United States Patent [19]

Drummond

[11] **3,876,404**

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[54] **METHOD AND APPARATUS FOR REDUCING TENSION AND TRAVERSING GLASS FIBER STRAND**

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[52] **U.S. Cl.** .... **65/2;** 65/3; 65/11 W; 242/18 G; 242/43.2

[51] **Int. Cl.** **C03b 37/02**

[58] **Field of Search** .... 65/2, 3, 11 W; 242/18 G, 242/43, 155 R, 43.2; 28/1.8, 72.15

[56] **References Cited**

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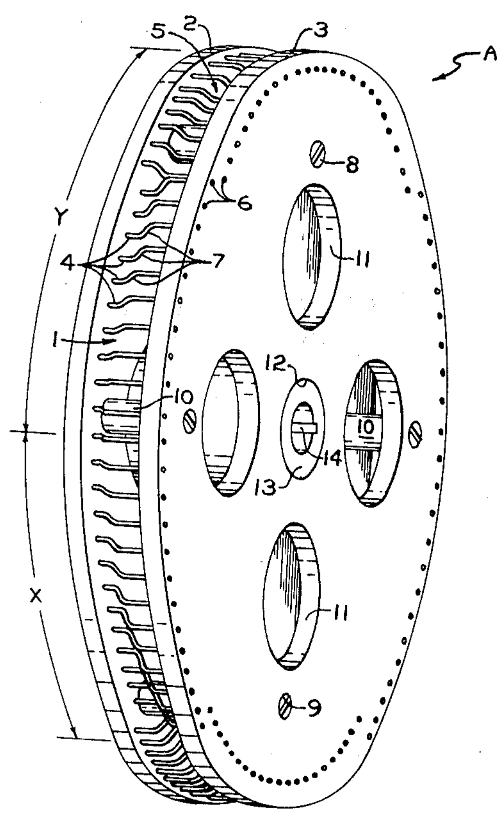
[57] **ABSTRACT**

A method and apparatus for reducing the tension of continuous glass fiber strand is disclosed. The apparatus is composed of a traveling surface rotating about an axis. The surface has a plurality of tracks of variable lengths running oblique to the axis of rotation of the surface. The termination point of the track on the traveling surface is also the point of origin of a subsequent track, thus a continuous irregular path is defined by the tracks. The tracks are determined by a plurality of contact points on which the glass fiber strand engages. The surface travels at a slightly greater linear speed than the take-up winder thus reducing the tension of the strand on the glass fiber strand package. Additionally, the surface may be reciprocally traversed the length of the take-up package or alternatively the take-up package can be traversed to obtain a random wind of glass fiber strand.

12 Claims, 3 Drawing Figures



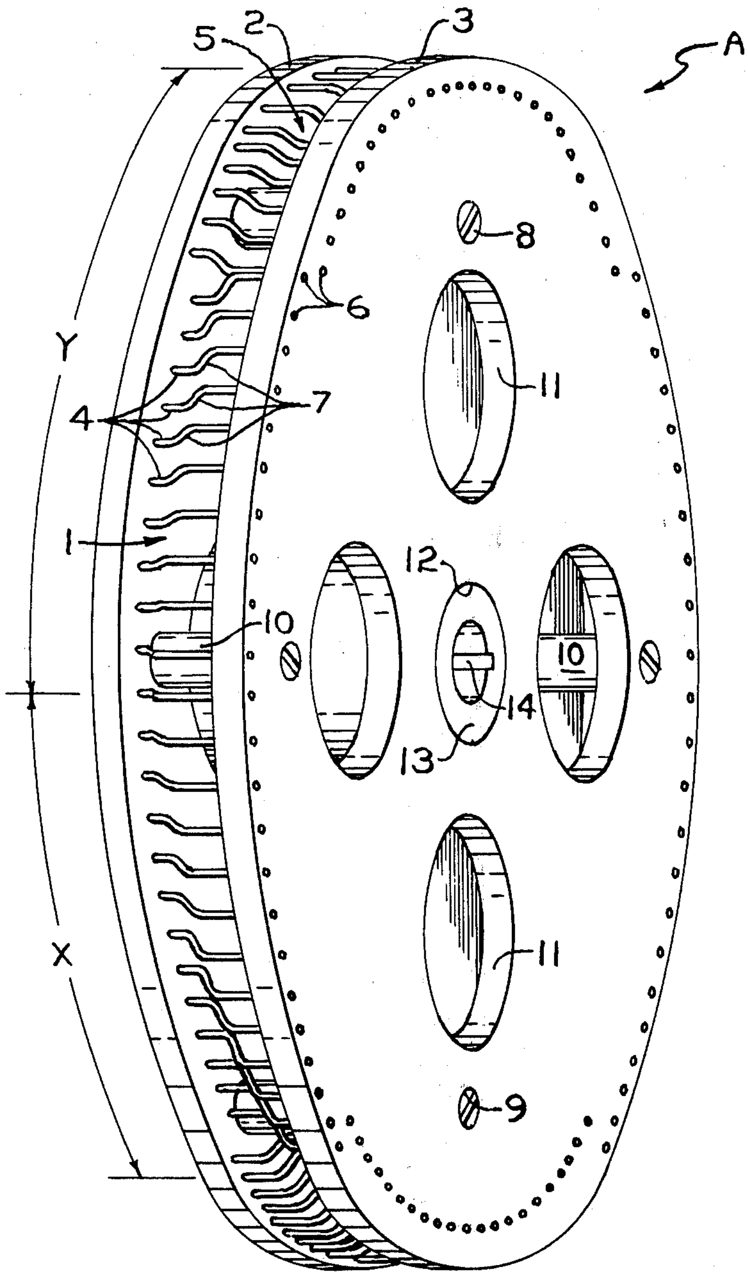
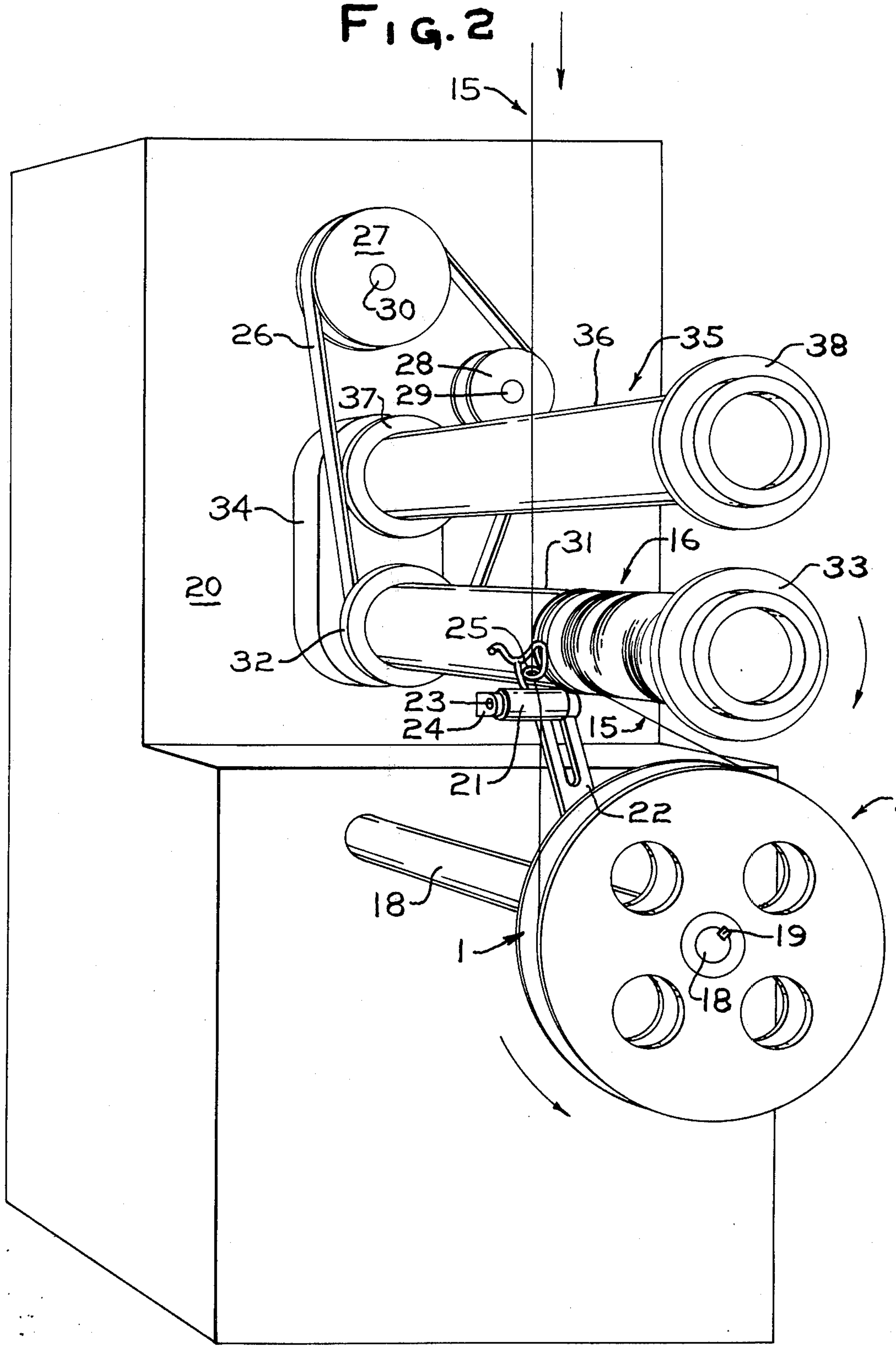


FIG. 1

FIG. 2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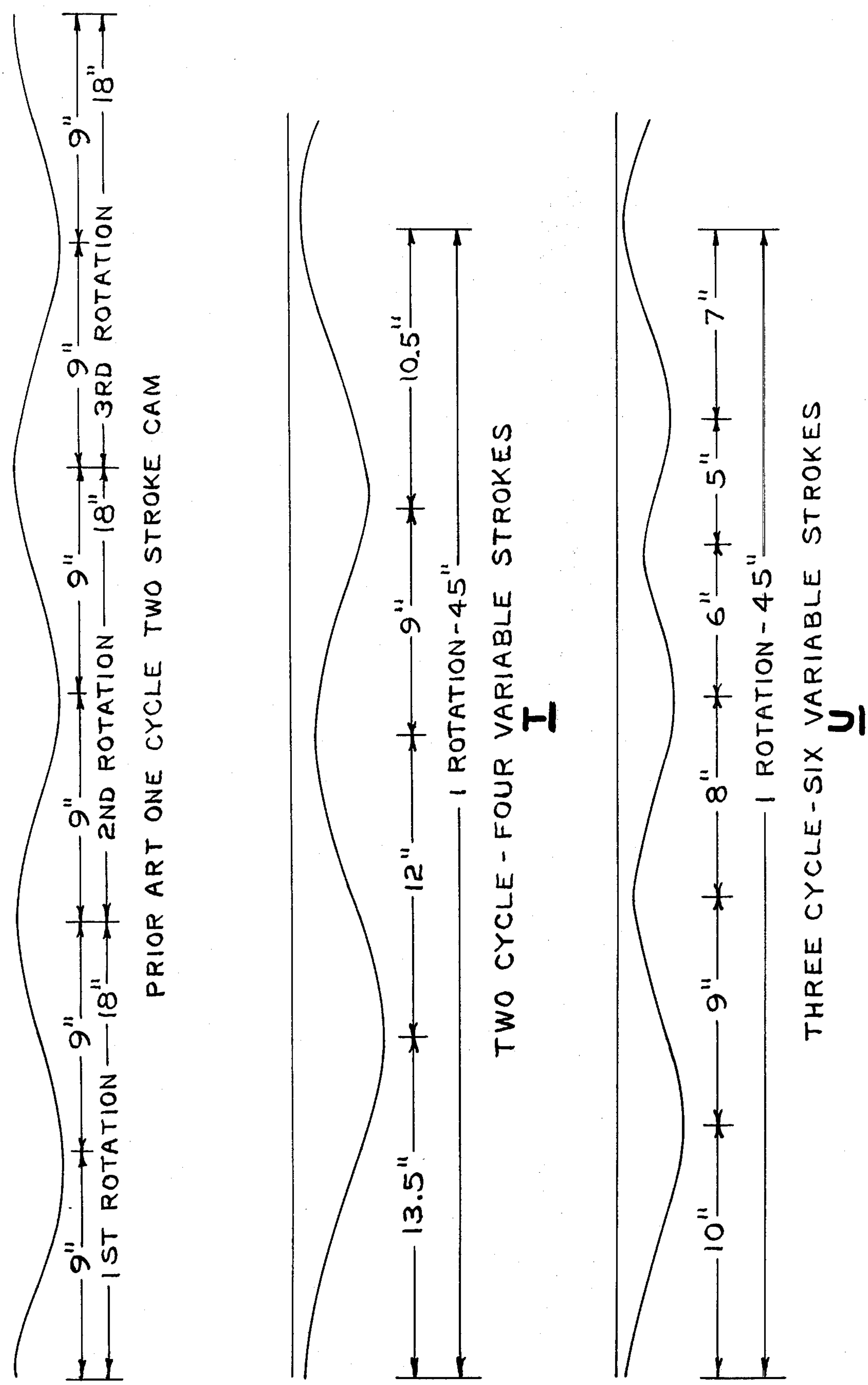
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18"
18"
1ST ROTATION
2ND ROTATION
3RD ROTATION
PRIOR ART ONE CYCLE TWO STROKE CAM
13.5"
12"
9"
10.5"
1 ROTATION - 45"
TWO CYCLE - FOUR VARIABLE STROKES
I
10"
9"
8"
6"
5"
7"
1 ROTATION - 45"
THREE CYCLE - SIX VARIABLE STROKES
U

FIG. 3

METHOD AND APPARATUS FOR REDUCING TENSION AND TRAVERSING GLASS FIBER STRAND

BACKGROUND OF THE INVENTION

This invention relates to a method and apparatus of traversing and tension reducing continuous glass fiber strand.

Glass fibers are formed by attenuation from a plurality of molten cones of glass at the tips of orifices in a glass fiber forming bushing.

During the formation of the filaments a sizing composition is applied thereto to provide lubricity to the filaments so they do not abrade against each other and break. The sizing composition usually contains a binder which binds the filaments into a strand which is subsequently formed. Both the binder and the lubricant are provided not only for processability but also for compatibility for the final use to which the glass fibers are adapted. Such uses are typically in the fields of plastic reinforcement, rubber reinforcement, such as tire cord, and textile applications.

After the glass fibers are sized they are gathered into strands usually by means of a gathering shoe which is normally a grooved graphite wheel. The strand is then passed over a traversing mechanism which contacts the strand and directs the strand over the surface of a forming tube.

The forming tube is mounted on a winder which is a rotating drum or collet providing the attenuative force to the glass fiber filaments drawn from the bushing. The forming tube is a thin cylindrical sleeve usually constructed of cardboard which fits securely over the winder collet. As the package is wound the strand is guided by the traversing mechanism to distribute the strand across the surface of the cylindrical forming package.

After a predetermined amount of glass fiber strand has been wound on a particular package the attenuation process is usually stopped, the wound package is removed and another empty forming package is placed on the winder and the glass fiber forming process is continued.

The interruption of the forming operation at frequent intervals is necessitated by the minimal amount of strand which can be wound on a single forming package. After a wind depth of about one-half inch of strand is reached, further winding on the forming package causes the inside strands of the package to wrinkle, in a path parallel to the axis of rotation of the forming package, due to strand tension. This wrinkling causes difficulty in unwinding of the packages due to breakage and difficulty in end finding.

During the formation of fibers into strand and the winding of the strand on the forming package, the attenuative force being supplied by the winder produces substantial tension within the strand package. This increased tension causes the strand to flatten when wound on the package. Flattening of strand detracts from the weaving characteristics of the strand when it is used in the corresponding product area, in addition to the wrinkling problem hereinbefore discussed.

During the winding of the strand on the forming package, the traversing mechanism causes the strand to be laid on the package at angles oblique to the axis of rotation of the cylindrical winder. Ideally, each layer of strand on the package should be laid non-parallel to the layer of strand on which it is wound, however, do to a failure of the traversing mechanism to provide such non-parallelism, several parallel winds are encountered within the strand package. These parallel winds cause difficulty, in that breaking and fuzzing of the strand during subsequent processing occurs because fibers which are wound in parallel layers have a tendency to adhere to each other.

Therefore, the glass fiber strand industry has desired a method of producing and an apparatus to produce a glass fiber strand package which is randomly wound with a minimum of parallel winds and producing a strand package with low tension.

The instant invention provides an apparatus for reducing the tension of glass fiber strand wound on forming packages.

Additionally, the invention provides a method of winding strand on a forming package with the layers being in substantially non-parallel relationship to each other.

Further, the invention provides an apparatus for traversing strand to form a substantially non-parallel wound forming package.

Still further, the invention provides an apparatus for reducing the tension of glass fiber forming packages, thus permitting a package capable of supporting a large amount of glass fiber strand.

These and other advantages of the invention will become apparent from the ensuing description.

BRIEF DESCRIPTION OF THE INVENTION

Briefly the invention involves a traveling surface for glass strand which is positioned between the gathering shoe and the winder, in a glass fiber strand forming operation. This traveling surface imposes a linear velocity to the strand slightly greater than that imposed by the winder thus reducing the tension in the strand being wound. This traveling surface is composed of a plurality of contact points on which the strand engages. These contact points define a plurality of tracks of travel on which the strand rides. Each track traverses the surface of the traveling surface at an angle oblique to the axis of rotation of the surface. There are several tracks of varying length on this traveling surface. The origin of any one of these tracks is the termination point of another one of the tracks on the traveling surface on which the strand rides. The traveling surface is positioned in such a manner that it contacts the strand but does not wind the strand thereon.

Further details and other advantages of the invention will appear from the following description of the preferred embodiment of the invention and the accompanying drawings in which:

FIG. **1** is a side elevational view, partly in perspective, of suitable apparatus for providing a traveling surface which reduces tension and randomly winds glass fiber packages;

FIG. **2** is a front elevational view, partially in perspective, of the apparatus of FIG. **1** in operation; and

FIG. **3** is a graphic representation comparing the traversing mechanism of the prior art with two embodiments of the invention.

Referring now to FIG. **1**, there is shown a traveling surface **1** mounted between two annular plates **2** and **3**. The annular plates **2** and **3** are constructed of a preferably light weight metal or alloy of such a metal. Aluminum and magnesium are typical metals employed and provide minimum weight on the shaft (not shown) on which the apparatus is mounted. Between the two annular plates **2** and **3** are mounted a plurality of wire members **4**. These wire members **4** are constructed of metal such as brass or steel. These materials have substantial rigidity and consequently provide constant form to the tracks **5**. The wire members **4** are mounted in a plurality of apertures **6** in the annular plates **2** and **3**. The tracks **5** are determined by the progressive bends **7** in the wire members **4**. The tracks **5** are preferably of different lengths to provide a random path to the strand to be engaged therewith. Hence, the arc length *x* and *y* which define separate track lengths are diverse in distance. On this particular apparatus, there are four separate tracks **5**, two of which are not shown.

The wire members **4** provide the point contact for the strand facing along the traveling surface. Point contact is preferable to minimize contact of the surface with the strand. A continuous surface which contacts the strand is undesirable in the apparatus of FIG. 1 because the forming strands, typically containing an aqueous sizing composition thereon, tend to adhere to a continuous surface thus causing wrapping of the strand about a continuous surface. Any wrapping of strand on such a surface prevents adequate transfer of the strands from the surface to the forming package on which the strands are wound. This wrapping of strand occurs primarily when any slight speed change of the strand is encountered by a continuous surface. Utilizing point contact on the traversing surface in lieu of a continuous contact alleviated this condition.

The two annular plates, **2** and **3**, are fastened together by means of screws **8** which are fitted into apertures **9** in the annular plate **3**. The screws **8** are attached to sleeves **10**, which are permanently affixed to annular plate **1**. Thus, if wire members **4** are to be replaced or adjusted to form different track lengths, annular plates **2** and **3** can be separated by disengaging the screws **8** and replacing the wire members **4** in the apertures **6** of the annular plates **2** and **3**. Perforations **11** are provided in annular plates **2** and **3** to reduce the weight of the total apparatus of FIG. 1. At the center of annular plates **2** and **3** is a channel **12** having a sleeve member **13** mounted therein to receive a drive shaft not shown in FIG. 1. The sleeve member **13** has a key receiver **14** for securing the apparatus of FIG. 1 on the drive shaft (not shown).

Instead of the wire track configuration of FIG. 1, a continuous solid surface can be made to produce a plurality of points on the continuous surface to contact the strand. This can be accomplished by having, instead of wires raised portions on the continuous surface defining tracks having the mechanical characteristics of the tracks shown in FIG. 1.

Other apparatus which would provide point contact with the strand and define tracks through which the strand rides can be constructed by those skilled in the art.

Referring to FIG. 2, the apparatus of FIG. 1 is shown tension reducing and traversing a glass fiber strand **15** while the strand **15** is being wound on a mandrel **16**. The glass fiber strand **15** is formed by a gathering shoe not shown which gathers the filaments produced from a glass fiber forming bushing into the strand **15**. The traverse A of FIG. 1 is mounted on a shaft **18** secured by a key **19** which provides the fixed attachment of the traverse A to the shaft **18**. The shaft **18** is driven by a motor, not shown. The linear velocity of the surface **1** of the traverse A is greater than the linear velocity of the surface of the mandrel **16**. In this particular example the linear velocity of the surface **1** is 12,100 feet per minute whereas the linear velocity of the mandrel **16** is 12,000 feet per minute. The normal range of speed differential between the traverse A and the mandrel **16** is normally between 5 and 10 percent. Thus, the traverse A travels at a surface linear speed 5 to 10 percent greater than the surface linear speed of the mandrel **16**. In general, the greater the differential maintained between the surface velocity of traverse A and the surface velocity of the mandrel **16**, the greater the degree of tension reduction of the strand being wound. However, if traverse A is operated at a surface linear velocity substantially greater than mandrel **16**, the forming package formed on the mandrel **16** will be too loosely wound and will cause problems in further handling of such strand packages. Thus, the differential in linear speeds is somewhat dependent upon the type of forming package desired.

The strand **15**, as can be seen in FIG. **2**, is passed over the guide **25** of the free wheeling idling arm **21**. The free wheeling idling arm **21** is supported by a bracket **24** which supports the mounting shaft **23**. Both the guide **25** and the idling arm **21** and its support members **23** and **24** are connected to a support arm **22** which is mounted on the shaft **18**. Thus, the guide eye **25** and the idler **21** direct the strand onto the center line of the traverse A providing a uniform plane of initial contact of the strand **15** on the surface **1** of the traverse A.

The traverse A is traversed the length of the mandrel **16** by means of extending and retracting the shaft **18** by a reciprocating mechanism, not shown, in the housing **20**. The mandrel **16** is rotated at a constant speed by means of a driving belt **26** driven by a pulley **27**. The belt **26** contacts a second pulley **28** which is free wheeling about the shaft **29**. As the belt **26** is turned by the pulley **27**, mounted on the drive shaft **30**, it rotates the shaft of the mandrel **16** by means of the pulley (not shown) positioned behind the stop plate **32**. As the strand **15** is accumulated on the mandrel **16**, the speed of the mandrel is adjusted so that a constant peripheral speed is obtained on the surface of the strand **15** wound on the mandrel **16**. This adjustment in winding is achieved by programing the speed of the motor not shown to adjust the depth of strand **15** wound on the mandrel **16**. On the surface of the mandrel **16** is a sleeve **31** on which the strand accumulates.

Because the traveling surface **1** of the traverse A has random track lengths, the angle of winding of the strand **15** on the mandrel **16** with relation to the axis of rotation of the mandrel **16** will be random, therefore producing a minimum amount of parallel winds on the strand package to be subsequently formed. The sleeve **31** is mounted on the shaft **16** between two stop plates **32** and **33**. Stop plate **32** is permanently affixed to the mandrel **16** and the opposing stop plate **33** is removably mounted on the mandrel **16** to facilitate the removal of a full glass fiber forming package composed of the wound strand **15** on the sleeve **31**.

After the sleeve **31** has the desired amount of glass fiber strand **15** wound thereon, the hub member **34** is rotated so that another mandrel **35** is in position to receive the glass fiber strand **15**. The depth of wind on the sleeve **31** is normally 1 to 2 inches as opposed to a conventionally wound package of one-half inch. This increased depth of wind is attributable to the substantially reduced tension of the strand because of the tension reduction of the traverse A.

A second mandrel **35** has a sleeve **36** mounted by means of stop plates **37** and **38.** Stop plate **37** is permanently affixed to mandrel **35.** Stop plate **38** is removably mounted on the mandrel **35** to facilitate the removal of a full forming package on the sleeve **36.**

The means for driving the mandrel **35** when in position is the pulley **27** affixed to the shaft **30** which is driven by a motor, not shown. The belt **26** rotates the mandrel **35** by a drive pulley (not shown) positioned behind the stop plate **37.**

Hence, it can be seen that the continuous forming operation can be provided by the apparatus of the invention without discontinuance of the forming operation simply by alternating the mandrel **16** and **35** and removing the full forming packages which were wound thereon.

Unlike the conventional manner of forming glass fibers, the sleeves **36** and **31,** with the glass fiber strand wound thereon are easily removable from the mandrels **35** and **16** because of the substantially reduced tension attributed to the traverse A. Additionally, when the mandrels **16** and **35** are interchanged, any change in speed of winding can be tolerated because the tension reducing characteristics of the traverse A prevents wrapping of the strand about the traverse and looping of the strand **15** about either of the mandrels **16** and **35.**

Further, unwinding of this strand is facilitated in that there is reduced tension in the glass fiber forming package and there is a negligible amount of parallel winds which provides for improved end finding and a minimal amount of breaks during the unwinding of the strand package.

The glass fiber strand produced by the apparatus of FIG. **2** is substantially round rather than flattened due to the reduction of tension while winding on the mandrels **35** and **36** thus providing an improved glass fiber strand for the production of yarn and textile glass fibers.

Referring now to FIG. **3,** a comparison of the transversing mechanism of the invention and that of the prior art is shown. In the prior art, the common method of traversing strand material has been by a one-cycle two-stroke cam traverse such as is shown in U.S. Pat. No. 2,391,870, the strokes being of the same length. Because of this one-cycle two-stroke cam, minimal randomness is encountered causing a plurality of parallel winds on a single strand package which in turn causes difficulty in unwinding such forming packages for subsequent use.

Graph T shows traverse which is a two-cycle four variable stroke cam which is made in accordance with the invention. The circumference of this cam is 45 inches and provides four different track lengths or strokes. Each track or stroke runs directionally from one side of the rotating surface to the opposite side of the rotating surface e.g., between the two annular plates as depicted in FIGS. **1** and **2** thus, a two-cycle cam is defined. This variable track or stroke causes the random wind on the glass fiber forming package.

Graph U of FIG. **3** shows a traverse defined by a cam having three cycles and six variable strokes. Again the circumference of the apparatus is 45 inches and the stroke lengths vary between 5 inches and 10 inches providing even more random placement of the strand on the forming package than the two-cycle four-stroke cam.

As can be readily determined from these graphs and in the previous description of the invention, there is no limitation as to the number of cycles or strokes capable of being formed on the traverse. Further, the circumference of the traverse can be varied.

An advantage of having a large circumference is that the rotational speed of the traverse of the invention can be substantially reduced with relation to that of the prior art since the larger circumferential distance, the less rotations per minute is required to achieve the desired linear speed for tension reducing the strand. This is advantageous in that the strain on the moving parts such as bearings and gears of the apparatus is substantially reduced.

It is apparent that within the scope of the invention modifications and different arrangements may be made other than as herein described. The present disclosure is illustrative of the invention comprehending all variations thereof. The invention is not to be limited only as is set forth in the accompanying claims.

I claim:

1. A glass strand traversing apparatus for depositing a strand on a forming package comprising:
- a pair of plate members,
- a plurality of spaced transversely extending supporting members secured to the opposing faces of said plates, said supporting members each having an inwardly depressed portion which lie upon and define a nonuniform undulating path between said supporting members to provide a rotatable support for said strand.

2. The apparatus of claim **1** wherein said supporting members are wire members.

3. The apparatus of claim **1** wherein said plate members are annular.

4. The apparatus of claim **3** wherein said supporting members are a plurality of wires mounted parallel to the axis of rotation of said annular plate members, said wires being supported by apertures in said annular plate.

5. In the method of forming a continuous glass fiber strand comprising drawing fine glass fibers from molten cones of glass at a bushing by attenuation, applying to said fibers during formation an aqueous sizing composition, gathering said fibers into strands, traversing the strands across a reciprocating path, winding said glass fiber strands on a winder, the improvement comprising
- pulling said strands with a plurality of spaced transversely extending supporting members secured to the opposing faces of a pair of annular plate members, said supporting members each having an inwardly depressed portion which lie upon and define a nonuniform undulating path between said supporting members, said pulling step being interposed between said gathering step and said winding step.

6. The method of claim **5** including traversing said strand across the surface of said winder during said pulling step.

7. In the method of forming continuous glass fiber strand comprising drawing fine fibers from molten cones of glass at a bushing by attenuation, applying to said fibers during formation an aqueous sizing composition, gathering said fibers into strand and collecting said fibers, the improvement comprising applying a plurality of pulling forces simultaneously at discrete points along said strand while imparting an undulating path of travel to said strands, said plurality of pulling forces being applied between said gathering step and said collecting step.

8. The method of claim **7** wherein said collecting step is accomplished by winding.

9. A method of forming glass fiber strand comprising:

attenuating glass fiber filaments from molten cones of glass,

applying an aqueous sizing composition to said filaments,

gathering said filaments into strand,

applying simultaneously, a plurality of pulling forces to said strand at discrete points along said strand,

applying a last pulling force to said strand, subsequent to said plurality of pulling forces and collecting said strand.

10. The method of claim **9** wherein said last pulling force is a winder.

11. The method of claim **9** wherein said last pulling force is greater than said plurality of pulling forces.

12. The method of claim **9** wherein said last pulling force is less than said plurality of pulling forces.

* * * * *