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METHOD AND APPARATUS FOR FORMING FIBERS

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FIG. 1

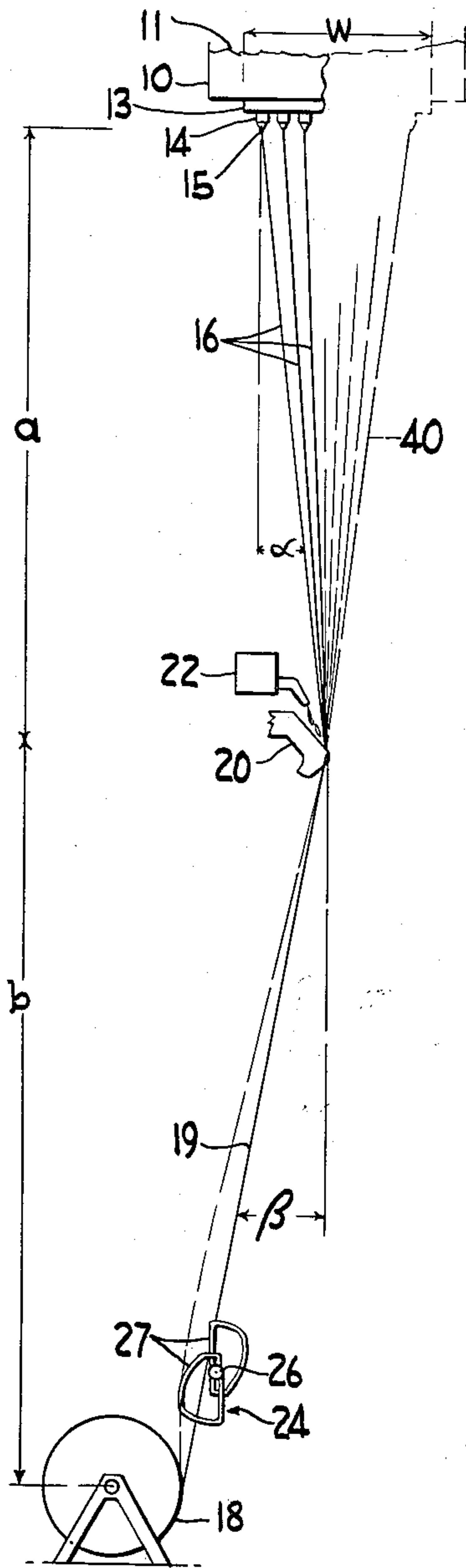
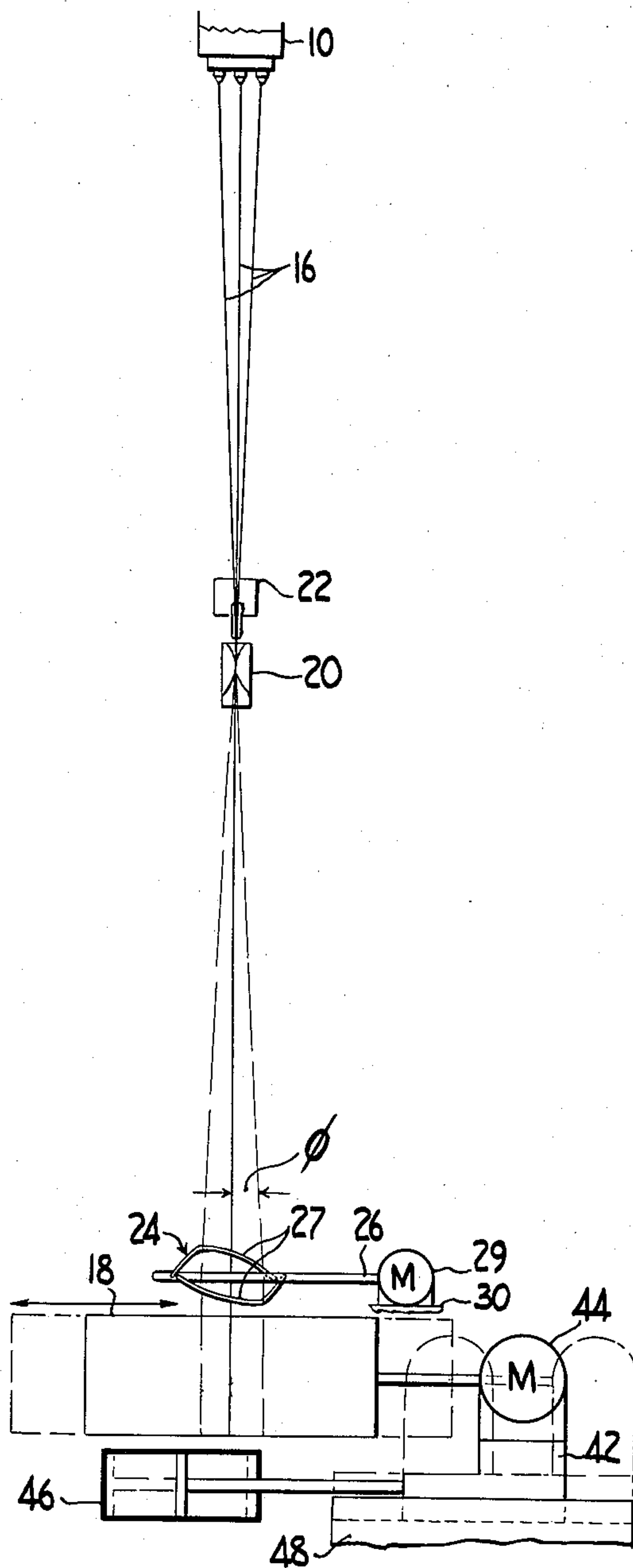


FIG. 2



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1

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METHOD AND APPARATUS FOR FORMING FIBERS

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5 Claims. (Cl. 18-8)

The present invention relates to apparatus for winding fibers on a tube, and it has particular relation to an improvement in a process of forming glass fibers by drawing them from a molten supply of glass and winding the fibers at a high rate of speed on a forming tube.

A process for forming continuous filament textile glass fibers is shown and described in U.S. Patent No. 2,391,870. In this process a number of glass filaments are drawn from a molten supply of glass at a high rate of speed, i.e., 5,000 to 20,000 feet per minute. The glass passes through orifices in a bushing and forms cones of glass at the tips of the orifices. The individual filaments are drawn from the cones of glass and are grouped together into a strand as they pass over a guide. The strand is thereafter wound in an open wind on a rapidly rotating forming tube.

There is no twist in the strand as it is thus formed and a binder is applied to the filaments prior to the winding of the strand on the tube in order to bond them together and maintain the integrity of the strand. An open wind, rather than a parallel, level wind, is desired on the forming tube in order to aid removal of the strand from the tube. If a parallel, level wind is used, the untwisted strand is very difficult to remove when the filaments become broken. In this event, successive turns of the strand become entangled and it soon becomes impossible to unwind the strand and remove it from the tube. The open wind is such that the strand is traversed the length of the tube for a relatively few turns of strand on the tube, i.e., 2 to 5 or more turns for a 7 to 10 inch long package for each traverse of the length of the tube. With this type of wind the succeeding turns of strand cross each other at a minimum angle of at least 5°.

The spiral wire traverse shown in U.S. Patent No. 2,391,870 has proved to be satisfactory for traversing a strand at the very high rate of speed which is employed to wind the strand on a forming tube. This traverse, in addition to rotating about its own axis, is reciprocated axially in order to distribute the strand over the length of the tube. This type of traverse requires that there be a certain minimum tension on the strand as it passes over the cams of the traverse to hold it on the cams as they tend to push the strand toward either end of the forming tube. There is a natural tendency for the strand to return to the center of the forming tube, and there is a minimum tension which is required to overcome this tendency and maintain the strand at its proper position on the cam to produce the desired open wind. If this tension becomes too great, there is the problem of the individual filaments of the strand breaking at the gathering guide due to too much friction as they pass over the guide. As soon as one filament breaks, the whole strand usually breaks.

This problem of tension on the strand has become aggravated by a desire to have the glass fiber process performed all on one floor; whereas, it has been previously conducted on two floors. In the prior process, the bushing and forming tube were so far apart that the bushing and guide were located on one floor and the forming tube and traverse on a floor below. The two-floor process was believed to be necessary in order to provide the proper angles to the fibers as they pass from the bushing over the guide and onto the forming tube. The prior process has required a man on each floor to operate it. It is now desired to conduct the fiber-forming process on one floor

2

with the bushing and forming tube closer together so that one man can operate the process. This latter arrangement imposes more severe angles and tension conditions on the process.

It is an object of the invention to produce glass fiber strand according to the above-described process with a minimum distance between the bushing and forming tube. It is a further object of the invention to produce long packages of glass fiber strand on a forming tube. It is desired to achieve these objects while imposing a minimum amount of tension on the strand during the fiber-forming process. The manner of accomplishment of these and other objects will be apparent from the description of the drawing in which:

FIG. 1 is a diagrammatic view of the apparatus of the invention illustrating the variables in the process, and

FIG. 2 is a side view of FIG. 1.

In FIG. 1 of the drawing, there is shown a glass melting furnace or forehearth thereof 10 containing a supply of molten glass 11 and having a bushing 13 attached to the bottom of the furnace. The bushing is provided with a series of orifices in the form of tips 14 through which the molten glass flows and forms in small cores 15 suspended from the tips of the orifices 14. The tips are usually formed in a number of rows, for example, 4 to 6 or more rows having a great many tips in each row so that the total number of tips is about 204 or 408 in number. A smaller or greater number of tips may be present in the bushing.

Glass filaments 16 are pulled from the cones 15 of glass at a very high rate of speed, i.e., 5,000 to 20,000 feet per minute, and wound on a rapidly rotating forming tube 18 which may be approximately 6 to 7 inches in outside diameter and may rotate at approximately 2,000 to 10,000 r.p.m. The glass filaments are grouped into a strand 19 as they pass over guide 20 prior to their being wound on the tube 18. Usually a liquid binder and lubricant such as a combination of starch and vegetable oil are applied to the filaments in the strand as they pass over a felt pad on the guide which pad is saturated with the binder and lubricant. The binder and lubricant may be dripped onto the pad by means of an applicator 22.

As the strand 19 is wound on the tube 18, it is rapidly traversed in open wind along the length of the tube by means of the traverse 24. The traverse is composed of a shaft or spindle 26 having a pair of complementary, conical, spirally disposed, wire cams 27 mounted on the shaft 26. The shaft is caused to rotate at 1,000 to 2,500 r.p.m. by a motor 29 which is mounted on a base 30. The axis of the shaft 26 is parallel to the axis of the tube 18. The traverse 24 is located adjacent tube 18 at a point where it intersects the strand as it travels from the guide to the periphery of the tube 18. The traverse 24 in the process of U.S. 2,391,870 is made to reciprocate in the direction of its axis by moving it, the motor and the movable base on which the motor is attached; whereas in the present invention the traverse rotates but does not move or reciprocate in an axial direction.

The guide 20 is located directly beneath the center of the bushing 13. This is to maintain the angle α , which is the angle between the outside filament and a vertical line from the cone from which the outside filament is drawn, to a minimum. The forming tube must be off set from a vertical line drawn from the bushing through the guide by an angle β , which is the angle between the vertical line and a line drawn from the guide to the periphery of the tube upon which the strand is wound. The angle β must always be slightly larger than the angle α in order to hold the outside filament 40 in the groove on the guide 20. The angle β is rapidly and regularly increased a slight amount by the height of the

cams 27 on the traverse as the strand is moved back and forth over the cams.

Another angle which must be considered in the relative positioning of the guide, traverse and forming tube is the angle ϕ which is formed by a line drawn from the guide to the center of the strand package on the tube and a line drawn from the guide to the end of the strand package on the tube. The angle ϕ is in a plane which is at an angle to the plane in which the angles α and β are located.

The amount of tension on the strand is determined by the angles α , β and ϕ . The angle α is determined by the width w of the bushing and the distance a between the bushing 13 and the guide 20. As w is made greater and/or a is made smaller, α becomes greater. In the prior art process the distance a has been of the order of 40 inches and the distance w has been of the order of 4 to 12 inches. As the angle α becomes greater, angle β must become greater because as said above, β must always be slightly greater than α in order to keep outside filament 40 on the pad and guide.

Angle β is also affected by the distance b and angle ϕ . The distance b is the distance between the guide and the forming tube and in the prior art has been of the order of 80 inches or roughly twice as great as the distance a . As b becomes smaller, ϕ becomes greater for a given width of traverse on the tube. The strand moves back and forth on the traverse as the traverse rotates. As shown in U.S. 2,391,870, the traverse itself moves back and forth in a path parallel to the axis of the tube. As angle ϕ becomes greater, there is a greater tendency for the strand during its traverse to want to return to the center line running from the guide to the center of the package on the tube, and it is more difficult to keep the strand at the proper point on the wire cam of the traverse as it rotates. In order to keep the strand at the proper point on the traverse, especially at the extremes of traverse, it is necessary to increase the tension on the strand between the guide and the tube. This is done by increasing the angle β .

In order to convert this process from a two-floor to a one-floor process, it can be seen that the distances a and b must be reduced and it is proposed that they be reduced to the point where they are about 30 and 35 inches respectively. It is also desired to increase the width w of the bushing in order to increase the number of orifices and filaments which are produced from one bushing. It is further desired to improve the process by making a longer package on the forming tube. It can be seen that each of these changes has the effect of increasing the angles α , β and ϕ and thereby increasing the tension on the strand and friction on the strand as it passes over the guide 20.

In the drawing there is shown a modification of the process described in the patent. This modification permits the angle ϕ to be at a minimum and thereby permit the angle β to be at its minimum which is required to keep the outside filament 40 on the guide. This is accomplished by maintaining the traverse 24 in fixed position with respect to a line drawn from the guide to the center of the package to be formed on the tube. The traverse 24 rotates but does not reciprocate axially. The angle ϕ is thereby maintained at its minimum. In order to build up the package throughout the length of the tube, the tube 18 is reciprocated along its axis as it rotates. This is accomplished by reciprocating the movable base 42 on which the motor 44 which drives the spindle on which the tube is mounted. The reciprocation is achieved by means of a reversible motor 46 operatively connected to the base 42 to move the base back and forth in slide 48. By reason of these changes in the functioning of the traverse and forming tube, longer packages can be made with less tension on the strand than previously required. The reduced amount of tension has also permitted the distances a and b to be reduced and

allow the fiber forming operation to be performed on one floor and handled by a single operator.

The following conditions of operation of the apparatus of the invention are given by way of example. The strand 19 travels at a speed of 12,000 feet per minute and is wound on the periphery of a forming tube 18 having a diameter of about 6 $\frac{3}{8}$ inches and rotating at about 7,000 revolutions per minute. The traverse 24 rotates at a speed of about 2,000 revolutions per minute and traverses the strand on the tube through a distance of about 2 $\frac{1}{2}$ to 5 inches for each half revolution. The tube reciprocates back and forth once every 10 seconds to permit winding of the strand over the length of the tube.

Although the invention has been described with respect to specific details of certain embodiments thereof, it is not intended that such details be considered as limitations upon the scope of the invention except insofar as set forth in the accompanying claims.

I claim:

1. An apparatus for forming glass fibers which comprises a stationary container for a supply of molten glass, a bushing in the bottom of the container and means for drawing glass filaments from the bushing including means for applying a size to the filaments, a stationary guide for grouping the filaments into a strand, a rotatable tube for winding the strand thereon, means for rotating the tube, a rotatable traverse mounted adjacent the tube in a fixed position relative to the guide for distributing the strand on the tube in an open wind, means for rotating the traverse, and means for continuously reciprocating the tube in an axial direction throughout the length of the strand package formed on the tube a plurality of times during the winding.

2. An apparatus for forming glass fibers which comprises a stationary container for a supply of molten glass, a bushing in the bottom of the container and means for drawing glass filaments from the bushing including means for applying a size to the filaments, a stationary guide for grouping the filaments into a strand, a rotatable tube for winding the strand thereon, means for rotating the tube, a rotatable traverse for distributing the strand on the tube in an open wind composed of a shaft rotating on an axis parallel to the axis of the tube, a pair of independent, complementary cams mounted on the shaft for engaging the strand and moving it longitudinally of the tube in a reciprocating manner as the traverse rotates, means for rotating the traverse, the traverse being mounted adjacent to the tube in fixed relation with respect to the guide, and means for continuously reciprocating the tube in an axial direction throughout the length of the strand forming package a plurality of times during the winding.

3. A method of forming a strand of glass fibers which comprises drawing a plurality of filaments from a supply of molten glass, applying a size to the filaments of the strand, passing the filaments over a guide to group them into a strand, passing the strand to a traversing station, effecting a small traverse of the strand as it passes between the guide and traversing station, winding the traversing strand on a rotating tube and continuously causing relative reciprocation of the tube and the traversing station in a line parallel with the axis of the tube throughout the length of the strand forming package on the tube a plurality of times during the winding while maintaining the relative position of the guide and traversing station constant to permit winding of the strand with each turn of strand being at a slight angle to adjacent turns throughout the length of the tube while holding to a minimum the tension on the strand as it passes over the guide.

4. A method of forming a strand of glass fibers which comprises drawing a plurality of filaments from a supply of molten glass, applying a size to the filaments, passing the filaments over a guide to group them into a strand, passing the strand to a traversing station, continuously

5

effecting a small traverse to the strand as it passes between the guide and traversing station on its way to a rotating tube, winding the traversing strand on the rotating tube with each turn of the strand being laid down on the tube at a slight angle to adjacent turns and continuously causing relative reciprocation of the tube and traversing station in a line parallel to the axis of the tube throughout the length of the strand forming package a plurality of times during the winding while maintaining substantially constant the distance between parallel planes which are perpendicular to the axis of the tube and which pass through the guide and traversing station respectively to thereby minimize the tension of the strand as it passes over the guide.

5. An apparatus for forming glass fibers which comprises a container for a supply of molten glass, a bushing in the bottom of the container and means for drawing glass filaments from the bushing including means for applying a size to the filaments, a guide for grouping the filaments into a strand, a rotatable tube for winding the

6

strand thereon, means for rotating the tube, a traverse means mounted adjacent the tube in a fixed position relative to the grouping guide, said traverse means distributing the strand on the tube in an open wind, and means for continuously reciprocating the tube in an axial direction throughout the length of the strand forming package a plurality of times during the winding.

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