Aug. 19, 1952 I. G. BRENNER 2,607,167

METHOD AND APPARATUS FOR MAKING GLASS FIBER TEXTILE SLIVERS

Filed April 1, 1948

2 SHEETS—SHEET 1

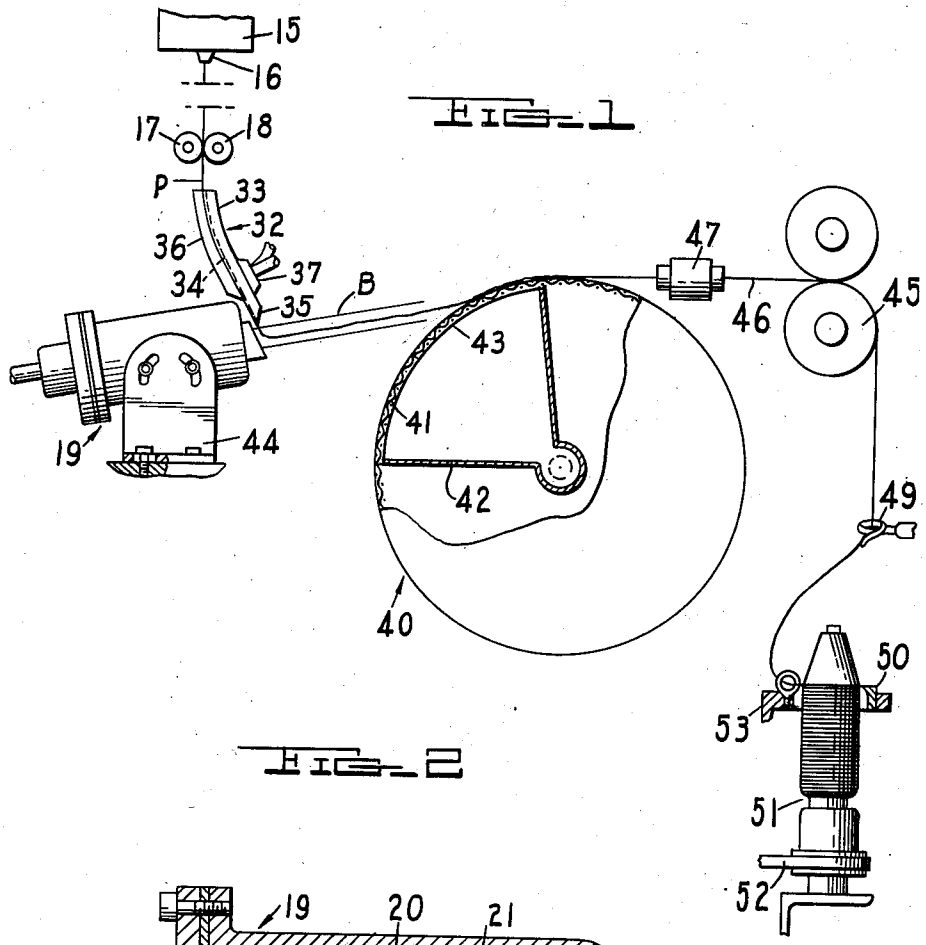


FIG. 1

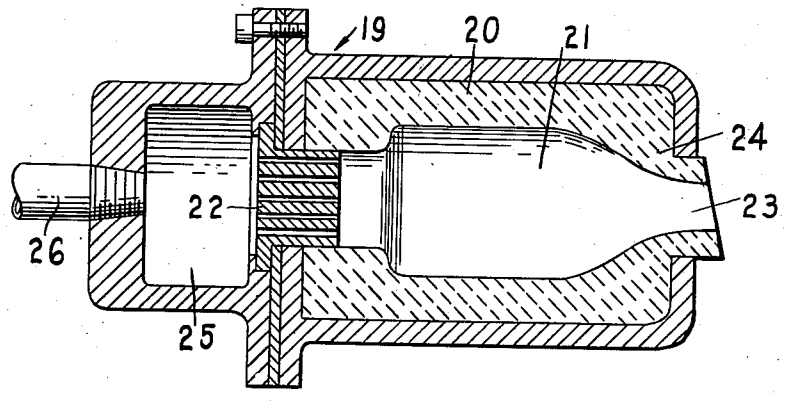


FIG. 2

INVENTOR.
IVAN G. BRENNER
BY
Staelin & Overman
ATTORNEYS

Aug. 19, 1952 I. G. BRENNER 2,607,167

METHOD AND APPARATUS FOR MAKING GLASS FIBER TEXTILE SLIVERS

Filed April 1, 1948

2 SHEETS—SHEET 2

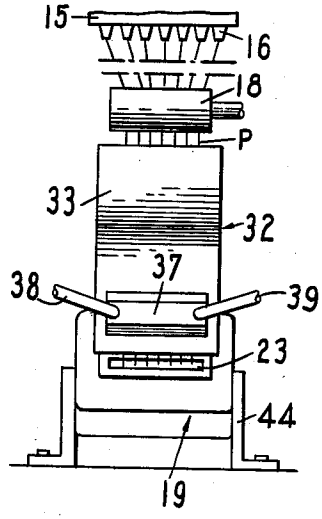


FIG. 3

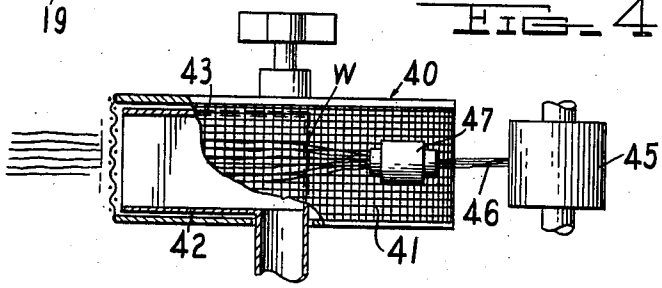


FIG. 4

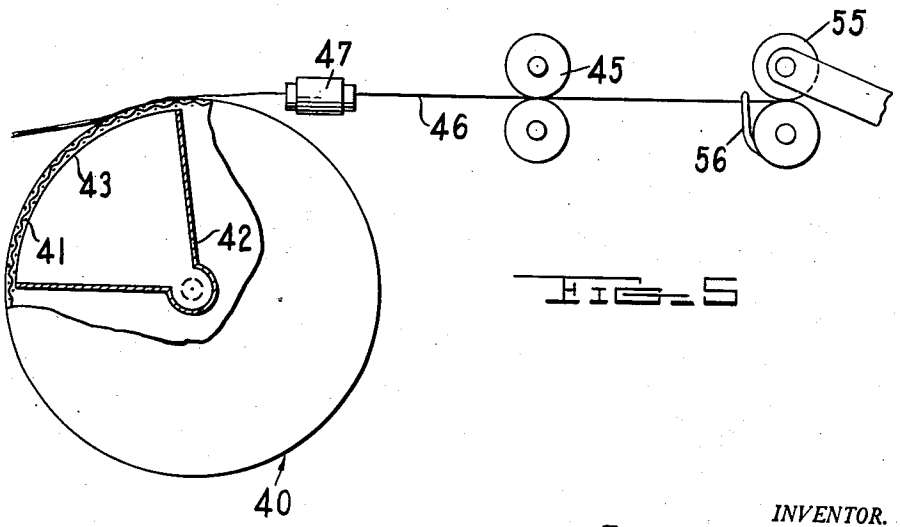


FIG. 5

INVENTOR.
IVAN G. BRENNER
BY
Staelin & Overman
ATTORNEYS

Patented Aug. 19, 1952

2,607,167

UNITED STATES PATENT OFFICE

2,607,167

METHOD AND APPARATUS FOR MAKING GLASS FIBER TEXTILE SLIVERS

Ivan G. Brenner, Newark, Ohio, assignor to Owens-Corning Fiberglas Corporation, a corporation of Delaware

Application April 1, 1948, Serial No. 18,306

5 Claims. (Cl. 49—17)

1

This invention relates to textiles of the staple type and more particularly to improvements in methods and apparatus for producing glass fiber strands, slivers or yarns of the staple type.

Staple strands or slivers may be produced by blowing fibers with a blast of gas onto a collecting surface in a manner such that the fibers, in effect, double back and forth on the collecting surface to form a mat having the fibers extending in practically all directions in the plane of the mat. This web or mat of haphazardly arranged fibers is then drawn from the collecting surface with sufficient drafting or pulling force to rearrange the fibers so that they extend generally parallel in the direction of length of the strand or sliver and impart substantial tensile strength thereto.

The fibers employed in making the strand or sliver are produced from a thermoplastic or heat softenable material, such for example, as glass. These fibers may be formed by using a gaseous blast having a temperature exceeding the softening temperature of the material or glass and having a velocity sufficient to draw out or attenuate the softened glass into fibers of the required size. Briefly, glass rods or filaments may be fed into the blast near the origin of the blast at a rate such that the advancing ends of the rods are softened by the heat of the blast and are drawn out or attenuated to fibers by the velocity of the blast. This velocity is high enough to convey the fibers to a supporting surface which is of the suction type to collect the fibers thereon in the form of a mat.

In any case after the mat of fibers is formed on the collecting surface, it is removed from the surface in the form of a strand or sliver by the application of a pulling or drafting force on the mat. The pulling or drafting force applied to the web or mat to remove the same from the collecting surface in the form of a strand must be sufficient to rearrange the fibers in the mat so that these fibers extend generally parallel to each other in the direction of length of the strand. Although care may be taken to apply as uniform a drafting force as possible to the mat or web, nevertheless, there is a tendency for irregularities to develop in the thickness and density of the strand which have the effect of producing localized weak areas along the length of the strand.

One of the objects of this invention is to deposit the blast-borne fibers on the collecting surface before the fibers have an opportunity to become tangled or disarranged in the blast.

2

In accordance with this invention the point at which the rods or filaments are introduced into the blast is so closely related to the collecting surface that each rod is drawn out substantially continuously to a fine fiber, and the fibers thus formed are individually conveyed to the collecting surface and individually deposited thereon to provide a mat of fibers extending predominantly lengthwise of the mat. Thus the drafting or pulling force applied to the mat to remove the same from the collecting surface in the form of a strand or sliver may be substantially reduced, as this force is not required to rearrange the fibers so that they extend generally lengthwise of the strand or sliver.

Another object of this invention is to provide an arrangement of the above type wherein the strand or sliver may either be wound directly on a packaging spool or on a conventional twister spindle. In instances where the strand or sliver gathered from the mat deposited on the collecting surface is wound directly on the twister spindle, a considerable saving in production cost is realized because the intermediate step of packaging the sliver on a spool is eliminated.

Still another object of this invention is to propel relatively fine elongated fibers in substantial parallel relationship toward a cylindrical perforated collecting surface on a rotatable drum by a high velocity gaseous blast directed toward the drum in a manner such that a substantial component of movement of the blast extends generally in the direction of movement of the collecting surface. Thus the blast in effect sweeps over the collecting surface, and the fibers carried by the blast are not appreciably disarranged as would be the case if the blast impinged directly against the collecting surface.

A further feature of this invention is to deposit the blast-borne fibers on the collecting surface while maintaining the fibers in substantial parallel relationship lengthwise of the blast and produce a uniform, relatively narrow band or mat of fibers on the collecting surface. The width of the mat is confined by spacing the source of the blast from the drum a distance so determined with respect to the velocity of the blast that the blast approaches the collecting surface on the drum before it fans out sufficiently to cause disarrangement of the fibers, and in this respect, also assists in maintaining the fibers in parallel relationship as they are deposited on the drum. The force of the blast in the region of the collecting drum is no greater than required to maintain the fibers in substantial paral-

lel relation in a confined space with the result that the fibers may be drawn against the collecting surface by the application of a relatively light suction force at the inner side of the perforated collecting surface. Thus the mat accumulated on the collecting surface may be removed from the end of the suction area by the application of very little drafting force so that the resulting strand or sliver is more uniform in diameter and the tendency for weak areas to develop in the strand is materially reduced.

A still further object of this invention is to form the fibers in the same gaseous blast used in propelling the fibers toward the collecting surface. In the present instance an internal combustion torch type burner is provided having a chamber in which a combustible gas mixture is burned and having an opening in one wall of the burner through which the products of combustion are discharged. The discharge opening is restricted and shaped to produce a ribbon-like blast having a temperature exceeding the softening temperature of a thermoplastic material such as glass and having a velocity sufficient to attenuate the softened glass into fibers. Elongated glass bodies are fed into the blast from one side thereof at a point adjacent the discharge opening at a rate such that the advancing ends of the bodies are softened sufficiently to enable the force of the blast to draw the softened ends out into fibers. Thus the fibers extend generally in the direction of movement of the blast, and the burner is supported in a manner relative to the collecting drum to provide the desired relationship between the blast and collecting surface on the drum previously discussed.

The foregoing, as well as other objects, will be made more apparent as this description proceeds, especially when considered in connection with the accompanying drawings, wherein:

Figure 1 is a semi-diagrammatic elevational view of one type of apparatus capable of producing strands or slivers from thermoplastic materials such, for example, as glass in accordance with this invention;

Figure 2 is a sectional view through one type of burner and guide construction capable of being used as a part of the apparatus;

Figure 3 is a front elevational view of the burner and guide assembly;

Figure 4 is a fragmentary plan view of the fiber collecting drum; and

Figure 5 is a fragmentary plan view showing a modified construction.

The present invention provides an improved method and apparatus for manufacturing slivers, strands or yarns from various materials characterized in that they assume a molten or viscous condition when heated and become solidified when cooled. Such materials may be generally termed heat softenable or thermoplastic materials, and when in a molten or viscous condition, generally permit drawing the same out into fibers. One type of material having the desired characteristics is glass, and for the purpose of illustration, the present invention is described herein in connection with this material.

In accordance with this invention glass fibers as small as one micron or less and as large as two and one-half microns or more in diameter may be produced in large quantities on an economical production basis from primary glass filaments or rods of substantially greater diameter. The glass filaments or rods are indicated in the several figures of the drawings by the reference character P and may be readily produced in continuous lengths by the apparatus diagrammatically shown in Figure 1 of the drawings. In detail the reference character 15 indicates a glass feeder or bushing which may be in the form of a long, relatively narrow trough, having a plurality of feeding orifices 16 in its bottom wall. Glass cullet or glass batch is fed to the bushing in any suitable manner, and is heated while in the bushing to a molten condition. The molten glass flows from the orifices 16 in small streams which are attenuated to form the primary filaments P by means of coacting feed rolls 17 and 18 located a distance from the bushing 15 sufficient to assure cooling of the filaments to solidification before engagement by the rolls. One or both of the feed rolls may be driven by any suitable type of prime mover not shown herein.

The feed rolls also serve to project the primary filaments P into an intensely hot, high velocity gaseous blast B. The blast B is produced by a burner 19 having a body 20 of refractory material and having a combustion chamber 21 therein. One end of the combustion chamber terminates at a perforated wall 22 having a plurality of small orifices extending therethrough and the other end of the chamber is provided with a wall 24 having a restricted outlet or discharge passage 23 therein. The refractory body may be surrounded by a sheet metal shell which extends past one end of the body to form an inlet chamber 25 between the end of the shell and the perforated wall 22. A suitable conduit 26 connects with the shell to feed the combustible gaseous mixture into the inlet chamber 25. The gaseous mixture enters the inlet chamber 25 and passes through the orifices in the wall 22 where it ignites and burns with a resulting high degree of expansion. During operation the walls of the chamber 21 are heated by the burning gas and the hot walls tend to increase the rate at which the gas entering the chamber burns. The resulting high rate of combustion causes a great expansion of the products of combustion, which as they pass through the outlet passage 23, are accelerated into a very high velocity blast of intense heat.

The outlet passage 23 is elongated, and is substantially less in cross-sectional area than the chamber 21, so that the products of the combustion taking place within the chamber are accelerated as they pass through the opening or passage 23 to provide a blast B of the gases moving at a very high velocity. In this connection, it may be pointed out that the cross-sectional area of the passage 23 may be varied to some extent relative to the cross-sectional area of the chamber 21, depending upon the heat required in the blast leaving the outlet passage. Passages of greater cross-sectional area relative to the cross-sectional area of the chamber 21 permit burning a greater amount of gas and result in greater heat of the blast, but also cause a decrease in the velocity of the blast. Preferably, however, the cross-sectional area of the outlet passage 23 is not greater than necessary to obtain in the blast the heat required to raise the glass to the attenuating temperature. The best relation of the cross-sectional area of the passage 23 to the cross-sectional area of the chamber 21 may be determined by simple trial, but will be found to be within the range of 1:8 or 1:4. This arrangement provides for obtaining the high velocity of the blast coupled with sufficient

heat of the blast to quickly soften the glass to be attenuated.

The type of combustible gas used may be any suitable kind, but for reasons of economy, it is preferably an ordinary fuel gas, such as natural or manufactured fuel gas. This gas is mixed with the proper amount of air by means of the orthodox air and gas mixers. The gas and air mixture is taken from the mixer at moderate pressure of approximately one to five p. s. i., but may be considerably higher if desired, and is led through an ordinary conduit to an enclosed ignition chamber where ignition of the gaseous mixture takes place.

It has been found that the velocity and temperature of the blast is highest immediately adjacent the outlet opening 23 and decreases in both temperature and velocity as the distance from the opening increases. Thus in order to take full advantage of the maximum temperature and velocity of the blast, the primary filaments P are fed into the blast as near the discharge opening 23 as practical. In accordance with this invention the primary filaments P are guided into the blast by a guide 32 supported below the coacting feed rolls 17 and 18. The guide 32 comprises a plate 33 elongated in the direction of the path of travel of the primary fibers leaving the feed rolls and having a plurality of laterally spaced grooves 34 corresponding in number to the number of primary fibers. The lateral spacing of the grooves 34 is such that these grooves respectively receive the primary fibers leaving the feed rolls and the grooves extend for the full length of the plate 33. The lower end portion 35 of the plate 33 extends downwardly in juxtaposition to the front burner wall and terminates substantially flush with the top wall of the passage 23. It is pointed out in this connection that the width of the plate 33 corresponds to the length of the passage 23 or, in other words, to the width of the blast, so that all of the primary fibers leaving the delivery end of the plate or guide are projected into the gaseous blast issuing from the passage 23.

The guide 32 is provided with a cover 36, which is secured to the rear face of the plate 33 over the grooves 34 to enclose the primary fibers. The lower end of the cover 36 terminates short of the portion 35 of the plate 33 to expose the primary fibers directly to the heat radiating from the front burner wall. Due to the fact that the portion 35 of the guide or plate 33 extends in such close proximity to the wall 24 on the burner 19, this plate is subjected to high temperatures, and if desired, may be cooled by providing a jacket 37 at the front side of the plate 33. A cooling medium from a suitable source may be conveyed to the jacket 37 through an inlet conduit 38 and discharged from the jacket through an outlet conduit 39.

It follows from the above that the guide 32 is so positioned relative to the burner 19 that the primary glass filaments P are fed endwise into the blast in side by side relationship along a plane extending substantially normal to the blast B issuing from the outlet opening 23 in the burner chamber. The temperature of the blast exceeds the melting or softening temperature of the glass filaments and the rate of feed of the primary filaments into the blast is controlled in dependence upon the diameter of the filaments to assure softening or melting the advancing ends of the filaments in the blast, or in other words, before the filaments are projected through the blast.

The molten or softened glass at the advancing ends of the filaments is drawn out or attenuated into fibers by the force of the blast. Thus the fibers are elongated in the general direction of movement of the blast and are propelled through the atmosphere in substantial parallel relationship.

The fibers suspended or carried away by the blast are collected in the form of a mat or web W on a drum 40 supported opposite the burner 19 for rotation in a direction away from the burner and connected to a suitable prime mover, such for example, as an electric motor, not shown. The drum 40 has a perforated cylindrical surface 41 and a segmental shaped suction box 42 is supported within the confines of the surface 41. The box is fixed against rotation, and the side of the box adjacent the perforated surface is open to form a suction area 43 which extends for approximately 90° around the drum surface 41. The box 42 is fixedly supported in any suitable manner in the drum, and communicates with the suction side of a blower, not shown.

One of the features of this invention is to determine the distance between the point of introduction of the filaments P into the blast B and the fiber deposition surface 43 of the collecting drum 40, so that the fibers are maintained in substantially parallel relation throughout movement thereof by the blast to the surface 43. This distance varies with the size of the burner or velocity of the blast produced by the burner, but in any case, is such that the blast reaches the surface 43 on the collecting drum before it has an opportunity to fan out to such an extent that the generally parallel arrangement of the fibers is disturbed.

The burner selected herein for the purpose of illustration may have a combustion chamber 1½ inches in diameter and 3½ inches long overall. The orifice 23 of the burner may be from ⅝ inch to 1⅛ inches in width and $\frac{3}{32}$ inch to $\frac{5}{16}$ inch in height. Other size burners may, of course, be employed and the dimensions here given are solely for the purpose of setting out the principle of the invention and the best mode of applying the principle.

When employing a burner of substantially the size noted above, particularly satisfactory results are obtained by supporting the burner with the discharge opening 23 spaced from 6 to 8 inches from the collecting drum 40. However, as stated above, this distance will vary as the size of the burner varies. It is a relatively simple matter to adjust the position of any selected burner with respect to the collecting drum so that the fibers are deposited on the collecting surface 43 of the drum before the blast fans out to such an extent to materially disturb the generally parallel arrangement of the fibers carried thereby.

Although it is important to deliver the fibers to the collecting drum before the force of the blast diminishes to such an extent that the fibers become entangled before reaching the drum, nevertheless, it is ordinarily preferred to maintain the velocity of the blast as low as possible without disturbing the above desired operation. Generally speaking the lower the velocity of the blast at the drum collecting surface 43, the lower the suction required to draw the blast-borne fibers against the surface 43. The

advantage in reducing the amount of suction is two-fold, in that it not only enables correspondingly reducing the drafting or pulling force necessary to remove the fibrous mat from the collecting drum, but in addition, assists in depositing the fibers on the collecting surface without disarranging the fibers.

The burner 19 is supported on brackets 44 in a manner to permit angularly adjusting the burner in a vertical plane. In use the burner is positioned to direct the blast B toward the portion of the collecting surface 41 registering with the suction area, and is supported at such an angle that a substantial component of movement of the blast extends generally in the direction of movement of the collecting surface. The optimum angle at which the burner 19 is supported will, of course, vary depending upon the diameter of the drum 40 and to some extent upon the distance between the burner 19 and collecting surface on the drum. In an installation where the diameter of the drum is about 14 inches, and where the burner discharge opening 23 is spaced 6 to 8 inches from the collecting surface, satisfactory results may be obtained by tilting the burner 19 upwardly at an angle of 5 to 10 degrees. In any case the burner 19 is supported at such an angle relative to the collecting surface 41 registering with the suction area 43 that a substantial portion of the blast passes along the surface instead of impinging directly against the collecting surface. Thus there is less tendency for the fibers to become tangled or disarranged during the interval they are drawn against the collecting surface 41 by the suction in the box 42. In other words, the fibers in the blast are individually deposited on the collecting surface of the drum in substantially parallel relationship to form a uniform web or mat which may be removed and gathered into a strand or sliver by the application of a minimum drafting force to the leading end of the mat. This drafting force need not be great as it is not relied upon to pull the fibers in parallel relationship as is customary in staple forming processes practiced in the past. The importance of this feature will be readily appreciated when it is understood that one of the chief causes of non-uniformity in strand diameter heretofore experienced was due to the substantial drafting force heretofore required to pull the fibers into parallel relationship.

The fibrous mat formed on the collecting surface is separated from the latter at the leading side of the suction area 23 by rubber faced pull rolls 45 supported for rotation about axes parallel to the axis of rotation of the drum 41 and positioned with the contacting peripheral surfaces located in a plane substantially tangent to the cylindrical collecting surface 41 at the leading side of the suction area 43. The mat removed from the collecting surface 41 is gathered into a strand or sliver 46 by a condensing turbine 47, and the strand thus formed is passed between the peripheral surfaces of the pull rolls 45 The rolls 45 are driven by suitable power means (not shown) in the directions noted by the arrows in Figure 1 of the drawings, and the peripheral speed of the rolls is sufficiently greater than the speed of the drum to not only overcome the friction or drag applied to the strand by the turbine in gathering the mat, but to also supply the negligible or small amount of draft required to remove the mat from the collecting surface 41. The friction as well as the false twist of the strand caused by gathering the mat in the condensing turbine 47 is minimized by providing a turbine having a length merely sufficient to properly gather the relatively narrow mat into a strand. For most installations, the required amount of draft is obtained by rotating the pull rolls 45 at approximately twice the speed of the drum 40.

The strand or sliver delivered by the pull rolls may be twisted to form twisted slivers or yarns by orthodox equipment diagrammatically shown in Figure 1 of the drawings as comprising an eye 49 positioned to enable passing the strand therethrough as it leaves the bite between the pull rolls. From the eye 49 the strand is passed through a traveller 50 supported for rotation around a bobbin or spindle 51 which, in turn, is rotated by suitable power means including the belt 52. The traveller 50 is actually rotatably supported on traverse means 53 which reciprocates lengthwise of the spindle to distribute the strand 46 uniformly over the spindle to produce a package.

In some instances it may be desired to package the strand on a spool instead of a twister spindle and if such practice is desired, the embodiment shown in Figure 5 of the drawings may be provided. In detail, a spool 55 is rotatably supported beyond the pull rolls 45, and the strand 46 leaving the pull rolls is wound directly on the spool. In accordance with conventional practice the strand is reciprocated lengthwise of the spool during the winding operation by a suitable traverse indicated generally by the numeral 56 and of a design to uniformly distribute the strand over the spool to form a package.

I claim:

1. Apparatus for producing a strand of fibers of heat softenable material, comprising means for producing a gaseous blast having a temperature exceeding the softening temperature of the material and having a velocity sufficient to attenuate softened material into fibers, means for feeding an elongated body of heat softenable material into the blast at a rate such that the advancing end of the material is softened and drawn out to form fibers elongated in the direction of the blast, a perforated cylindrical fiber collecting surface supported for rotation and having a suction chamber extending for a limited distance along the inner side of the surface, means supporting the blast producing means in a position to direct the blast toward the cylindrical collecting surface at an angle such that a substantial component of movement of the blast extends generally tangential to said surface, means for drawing air through the portion of the surface registering with the suction area with sufficient force to draw fibers from the blast against said surface, and means for removing the collected fibers from the collecting surface at the end of said suction area and forming the fibers into a strand.

2. Apparatus for producing a strand of fibers of heat softenable material, comprising means for producing a gaseous blast having a temperature exceeding the softening temperature of the material and having a velocity sufficient to attenuate softened material into fibers, means for feeding an elongated body of heat softenable material into the blast at a rate such that the advancing end of the material is softened and drawn out to form fibers elongated in the direction of the blast, a relatively movable surface dis-

posed adjacent the blast producing means providing a fiber collecting zone; means supporting the blast producing means in a position to direct the blast toward the surface such that a substantial component of movement of the blast extends generally in the direction of movement of the portion of the surface forming the fiber collecting zone; a suction chamber disposed adjacent the fiber collecting zone of the surface; means for drawing air through the fiber collecting zone into the suction chamber with sufficient force to draw the fibers from the blast against the surface at the fiber collecting zone, and means for removing the collected fibers from the surface and forming them into a strand after they are conveyed by said surface away from the influence of the suction area at the fiber collecting zone.

3. Apparatus for producing a strand of fibers of heat softenable material, comprising means for producing a gaseous blast having a temperature exceeding the softening temperature of the material and having a velocity sufficient to attenuate softened material into fibers, means for feeding an elongated body of heat softenable material into the blast at a rate such that the advancing end of the material is softened and drawn out to form fibers elongated in the direction of the blast, a relatively movable perforated fiber collecting surface providing a fiber collecting zone; a suction chamber extending coincident with and adjacent the fiber collecting zone of the surface, means supporting the blast producing means in a position to direct the blast in the general direction of movement of the surface at the fiber collecting zone thereof; means for drawing air through the collecting zone of the surface registering with the suction area with sufficient force to draw fibers from the blast against the surface at the collecting zone, and means for removing the collected fibers from the collecting surface at the end of said suction area and forming the fibers into a strand.

4. The method of forming a strand of fibers of heat softenable material which comprises establishing a gaseous blast passing through a zone and having a temperature in the zone exceeding the softening temperature of the material and having a velocity sufficient to attenuate material heated in the zone into fibers, introducing heat softenable material into the blast in said zone to soften the material and to draw out the softened material in the direction of flow of the blast to form substantially parallelly arranged fibers in the blast, advancing the fibers by the force of the blast toward a collecting zone of a moving surface, moving the collecting surface in a direction bringing the collecting zone thereof generally coincident with the direction of movement of the fibers, disposing the fiber collecting zone adjacent the fiber forming zone of the blast whereby the blast entrained fibers are deposited on the surface at the collecting zone in substantially parallelly arranged relation before the blast fans out sufficiently to disturb the parallel arrangement of the fibers, establishing a subatmospheric pressure adjacent the fiber collecting zone to draw the fibers out of the blast onto the surface, and continuously removing the collected fibers from the surface as the fibers are carried by the surface away from the collecting zone.

5. The method of forming a strand of fibers of heat softenable material which includes establishing a gaseous blast providing a fiber attenuating zone and having a temperature exceeding the softening temperature of the material and having a velocity sufficient to attenuate softened material into fibers; introducing heat softenable material into the blast whereby the heat of the blast softens the material and the velocity of the blast draws out the softened material in the direction of flow of the blast into substantially parallelly arranged fibers in the fiber attenuating zone; establishing a suction zone effective at the end of the fiber attenuating zone of the blast for withdrawing the parallelly arranged fibers from the gaseous blast at the end of the fiber attenuating zone; depositing the fibers by the reduced pressure of the suction zone upon a surface moving in the general direction of movement of the fibers entrained in the blast to maintain the parallel arrangement of the fibers during the deposition thereof, and removing the collected fibers from the surface after the fibers are conveyed by the surface away from the influence of the suction zone.

IVAN G. BRENNER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,133,238	Slayter et al.	Oct. 11, 1938
2,313,630	Dockerty	Mar. 9, 1943
2,405,036	Hoffman	July 30, 1946
2,450,363	Slayter et al.	Sept. 28, 1948
2,489,242	Slayter et al.	Nov. 22, 1949