

April 24, 1956

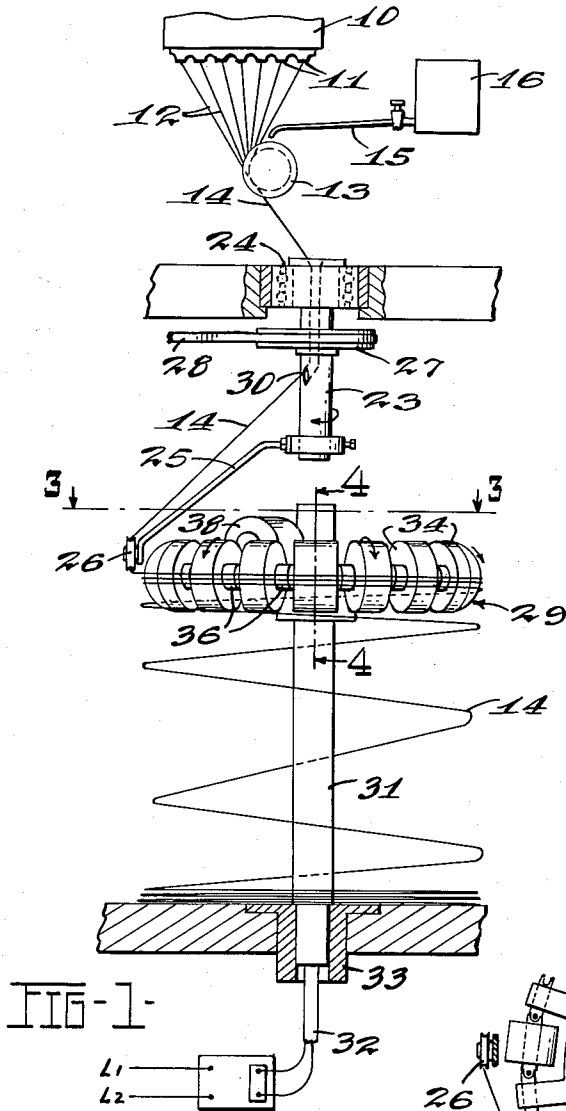
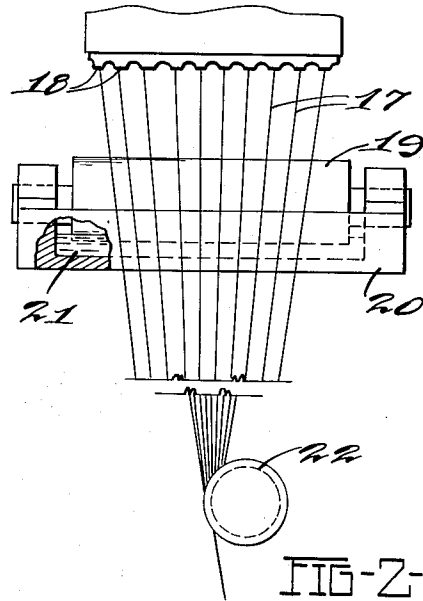
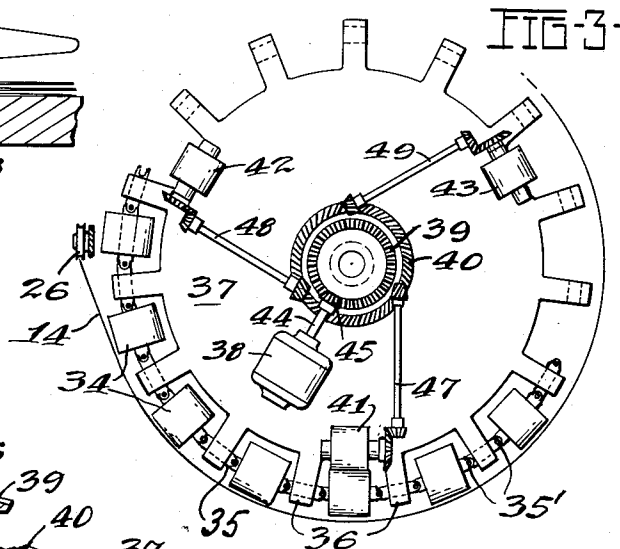
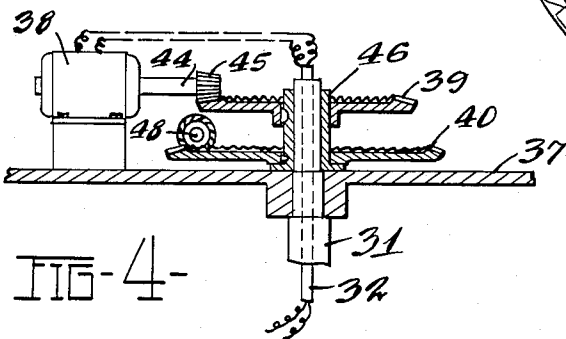
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2,742,737

METHOD AND APPARATUS FOR COLLECTING STRANDS

Filed Aug. 14, 1950

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

FIG-5-

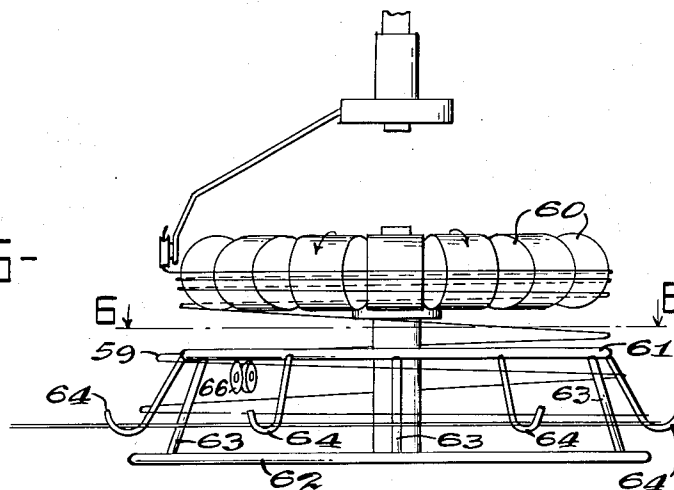
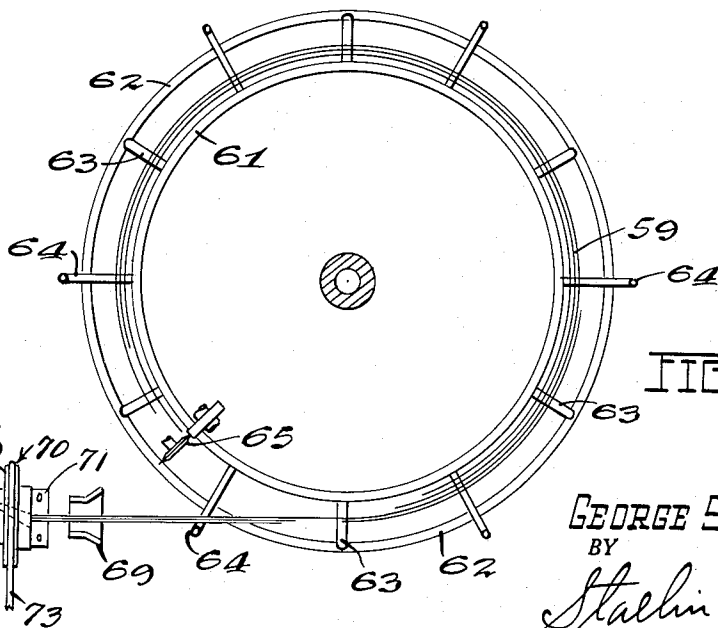


FIG-6-

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1

2,742,737

METHOD AND APPARATUS FOR COLLECTING STRANDS

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12 Claims. (Cl. 49—17)

This invention relates to a method and apparatus for the manufacturing, collecting, and processing of filaments, fibers, strands, yarns, and the like.

Hereafter and in the claims, the term "strand" is used to refer generically to these and similar products. Also, these products may comprise both continuous and staple strands provided the strand has sufficient mass integrity to be handled as a continuous strand. While the invention is described in connection with its most advantageous use, namely, the collection of a glass strand, particularly when the collection is concomitant with strand production, it is understood that the invention may be applied to the collection of still other types of strands.

In methods heretofore employed, glass fibers are attenuated, formed into strands, collected upon a drum, and subsequently unwound therefrom and further processed for particular uses. Several difficulties in methods of this nature have been encountered. In winding a strand of fibers upon a drum, the strand is in a state of considerable tension. Consequently, as the strand is collected and built up on the drum, the strand fibers, especially those in the undermost layers, are under such high pressure that they tend to cohere. This method of collection and accumulation of a strand also aggravates a tendency of the fibers to abrade and even sever one another by reason of the tension during winding.

In some methods, instead of being unwound from the drum, the collected fibers or strands are cut from the drum to form hanks of fibers that are subsequently cut to shorter lengths and rearranged into a mat. This process is disclosed in Patent No. 2,477,555 to Roberts and Metzler. Furthermore, the fibers of the strand influenced by the tension of winding cohere with a tenacity such that when the strand is subsequently severed to comparatively short lengths, the fibers are not readily separated but tend to remain in groups or clusters. Mechanical means, as, for example, a picker operation, is then employed to separate the strands and fibers of the groups or clusters.

However, this operation further increases the abrading of the individual fibers with a consequent weakening of them. The picking operation must also be very carefully done in order to separate effectively all of the strands so that only the desired bundles of strands or fibers remain in the resultant mass.

When the cut fiber mats are utilized as a reinforcing medium in plastics and the like, it is desired to have most and sometimes all of the fibers present in the form of bundles or strands. However, it is difficult to separate strands from each other in the hanks without also separating the strands into individual fibers. Also, these prior methods do not lend themselves to the most efficient and effective impregnation of the fibers by a resin, a step which is essential in producing the highest quality reinforcing plastics.

A leading object of the invention is to provide means

2

for the conversion of a strand into a readily handleable, easily transportable form.

Another object of the invention is to provide means for forming and collecting a strand into a comparatively loose package wherein tension in the strand is substantially reduced and the tendency of the individual fibers of the strand or adjacent strands to cohere is greatly minimized.

A further object is to provide convenient and efficient means for the conversion of a strand into a plurality of cut strands.

A still further object is to provide convenient and efficient means for the production of tow, twine, cordage, and the like from a single strand.

Still further objects include providing such means that is relatively simple in construction, that requires a minimum of supervision, and that is continuous in operation.

Additional objects and advantages are apparent from the following description which merely discloses and illustrates the invention and is not intended to limit the claims.

The invention depends for realization of the objects primarily on a cylindrical ring or torus member rotatable about an axis within the member. By torus is meant a doughnut-shaped member or, more particularly, that solid of revolution enclosed by a surface described by a conic section rotating about a straight line in its own plane. The preferred conic section is a circle.

Some of the forms this member may take and its part in the operation of the present invention are illustrated on the drawings, wherein:

Figure 1 is a semi-diagrammatic elevational view of one form of the invention;

Figure 2 illustrates a modification of part of the form of Figure 1;

Figure 3 is a section of Figure 1 taken on the line 3—3 and shows one construction of the torus member;

Figure 4 is a section of Figure 1 taken on the line 4—4 and illustrates the driving means for the torus of Figure 3;

Figure 5 is an elevational view of one form of the present invention when adapted to the production of cut strands; and

Figure 6 is a section of Figure 5 taken on the line 6—6 and shows how the cut strands may be converted to tow, twine, cordage, and the like.

The method and apparatus of the present invention may be used to advantage in manufacturing, collecting, and processing various types of strands both organic and inorganic, such as those made from polyamides (nylon), or cellulose and cellulose derivatives (rayon), or asbestos, or glass. However, the invention is uniquely adaptable to the manufacturing, collecting, and processing of glass strands since the operation of the invention simultaneously provides the attenuating force needed to draw out a plurality of fluid streams of molten glass into fine continuous fibers, as well as to collect and process them as hereafter described. In short, in the case of glass strands, the present invention by itself both forms and collects the strands in substantially one step of its operation.

Nevertheless, the invention need not always be so restricted when used with glass strands. For example, these and other strands may be fed to apparatus of the invention from previously collected rolls or packages, as when it is desired to make cut strands or tow, twine or cordage, as hereafter disclosed.

Referring to Figure 1, 10 represents a feeder containing molten glass. The glass issues through tiny orifices or feeder tips 11 as fluid streams which are simultaneously attenuated into fine continuous fibers 12 and drawn

3

over a gathering roll 13 by a pulling force below to be described. As the fibers pass over the roll they are grouped in strand form 14. Strand integrity is aided by a lubricant or binder applied to the strand from the roll 13 which is continually wetted by a steady drip of this fluid from a pipe 15 supplied from a reservoir 16. If a lubricant is desired, ordinary vegetable oil will suffice. If a binder is chosen, it may be thermosetting or thermoplastic. For example, an aqueous emulsion of phenol formaldehyde in the "B" stage of polymerization may be applied; or a melt of wax, polystyrene, methyl methacrylate, and the like, may be so added.

Another method of binder application particularly desirable when the binder is of the thermoplastic class, is illustrated in Figure 2. In this case, as the fibers 17 are attenuated from the feeder tips 18, they are pulled over a roll applicator 19 which is positioned at one end of a container 20 and journaled for rotation in its sides. The container is supplied with a thermoplastic melt 21 to a depth sufficient to wet the roll 19. Or the thermoplastic material may be melted directly in the container 20 as, for example, by electrical heating elements disposed in or about the container.

The frictional contact of the moving fibers 17 with the roll 19 may cause the latter to revolve which is thereby continuously wetted by the melt 21. Or if desired, the roll 19 may be driven as by conventional gearing. The melt which adheres to the roll is in turn wiped onto each individual fiber as it contacts the roll. The advantage of this method of application is that each individual fiber receives a continuous protective sleeving of thermoplastic material. Mutual cutting and abrading of the fibers is therefore practically nil, and consequently a strand of such fibers is able to realize much more nearly the inherently high strength in a glass fiber having an unblemished surface. After passing the roll 19, the fibers may be grouped into strand form by the gathering roll 22 as before.

The particular choice of a lubricant, binder, or method of application is largely dictated by the application intended for the collected strands. For instance, if it is desired merely to collect the strand in a convenient form, probably only a lubricant will be added to prevent the fibers in the strand from excessively cutting and abrading one another. However, if it is desired to make strand integrity more permanent, it is recommended to apply a binder which, in the case of a thermosetting binder, may subsequently be finally cured by heat. Or, if high tensile strength is desired as in tow, twine, and cordage, a thermoplastic binder in molten form as applied from the roll applicator 19 is preferred.

Referring again to Figure 1, a hollow shaft 23 is journaled at one end in a bearing 24 suitably supported below the roll 13. An arm or flyer 25 is mounted on the other end of the shaft and is provided with a fixed pulley-like tip 26 which is preferably of graphite to minimize friction. A suitable sheave 27 and drive belt 28 conventionally furnish the rotary power for the shaft 23.

In operation, the shaft is rotated at a rapid rate. The circumferential speed of the tip 26 winds the strand about the torus member 29. Due to the coaction of the rotation of the arm and the deposition of the strand on the torus approximately at its equator, the glass streams are drawn out to fine fibers. This pulling force also advances the strand 14 that is formed from the fibers into the hollow shaft 23 from above and then out a side opening 30 to the arm tip 26.

It is desirable that the strand 14 contact the torus member at or somewhat about a point corresponding to the largest diameter of the entire torus member in order to maintain a steady pulling force and uniform attenuation of the glass streams.

The coaction of the strand deposition at this point and rotation of the torus serves frictionally to anchor the strand to the torus and thereby resist the backward pull caused by the movement of the arm 25. Particular-

4

ly when the strand is deposited just above the largest diameter of the entire torus member, a slight tension is imparted to the strand when the rotation of the torus about an internal axis carries the strand to the greater circumferential distance represented by the largest torus diameter. This tension further aids the adherence of the strand to the torus. Continued rotation of the torus subsequently releases the strand.

In effect then, at a given instance the strand is temporarily fixed at two points, namely, at the torus and at the feeder tips. While this fixation is not rigid, it is sufficient to resist the pivoting of the arm 25 disposed between said points and contacting the strand to the extent that the strand is subjected to a steady attenuating pull.

In any event, the optimum point for strand deposition for a given apparatus is easily determined by a trial run. To this end, the arm 25 is preferably vertically adjustable on the shaft 23.

The torus member is supported over a hollow post 31 through which suitable electrical leads 32 are passed to furnish power to operate the member as presently described. The torus 29 rotates about an axis within the member which is preferably the circumference of a circle drawn through the geometrical center of the cylindrical ring. The direction of rotation is downward on the outside at all points and its rate of movement is considerably less than that of the flyer or arm 25. Consequently, a number of loops are caught by the torus 29 before the first is released. After leaving the torus, the loops superpose themselves about the base of the post 31 free of any tension. When a sufficient amount has gathered, the skein may be cut at one point and removed. Or if it is desired to preserve the continuous nature of the strand, a single strand is severed below the torus while the post 31 and its attendant apparatus are being lifted from a supporting socket 33 to allow withdrawal of the uncut skein. To this end, the wires 32 are detachably joined to a power box, as shown, to which current is supplied by the main power lines L₁ and L₂. Or the torus and attendant apparatus may be supported on a carriage mounted on tracks. When a sufficient amount of skein has been collected, a single strand may be severed as before and the carriage pulled along the tracks and simultaneously replaced with a similar unit to continue the collection.

In Figures 3 and 4, the construction of the torus member of Figure 1 is shown in greater detail. The torus here comprises a plurality of rubber faced rollers 34 which are joined one to another as, for example, through couplings 35. The couplings are linked by universal joints 35' journaled for rotation in the fingers 36 of a supporting platform or plate 37 which in turn is secured to and supported by the post 31 of Figure 1. The platform supports a motor 38, spur gears 39 and 40, and drive rolls 41, 42 and 43 which are journaled in suitable bearings and having their axes provided with pinions. The gearing may be bevel, hypoid, or the like.

Referring particularly to Figure 4, in operation the motor 38 drives a shaft 44 having a pinion 45 engaging a spur gear 39. This gear and a similar spur gear 40 have a common sleeve 46 rotatable about the post 31 on a bearing fixed to the platform 37 so that the rotary motion of one gear is thus imparted to the other. The gear 49 in turn rotates the engaging pinions joined to the drive shafts 47, 48 and 49. These shafts in a similar manner have pinions at their other ends mating with the pinions of the drive rolls 41, 42 and 43 of Figure 3. As the drive rolls are thus made to rotate, they transmit the motion to those of the rubber face rollers 34 which they frictionally contact. Those that are not so contacted are made to rotate similarly by means of the universal couplings 35.

While three drive rolls and auxiliary drive shafts are here shown, it is understood more or even less may be used, relying on the universal couplings to transmit the motion about the torus. In practice, the number of such

5

drive rolls is usually determined by the energy needed to overcome the friction and inertia of the particular apparatus employed.

Several modifications are possible in the construction just described. For example, the motor 38 and its spur gear 39 may be eliminated from the platform by placing the sleeve 46 within the hollow post 31. The sleeve may extend above the post in order to engage a spur gear and below the entire apparatus to mate with conventional driving means.

If it is desired to make cut strands or tow, twine or cordage by the present invention, a form as shown in Figures 5 and 6 may be used. In this case, as the strands 59 fall from the torus member 60, here shown to be of the type illustrated by Figure 3, they drop into a trough. The trough may comprise upper and lower rings 61 and 62, respectively, which are held spaced apart by ribs 63. Alternatively disposed between adjacent ribs are hooks 64 which catch the falling strands. The strands are cut as they pass on their way to the trough, for example, by conventional cooperating cutting rolls 65 and 66.

The strands may be cut optionally at one (as here shown) or a plurality of points depending on the final use intended for the strands. Cut strands of only a few inches in length are frequently used to reinforce plastics. When the strand is being cut to this length, the short lengths may simply be caught in a receptacle. If the strand is cut to a greater length, the cut portions may be scooped from the trough when a sufficient amount has accumulated.

If it is desired to make tow, twine or cordage, or when the strand is cut only a few times, the superposed cut strands may be removed from the trough in the manner illustrated by Figure 6. As the strands fall into the trough, they form at this stage of the operation a tow or roving in which the ends of the successively cut strands are spaced apart a distance regulated by the rate of withdrawal of the tow. The withdrawal is accomplished by pulling rolls 67 and 68 located in alignment with and a slight distance from the trough. The tow may be fed into a gathering funnel or guide 69 to condense the tow and then continued through a twister mechanism 70 to form twine or cordage. The twister 70 may be of any conventional construction, one suitable twister being described in detail in Patent No. 2,363,470 to Lannan and Vanucci. In brief, such a device includes a stationary supporting frame 71 and a rotor mounted therein. The rotor, which may be revolved by any suitable means, such as by a sheave 72 and drive belt 73, is provided with an eccentrically disposed opening in one face communicating with an axial opening in the opposite face.

As the rotor turns, it revolves the tow and strands about their longitudinal axes. This rotation extends to the pulling rolls 67 and 68 on one side and into or along the circular portion of the trough on the opposite side of the twister. The twisting of the strands and of the comparatively loose tow in the trough tends progressively to twist or fold in the newly deposited strands in the trough and combines them into an integral body. The twisted twine or cordage is moved forwardly by the pulling rolls 67 and 68, and the twisted product is then wound into a package by conventional winding machinery where additional twist may be imparted if desired.

Additional modifications and other arrangements may be made than are here described, the present disclosure being merely illustrative and comprehending all variations thereof.

I claim:

1. A method of making cut strands comprising depositing a strand about a torus member, revolving the member about an internal axis whereby the strand is released from the member in substantially loop form, and cutting each loop individually at least at one point.

2. The method of making tow, twine or cordage comprising winding a strand about a torus member, rotating the member about an internal axis, severing the loops of

6

strand as they fall from the member into a trough, and simultaneously interfelting and pulling the strands from the trough.

3. The method of manufacturing, collecting, and processing tow, twine or cordage comprising the steps of attenuating a plurality of streams of molten glass, grouping the fibers in strand form, contacting the strand by means comprising an arm pivotable about one end and having means at the other end to effect the contact, winding the strand by the arm about a torus member rotating concentrically about and in the same plane as the torus, successively severing the strand lops thus formed upon release from the torus at a given point with respect to the geometric disposition of the torus, catching the cut strands in a receptacle, collecting each successive strand length in linearly staggered relation with respect to those already collected, and continuously twining and pulling the body formed by the collected strand lengths from a given point of emittance of the receptacle.

4. Apparatus for collecting a strand comprising a platform disposed within a torus member and joined to the member at a plurality of points, a series of rollers constituting the torus and articulated between said points to be rotatably free of the platform, a drive roll to contact at least one roller, and means to rotate the drive roll.

5. Apparatus for collecting a strand comprising a platform disposed within a torus member and connected to the member at a plurality of points thus dividing the member into circumferential sections, a series of radially positioned rollers completing each section and having their axes joined through universal couplings, a drive roll supported by the platform and making frictional contact with at least one roller, and means stationed on the platform to rotate the drive roll.

6. Apparatus for collecting a strand comprising a hollow shaft having a side opening and an arm fixed at one end to the shaft and provided with strand contacting means at the other, means to rotate the shaft, a platform stationed below the shaft which is disposed within a torus member and joined thereto at a plurality of points, a series of rollers constituting the torus and articulated between said points to be rotatably free of the platform, a drive roll to contact at least one roller, and means to rotate the drive roll.

7. Apparatus for making cut strands comprising a platform disposed within a torus member and joined to the member at a plurality of points, a plurality of rollers constituting the torus and articulated between said points to be rotatably free of the platform, a drive roll to contact at least one roller, means to rotate the drive roll, and strand severing means positioned below the torus member.

8. Apparatus for making cut strands comprising a platform disposed within a torus member and connected to the member at a plurality of points thus dividing the member into circumferential sections, a series of radially positioned rollers completing each section and having their axes joined through universal couplings, a plurality of drive rolls supported by the platform and making frictional contact with at least one roller of each circumferential section, means to rotate the drive rolls, strand severing means positioned below the torus member, and a receptacle constructed of upper and lower rings held spaced-apart by ribs and strand-retaining hooks alternatively dispersed between the ribs.

9. Apparatus for collecting and processing a strand comprising in combination a hollow shaft having a side opening and an arm fixed at one end to the shaft and provided with strand contacting means at the other, means to rotate the shaft, a platform stationed below the shaft which is disposed within a torus member and joined thereto at a plurality of points, a series of rollers constituting the torus and articulated between said points to be rotatably free of the platform, a drive roll to contact at least one roller, means to rotate the drive roll, and strand severing means positioned below the torus member.

7

10. Apparatus for collecting and processing a strand comprising in combination a hollow shaft having a side opening and an arm fixed at one end to the shaft and provided with strand contacting means at the other, means to rotate the shaft, a platform stationed below the shaft which is disposed within a torus member and joined thereto at a plurality of points, a series of rollers constituting the torus and articulated between said points to be rotatably free of the platform, a drive roll to contact at least one roller, means to rotate the drive roll, strand severing means positioned below the torus member, a cut strand receptacle, and means simultaneously to interfelt and remove the strands.

11. Apparatus for manufacturing, collecting and processing a glass strand comprising in combination a feeder of a glass stream, a hollow shaft having a side opening and an arm fixed at one end to the shaft and provided with strand contacting means at the other, means to rotate the shaft, a platform stationed below the shaft which is disposed within a torus member and joined thereto at a plurality of points, a series of rollers constituting the torus and articulated between said points to be rotatably free of the platform, a drive roll to contact at least one roller, and means to rotate the drive roll.

12. Apparatus for manufacturing, collecting and processing a glass strand comprising in combination a feeder of glass streams, means to group fibers attenuated there-

8

from in strand form, a hollow shaft having a side opening and an arm fixed at one end to the shaft and provided with strand contacting means at the other, means to rotate the shaft, a platform stationed below the shaft which is disposed within a torus member and joined thereto at a plurality of points, a series of rollers constituting the torus and articulated between said points to be rotatably free of the platform, a drive roll to contact at least one roller, means to rotate the drive roll, and strand severing means positioned below the torus member.

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