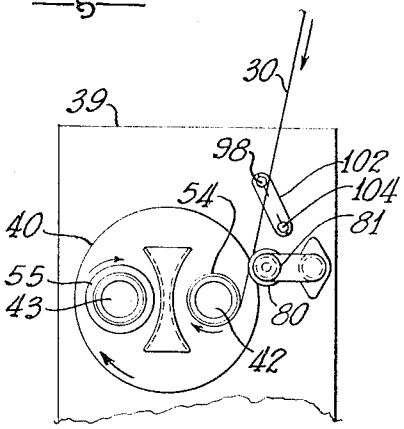

Fig. 5

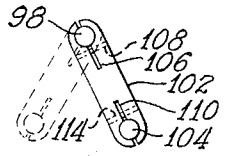

Fig. 7

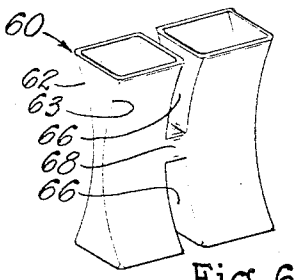

Fig. 6

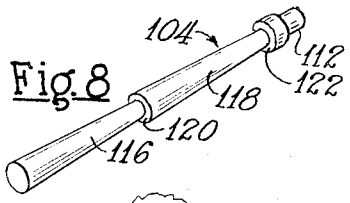

Fig. 8

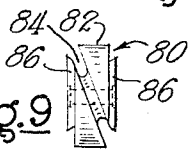

Fig. 9

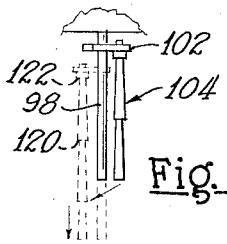

Fig. 10

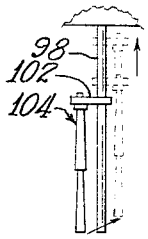

Fig. 11

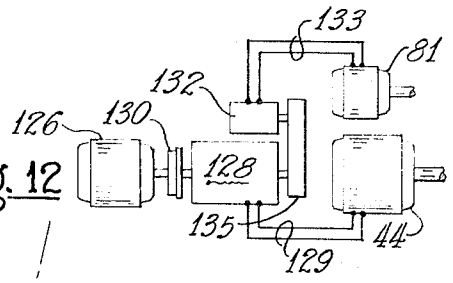

Fig. 12

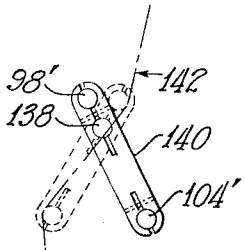

Fig. 13

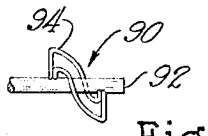

Fig. 14

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3,292,871
APPARATUS FOR FORMING AND COLLECTING FILAMENTS

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Filed Nov. 18, 1963, Ser. No. 324,281
3 Claims. (Cl. 242—18)

This invention relates to an apparatus for forming continuous filaments from heat-softened attenuable materials and more especially to a method of and apparatus for automatically and continuously attenuating groups of filaments from streams of heat-softened glass or other heat-softenable material or filament forming resins and collecting strands of the filaments by winding the strand or strands upon collecting means rotating at high speed and, upon completion of a strand package or packages, automatically transferring the strand or strands onto empty collecting means and initiating winding of succeeding packages without interruption of attenuation of the filaments.

The present invention embraces an apparatus for forming and collecting a strand of continuous filaments in a package by winding the strand on a rotatable collector while concomitantly traversing the strand on the package by a high speed, high frequency traverse means and wherein at the completion of a strand package, transfer of the strand is effected onto a rotating empty collector wherein two collector supporting collets are successively indexible to winding position and wherein effective control of the strand is maintained during transfer to initiate high frequency oscillation of the strand after transfer of the strand onto an empty collector is completed.

Another object of the invention resides in an apparatus for forming and collecting a strand of continuous filaments in a package by winding the strand on a rotatable collector while concomitantly traversing the strand on the package by a high speed high frequency strand oscillator and wherein at the completion of a strand package the strand is transferred from the completed package to an empty collector while maintaining full control of the path of linear travel of the strand during strand transfer wherein the strand transferring operation is rendered fully automatic without interrupting the linear travel of the strand.

Another object of the invention resides in an arrangement wherein control of the strand during strand transfer operations from a completed package to an empty sleeve is maintained through engagement of the strand with means arranged to facilitate proper tension in the strand and assure automatic transfer of the strand onto an empty collector without interrupting linear travel of the strand.

Another object of the invention resides in an apparatus for winding the strands upon collectors supported by a rotating collet wherein the speed of rotation of the collet is progressively reduced to maintain uniform linear travel of the strands to compensate for the enlarging strand packages and for correlating the speed of high speed strand oscillators whereby a proper crossing or overlapping of individual convolutions or wraps of strands in the packages is maintained throughout the formation of the packages.

Another object of the invention resides in an arrangement for correlating the speed of a winding collet and package being wound with a strand oscillating or traversing means through the use of variable speed electrically energizable components under the influence or control of variable frequency generators to assure proper change in speed of the strand oscillating means with the change in speed of the package as it is being formed.

Another object of the invention is the provision of guide means for controlling the strand during transfer of the strand from a completed package to an empty collector embodying a strand engaging surface for holding the strand in strand transfer position adjacent the end of a package until transfer of the strand onto an empty collector is completed.

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 side elevational view illustrating a form of automatic winding apparatus embodying the invention;

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

FIGURE 3 is a schematic view illustrating the method step of collecting or winding linear materials to form a package, the package being shown as substantially completed;

FIGURE 4 is a view similar to FIGURE 3 illustrating an indexing movement of the collet supporting head wherein the completed package is being moved away from the winding station and an empty collector being moved toward the winding station;

FIGURE 5 is a view similar to FIGURE 4 illustrating the transfer of the strand onto an empty collector;

FIGURE 6 is an isometric view of a baffle means mounted on the indexing head between the collector driving collets;

FIGURE 7 is an end view of the strand transfer control means of the character shown in FIGURES 3 through 5;

FIGURE 8 is an isometric view of strand engaging means for controlling a strand during strand transfer operations, the means forming a component of the construction shown in FIGURE 7;

FIGURE 9 is an elevational view of a strand oscillator and control means;

FIGURE 10 is a top plan view of the arrangement shown in FIGURE 7 illustrating the path of movement of a strand control means for moving the strand to a transfer position;

FIGURE 11 is a view similar to FIGURE 10 illustrating the strand control means in strand transferring position;

FIGURE 12 is a schematic view illustrating a method and means for concomitantly rotating a strand collector and strand traverse oscillator for varying the respective speeds thereof;

FIGURE 13 is a front elevational view of a modified arrangement of strand control for strand transfer operations, and

FIGURE 14 is an elevational view illustrating another form of strand oscillator.

While the method and apparatus of the invention are particularly usable in the formation of wound packages of strands formed of filaments of glass or other heat-softenable material, it is to be understood that the method and apparatus may be utilized to advantage in the collection and packaging of other linear bodies.

Referring to the drawings in detail and initially to FIGURES 1 and 2, there is illustrated a conventional type of stream feeder or bushing **10** containing a supply of heat-softened filament-forming material, such as glass, the feeder **10** having a floor provided with a comparatively large number of orificed tips or projections **14** arranged in two groups, each group flowing streams of glass **16**

and the streams attenuated to filaments 18 arranged in two groups 20 and 22.

The feeder 10 is formed of any alloy of platinum and rhodium or other material capable of withstanding the intense heat of molten glass.

The feeder is provided with terminals 12, one of which is shown in FIGURE 1, connected with a source of electric energy for heating the glass or other material, the energy input being controlled by conventional means (not shown) to maintain the material in the feeder at a proper viscosity to promote the formation of uniform streams 16.

The group of filaments 20 is converged by a gathering shoe or member 24 to form a strand 26, the filaments of the group 22 being converged by a gathering shoe 28 to form a strand 30. The filaments of the respective groups are coated with a lubricant, size or other coating material by means of dual applicator arrangements 32 and 34 of conventional construction, shown in FIGURE 1. Each applicator includes a receptacle 36 in which is journaled a roll 37 immersed in the coating material, an endless belt 38, being driven by the roll 37 acquiring a thin film of the size or coating material which is transferred to the filaments by wiping contact of the filaments with the film of size or coating on the belt.

The strands 26 and 30 are concomitantly wound upon rotatable collectors to form two individual packages of strand in end-to-end relation.

FIGURES 1 and 2 illustrate the automatic winding and package forming apparatus which is inclusive of a housing 39 enclosing the actuating and control components for carrying out or performing the steps in the method of attenuating the filaments and automatically packaging the strands of filaments. Journally supported by means contained within the housing is indexible and rotatable turret or head 40.

The portion of the head 40 at the front of the housing 39 is provided with two hollow boss portions 41 enclosing journal bearings on which are journally supported winding collets 42 and 43. Each of the collets 42 and 43 is individually driven by a motor 44, one of which is illustrated in FIGURE 1, the motors 44 being carried by the head or turret 40. The head or turret is indexible to two positions, the collet 43, in FIGURE 2 being shown in package winding or forming position while the collet 42 is in a diametrically opposed standby position.

The head 40 is adapted to be indexed in two positions in order to move the completed package away from winding position and an empty collector into winding position for the formation of a new package. The head 40 is rotated by a motor 46 through gear reduction mechanism contained within a housing 48 and through suitable drive means, such as a belt 50 and sprockets 51 and 52. The energization of the motor 46 is controlled by a suitable indexing means of conventional construction timed to index or rotate the head 40 upon the formation of a completed strand package at the winding station.

The collet driving motors 44 are of the variable speed type and are controlled by a method hereinafter described whereby the collet at the winding station is progressively reduced in speed as the strand package increases in size in order to maintain substantially constant the linear travel of the strands 26 and 30 and hence the formation of continuous filaments of uniform size. The purpose of automatically indexing the collets is to successively move completed strand packages away from the winding station and move the other collet and empty collectors into winding or package forming position.

Each of the collets 42 and 43 is adapted to accommodate strand collecting means such as tubular sleeves 54, there being two on each collet arranged in end-to-end relation. Each of the motors 44 for rotating the winding collets and strand collectors carried thereby is of a type in which the speed may be varied for the purpose of progressively reducing the speed of rotation of the collet at the winding station as the strand packages increase in diameter during the winding operation.

The peripheral region of each of the collets 42 and 43 is formed with longitudinally extending recesses in which are disposed bars or friction shoes (not shown) which are resiliently biased radially outwardly of the collets to frictionally grip the strand collectors or tubes to assure rotation of the same with the collets.

Disposed between the winding collets 42 and 43 and fixedly mounted by the head 40 is a baffle means 60, particularly shown in FIGURES 1, 2 and 6, which is of hourglass shape in cross-section defined by concave surfaces 62 and 63.

The baffle means is preferably of thin walled hollow configuration, as illustrated in FIGURE 6, the central region being provided with slots 66 to accommodate the strand 26 during indexing operations in moving completed packages away from winding position and empty collectors or tubes into winding position. The regions of the baffles adjacent the slots are joined by a connecting bridge 68. The curved surfaces 62 and 63 of the baffle means 60 are disposed between the collets to confine water sprayed from spray nozzles 72 onto the strand oscillators in the region of the strand packages being formed.

The winding apparatus includes strand traverse means for distributing the strands lengthwise of the packages and for oscillating the strand during traverse of the strand lengthwise of the packages in order to effect crossing of individual convolutions or wraps of the strands as they are collected on the packages. In the embodiment illustrated, a strand oscillator carrier 74 is supported by a reciprocable shaft 75 which extends into the housing 39. The shaft 75 is reciprocated by conventional means, such as the means disclosed and described in Smith Patent 3,109,602, in which successive reciprocations of the carrier are progressively reduced in length to build strand packages of generally uniform thickness with tapered ends to prevent sloughing of the strand at the ends of the packages.

Journally supported upon the carrier 74 is a pair of strand oscillators or strand guide means 80 mounted upon a shaft 76 supported in suitable bearings mounted by the carrier 74 which are driven by a variable speed electrically energizable motor 81 for guiding and traversing the strands as they are collected upon the collectors or tubes 54 at the winding station. As the strands 26 and 30 travel at comparatively high linear speeds of upwards of fifteen thousand feet or more per minute, the strand oscillators 80 are rotated at comparatively high speeds to effect high frequency oscillation of the strands to effect a crossing of individual convolutions or wraps of strand on a collector.

FIGURE 9 illustrates one form of oscillator 80. In this form, the oscillator body 82 is of cylindrical shape and is preferably formed of phenolic resin reinforced with laminations of cloth, such material being commercially known as Westinghouse Micarta grade 286. The body 82 is fashioned with an angularly disposed peripheral recess or groove 84 adapted to accommodate and guide the strand. Integrally formed at each side of the cylindrical body 82 is a frusto-conically shaped shoulder or ledge 86 to facilitate re-entry of the strand into the traverse groove 84 after transfer of the strand from a completed package onto an empty tube or collector has been effected as hereinafter described.

FIGURE 14 illustrates another form of strand guide or oscillator 90 which includes a supporting shaft 92 and a strand engaging portion 94, the latter being formed of wire into the configuration illustrated in FIGURE 14. The strand-engaging wire component 94 is of conventional character and, when rotated at high speed, effects a high frequency oscillattion of the strand. The strand oscillator 80, illustrated in FIGURE 9, or the strand oscillator 90, illustrated in FIGURE 14, may be used as

a strand oscillating and guide means in the winding apparatus illustrated in FIGURES 1 and 2.

The arrangement illustrated in FIGURES 1 and 2 is inclusive of means to maintain positive control of the strands during transfer of the strands from completed packages onto empty collectors at the winding station. In the arrangement shown in FIGURES 1 and 2, the strands are disengaged from the oscillators at the completion of packages and are moved or diverted to the regions of the collectors at the ends of the respective packages just prior to transfer of the strands onto the empty collectors.

The strand control means for effecting strand transfer is inclusive of a shaft **98** which extends into the housing **39** and is reciprocated by conventional means, shown in Patent 3,109,602, disposed within the housing in timed relation with the indexing of the collet supporting head or turret **40**. Fixedly secured to the shaft or member **98** is an arm or member **102** and secured to the distal end of the arm **102** is a strand control or strand hold off means or member **104**. One form of member **104** is illustrated in detail in FIGURE 8.

With particular reference to FIGURE 7, it will be seen that one end region of the arm **102** is provided with a slot or kerf **106** and a circular opening, the latter accommodating the shaft or member **98**, a threaded member or screw **108** being adapted to clamp the furcations defined by the slot into securing engagement with the shaft or member **98**. The opposite or distal end of the member **102** is likewise fashioned with a kerf or slot **110** and a circular opening accommodating the strand control means **104**, the furcations defined by the kerf **110** being drawn into securing engagement with a tenon portion **112** or member **104** by a screw **114**.

The strand control member **104** is fashioned with two tapered portions **116** and **118**, the juncture of the portions forming a circular abutment or shoulder **120**. The region of reduced diameter of tapered portion **118** terminates in a circular abutment or shoulder **122**. The shaft **98**, in addition to being arranged for reciprocation at the time of indexing of the head **40**, is adapted to be rotated through a partial revolution from a position shown in full lines in FIGURE 7 to the position shown in broken lines to effect disengagement of the strands from the oscillators **80**.

In effecting transfer of the strands from completed packages onto empty collectors, it is desirable that each strand be transferred to an end region of the adjacent collector in order to render the strand end readily accessible for future processing.

The member **104** functions to disengage the strands from the oscillators **80** and transfer the strands to the end regions of the collectors at the time of transfer of the strands from completed packages to empty collectors and to maintain effective control of the strands when the latter are disengaged from the oscillators.

FIGURES 3, 4, 5, 10 and 11 illustrate, in semi-schematic form, the method steps involved in the strand transferring operations. FIGURES 1 and 2 illustrate the normal travel of the strands in engagement with the traverse oscillators **80** during formation of strand packages **55** at the winding station. During winding operations, the shaft **98**, arm **102** and member **104** occupy the relative positions illustrated in full lines in FIGURES 2 and 10. Just prior to indexing the turret or head **40**, rotation of the standby collet **42** is automatically initiated to bring the peripheral speed of the standby package collectors on the collet **42** to approximately the linear speed of the strands.

The shaft **98** is first rotated from the position shown in full lines in FIGURE 7 to the position shown in broken lines in FIGURE 7 and in full lines in FIGURE 3, the strands **26** and **30** engaging the shaft **98** and the bar or member **104** to guide the strand in the path illustrated in FIGURE 3 and disengage the strands from the oscillators **80**. After the partial rotation of shaft **98** and member **104** takes place, the shaft or member **98** and member **104** are moved lengthwise to the broken line positions illustrated in FIGURE 10.

With the completion of the rotative movement of shaft **98**, the strands **26** and **30** are engaged with the tapered portions **116** and **118** and are disengaged from the oscillators **80**. During this lengthwise movement, the strands are engaged by the shoulders **120** and **122** and are concomitantly moved into registration with the respective end regions of the collectors or tubes **54** bearing the completed packages **55**. This action completes the positioning of the rapidly moving strands at the end regions of the collectors and winding of the strand continues on these regions of the collectors of the completed packages.

The head **40** is then automatically indexed to move the completed packages **55** away from winding position and the standby collet **42** and its collectors toward the winding station, the relative positions of these components during an indexing operation being illustrated in FIGURE 4, the head **40** being in an intermediate position. The head **40** contnues its indexing movement in a clockwise direction to the position illustrated in FIGURE 5 with the collet **42** and its collector **54** at the winding station in position to effect collection of the strands on the empty collectors **54**.

During the indexing movement of the head **40**, the completed package **55** is rapidly reduced in speed and the peripheral speed of the collector **54** on collet **42** is rotating at a peripheral speed substantially equal to the linear speed of the strands.

As the speed of the completed packages **55** is reduced, loops are formed in the strands between the completed packages and the empty collectors whereby the strands of the loops adhere or lick to the surfaces of the empty collectors **54** and are snubbed by successive turns or wraps of the strands.

This action of initiating winding of the strands onto the empty collectors fractures the strands between completed packages and the empty collectors so that winding of the strands on the empty collectors continues at the end or transfer regions of the empty collectors. When the head **40** is fully indexed to the position shown in FIGURE 5, the strands are being wound upon the end regions of the empty collectors **54**. At this period in the operation, the shaft **98** is partially rotated in the opposite direction to move or swing the member **104** to the position shown in FIGURE 5 and indicated by broken lines in FIGURE 11 out of engagement with the strands **26** and **30**.

When the member **104** moves out of engagement with the strands, they are re-engaged in the grooves **84** of the oscillators **80**, being guided therein by the frusto-conically shaped regions **86**, shown in FIGURE 9. The shaft **98** is then retracted lengthwise to return the member **104** from the broken line position, shown in FIGURE 11, to the full line position, shown in FIGURE 10. This action restores control of the strands to the traverse oscillators **80** and traverse of the strand continues in a normal manner in forming packages on the collectors **54** carried by the collet **42** at the winding station.

In order to maintain a substantially constant linear speed of the strands, it is essential during formation of the strand packages to modulate the speed of the collet and collectors upon which packages are being formed so as to progressively reduce the collet speed as the strand packages enlarge in diameter and to progressively reduce the speed of rotation of the strand oscillators **80** at a substantially fixed ratio with respect to the speed of the collet in order to attain or effect a proper crossing of the convolutions or wraps of strands as they are collected in the packages.

FIGURE 12 is a schematic illustration of an arrangement for modulating the respective speeds of the drive motors **44** for the winding collets when in winding posi-

tion and the motor 81 rotating oscillators 80. The motors 44 for driving the collets 42 and 43 and the motor 81 for rotating the oscillator 80 are of a type wherein the speed may be varied by varying the frequency of the input current.

In the arrangement shown in FIGURE 12, a motor 126 of the constant speed type, such as a synchronous motor, is arranged to drive a high frequency alternator or generator 128 through the medium of a magnetic coupling arrangement schematically illustrated at 130. The coupling 130 is of the slip type and is controlled by conventional means of the character shown in Patent 3,109,602 to progressively reduce the speed of the alternator 128 during the formation of strand packages.

The output frequency of the generator or alternator 128 is progressively reduced, and current conveyed by conductors 129 to the motor 44 modulates or progressively reduces the speed of the motor and the collet at the winding station as the strand packages increases in size.

A second alternator or generator 132 is connected by conductors 133 with the oscillator drive motor 81. A suitable drive arrangement, schematically illustrated at 135, is arranged between the alternator 128 and the alternator 132 whereby both alternators are simultaneously driven at different speeds, but in a constant ratio through the drive arrangement 135.

The alternator 132 is also of the varying frequency type and as its speed is reduced through its drive arangement 135, the frequency of the alternator 132 is progressively reduced whereby the speed of the oscillator drive motor 81 is progressively reduced so as to effect the proper crossing of convolutions or wraps of strands on the packages as the packages increase in size. The varying voltage of the alternators 128 and 132 may be utilized in lieu of the varying frequency for varying the speeds of the motors 44 and 81.

FIGURE 13 illustrates a modified form of strand guide and control means for use in effecting transfer of strands from completed packages onto empty sleeves. In this form a shaft 138 is provided with an arm 140, the shaft 138 being reciprocable in the manner of the shaft 98 hereinbefore described.

Secured in an opening in the upper end region of the arm 140 is a strand engaging bar or member 98'. Secured in an opening in the lower end of the arm 140 is a strand engaging hold off bar 104'.

In this form, the region of connection of the arm 140 with its supporting shaft 138 is between the region of mounting of the members 98' and 104' on the arm 140. The operation of the arrangement shown in FIGURE 13 in effecting transfer of strands from completed packages onto empty collectors is the same as the strand transfer operations shown in FIGURES 3, 4 and 5 and hereinbefore described. The path of a strand in strand transfer position is indicated by the broken line 142 when the arm 140 and the members 95' and 104' are in strand transfer position to disengage the strands from the oscillators 80.

From the foregoing it will be apparent that in the arrangements shown in the drawings and described herein, effective control of the strand and tension in the strand is maintained during normal winding operations in forming the strand packages and during transfer of the strands from completed packages onto empty collectors without interrupting advancement of the strands whereby the operating conditions for forming the filaments of the strands are maintained substantially constant with a minimum liability of breakouts.

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. Apparatus of the character disclosed, in combination, a frame, an indexible head journaled on the frame, a plurality of winding collets mounted by said head, driving means individual to each collet for rotating the same, each of said collets being arranged to receive and support a collector upon which a strand of filaments is wound to form a package, said head being indexible to successively move a collet and collector to a winding station, motive means for indexing the head, means for distributing the strand on the collector at the winding station including a carrier reciprocable lengthwise of the collector at the winding station and a strand oscillator journally supported on said carrier, means for rotating said oscillator to distribute the strand lengthwise of the collector and effect crossing of the individual wraps of strand as they are collected, a strand engaging hold-off means for effecting transfer of the strand from a completed package onto an empty collector, said hold-off means including a strand engaging shaft disposed lengthwise of the collector, and a strand engaging bar spaced from said shaft and having a shoulder, said strand passing between shaft and said bar, said bar being pivotable to effect engagement of the bar with the strand to disengage the strand from the oscillator, the strand engaging bar being reciprocable to engage the strand with the shoulder on the strand engaging bar to move the strand to strand transfer position adjacent the end of the package during indexing movement of the head.

2. Apparatus of the character disclosed, in combination, a frame, an indexible head journaled on the frame, a plurality of winding collets mounted by said head, driving means individual to each collet for rotating the same, each of said collets being arranged to receive and support a collector upon which a strand of filaments is wound to form a package, said head being indexible to successively move a collet and collector to a winding station, motive means for indexing the head, means for distributing the strand on the collector at the winding station including a carrier reciprocable lengthwise of the collector at the winding station and a strand oscillator journally supported on said carrier, means for rotating said oscillator to distribute the strand lengthwise of the collector and effect crossing of the individual wraps of strand as they are collected, a strand engaging hold-off means for effecting transfer of the strand from a completed package onto an empty collector, said hold-off means including a strand engaging shaft disposed lengthwise of the collector, and a strand engaging bar spaced from said shaft having a circular shoulder portion, said strand passing between said shaft and said bar, said bar being pivotable to effect engagement of the strand engaging bar with the strand to disengage the strand from the oscillator, the strand engaging bar being reciprocable to engage the strand with the circular shoulder on the strand engaging bar to move the strand to strand transfer position adjacent the end of the package during indexing movement of the head.

3. Apparatus of the character disclosed, in combination, a frame, an indexible head journaled on the frame, a plurality of winding collets mounted by said head, driving means individual to each collet for rotating the same, each of said collets being arranged to receive and support two collectors upon which strands of filaments are wound to form a package, said head being indexible to successively move a collet and collectors supported thereon to a winding station, means for distributing the strands on the collectors at the winding station including a carrier reciprocable lengthwise of the collector at the winding station and strand oscillators journally supported on said carrier, means for rotating said oscillators to distribute the strands lengthwise of the collector and effect crossing of the individual wraps of strand as they are col-

lected, a strand engaging hold-off means for effecting transfer of the strand from a completed package onto an empty collector, said hold-off means including a strand engaging shaft reciprocable lengthwise of the collector and a strand engaging member spaced from the shaft, said strand passing between said shaft and said member, said member having a pair of spaced circular shoulder portions joined by tapered portions, said hold-off means being rotatable to effect engagement of the shaft and member with the strands to disengage the strands from the oscillators, the hold-off means being reciprocable to engage the strands with the shoulders on the strand-engaging member to move the strands to strand transfer position adjacent the end of the package, said strands being in engagement with the shaft and member during a strand transferring operation to maintain control of the path of the strand.

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