July 3, 1962 F. H. GREEN 3,041,664
APPARATUS FOR FORMING FIBERS
Filed Dec. 23, 1958

FIG. 1

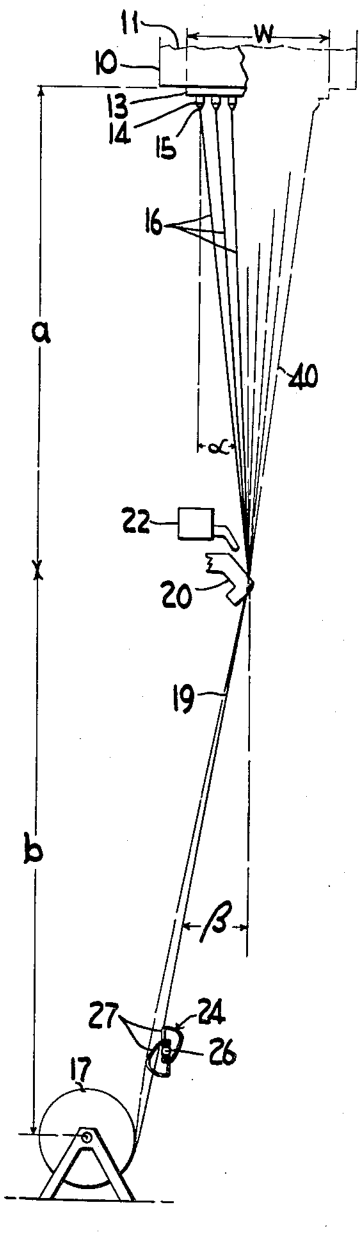
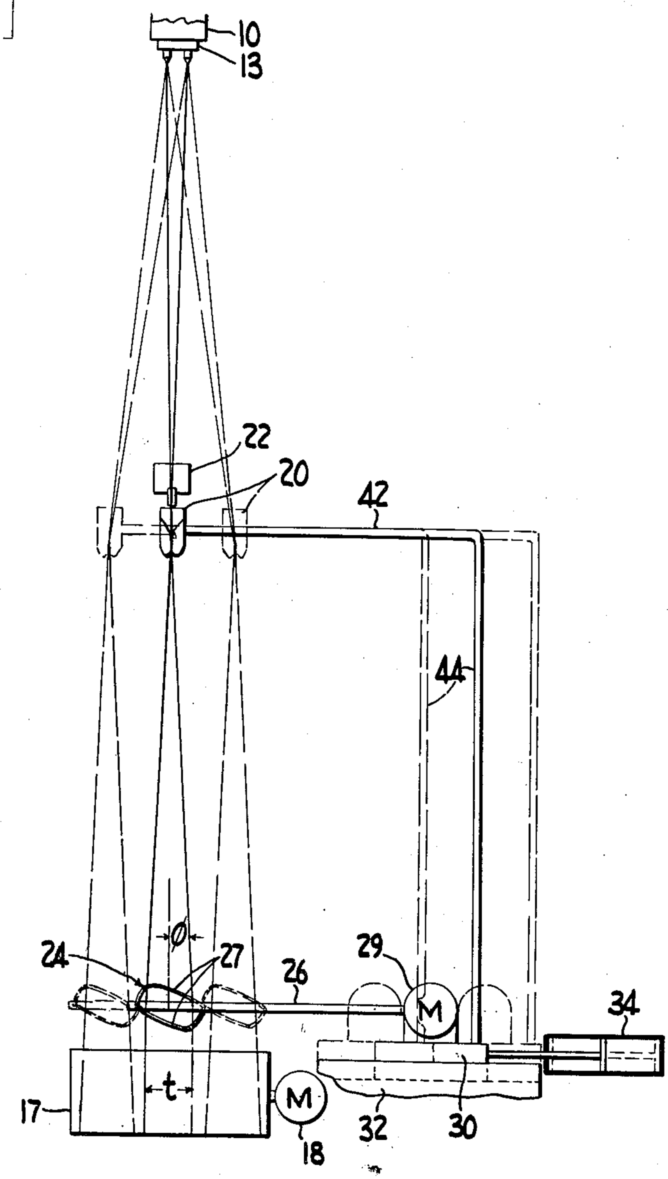


FIG. 2



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United States Patent Office

3,041,664

Patented July 3, 1962

3,041,664
APPARATUS FOR FORMING FIBERS

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Filed Dec. 23, 1958, Ser. No. 782,429
3 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 packages 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 bush-

ing 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 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 witht a series of orifices in the form of tips **14** through which the molten glass flows and forms in small cones **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 **17** which may be approximately 6 to 7 inches in outside diameter. The tube may be rotated at approximately 2,000 to 10,000 r.p.m. by a motor **18** which is axially connected to the tube. The glass filaments are grouped into a strand **19** as they pass over guide **20** prior to their being wound on the tube **17**. 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 **17**, 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 **17**. The traverse **24** is located adjacent tube **17** at a point where it intersects the strand as it travels from the guide to the periphery of the tube **17**. The traverse **24** is made to reciprocate in the direction of its axis by moving the base

30 in slideway 32 by suitable means such as a reciprocating motor 34 which is attached to the base.

The guide 20 is normally 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 offset 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 this 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 or on the pad on the guide 20. The angle β is rapidly and regularly increased in 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 t 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 each 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 permits the angle β to be at its minimum which is required to keep the outside filament 40 on the guide. This is accomplished by causing the guide 20 to reciprocate in a path which is parallel to the axis of the traverse 24 and in coordination with the reciprocation of the traverse 24. As the traverse moves to one end of the package, the guide moves in that direction also and as the traverse returns to the center and moves to the other end of the package, the guide moves in that direction also. The guide moves approximately the same distance as the traverse during these regular and continuous reciprocations. This may be accomplished by mounting the guide 20 on frame elements 42 and 44 which are rigidly connected to the base 32 on which the traverse 24 and motor 29 therefor are mounted. As the base moves in and out to reciprocate the traverse, the guide 20 also reciprocates through the same distance.

The reciprocation of the guide 20 with the traverse reduces the angle ϕ to the minimum which is required by the distance of throw created by the traverse in order to produce the minimum angle of crossing of the strand for the open wind on the package. The angle ϕ is thereby maintained at its minimum, and angle β may also be maintained at its minimum. By reason of the reciprocation of the guide, longer packages can be made with less tension on the strand than previously required. The reduced amounnt 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 17 having a diameter of about 6⅜ 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 2½ to 5 inches for each half revolution. The traverse 24 and guide 20 reciprocate back and forth over the length of the tube once every 10 seconds.

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 a 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 for distributing the strand on the tube in an open wind, means for rotating the traverse, means for reciprocating the traverse in a path which is parallel to the axis of the tube and means for reciprocating the guide in a line parallel to the axis of the tube and in coordination with the reciprocation of the traverse.

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 a 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, means for reciprocating the traverse in a path which is parallel to the axis of the tube and means for reciprocating the guide in a line parallel to the axis of the tube and in coordination with the reciprocation of the traverse.

3. 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 a guide for grouping the filaments into a strand, a rotatable tube for winding the strand thereon, means for rotating the tube, a traverse mounted adjacent the tube for distributing the strand on the tube in an open wind, means for reciprocating the traverse in a path which is parallel to the axis of the tube and means for reciprocating the guide in a line parallel to the axis of the tube and in coordination with the reciprocation of the traverse.

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