May 28, 1957 W. P. DOOLEY 2,793,396

TUBE-TROUGH SPINNING APPARATUS

Filed March 10, 1954 2 Sheets-Sheet 1

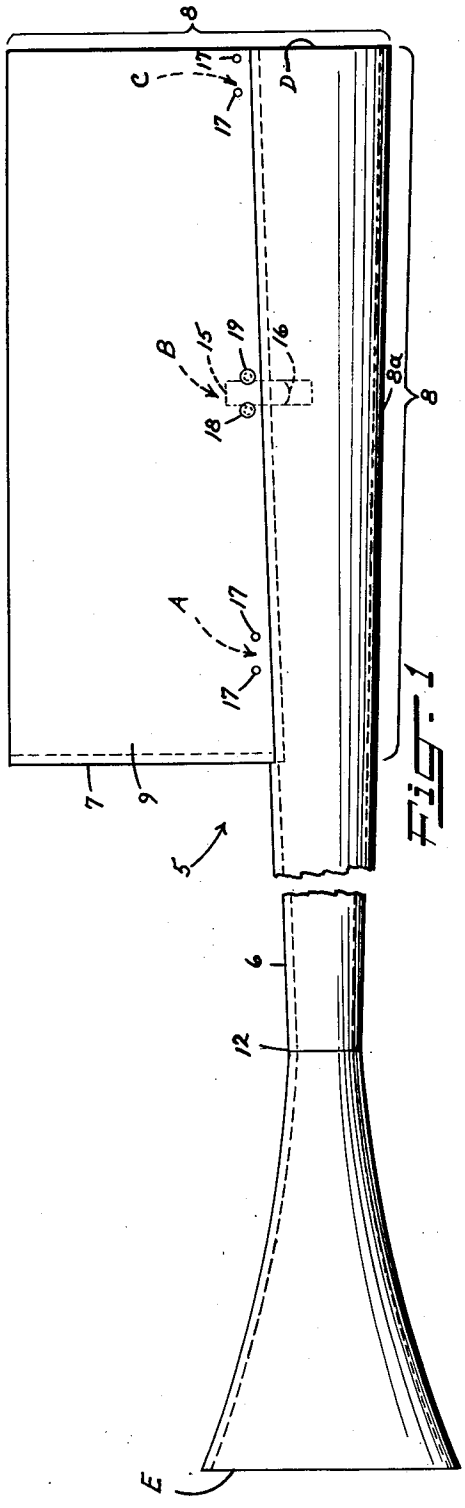


Fig. 1

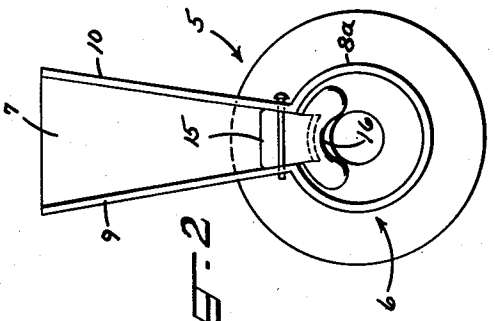


Fig. 2

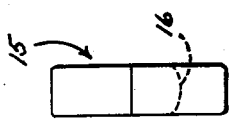


Fig. 5

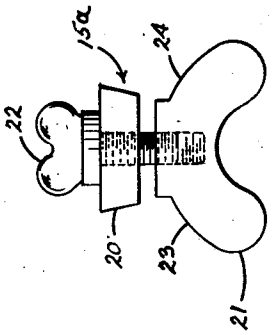


Fig. 6

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TUBE-TROUGH SPINNING APPARATUS

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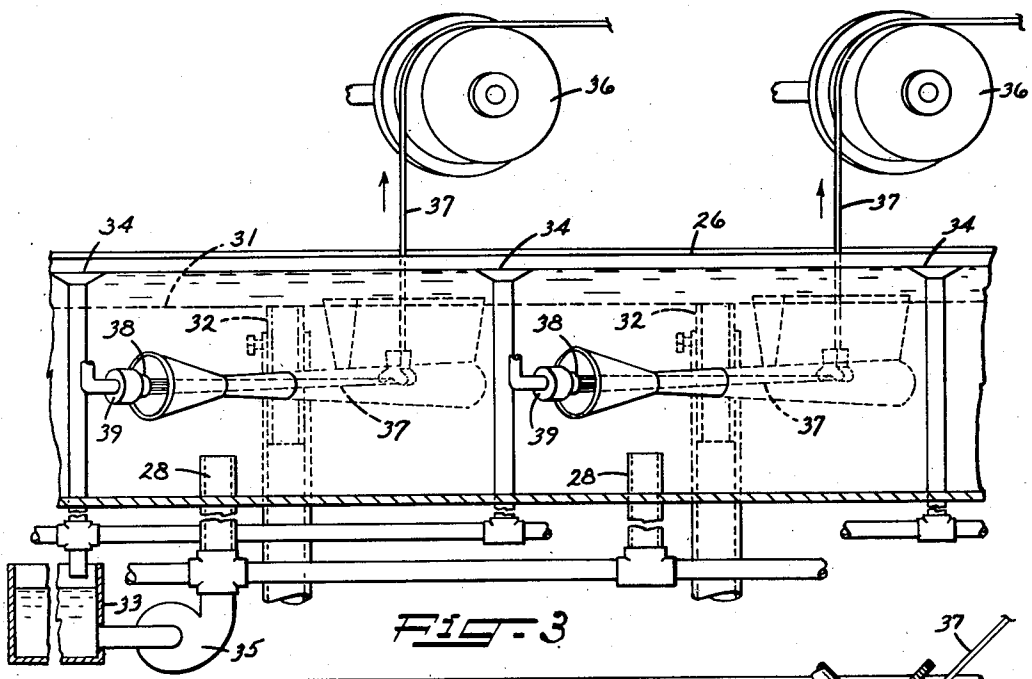


Fig. 3

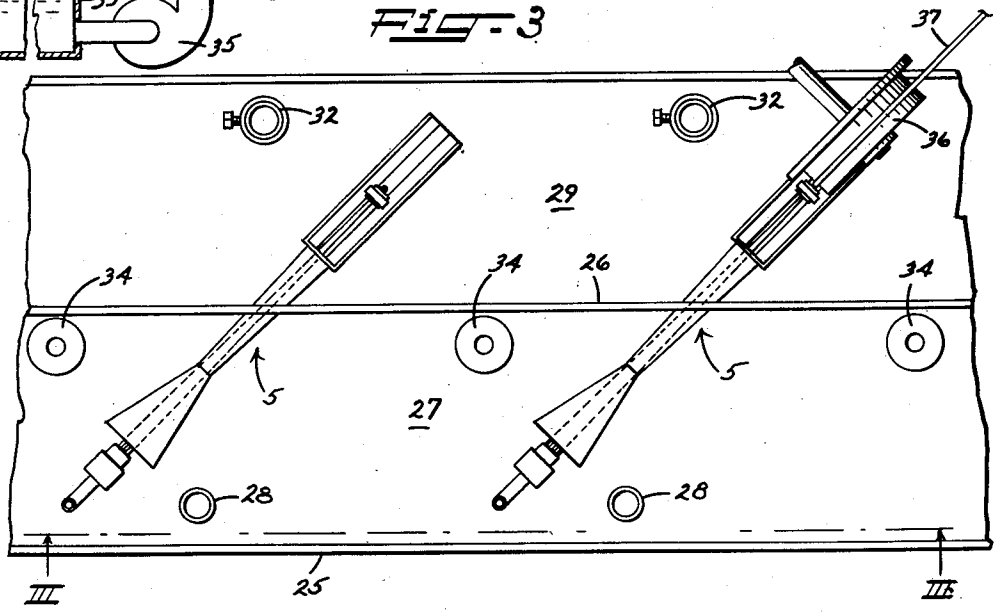


Fig. 4

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2,793,396

TUBE-TROUGH SPINNING APPARATUS

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Application March 10, 1954, Serial No. 415,233

11 Claims. (Cl. 18—8)

The present invention relates to improvements and equipment for spinning artificial yarn such as that used in wet spinning of viscose yarn, and particularly to the spinning of large continuous bundles each of which may comprise thousands of filaments.

One of the most troublesome difficulties that arises in the spinning of the extremely heavy denier strands, such as the tows of viscose filaments that are spun in the manufacturing of staple rayon fiber, is the tendency of adjacent filaments to be brought together within the coagulant while still in a tacky condition just after extrusion. The joining of filaments in this undesirable fashion is referred to in the trade as "splinters" or "splintering." The resulting adhesion of the filaments is thought to arise at least substantially from turbulence of the coagulant through which the freshly extruded material passes while tacky, and partly from the retention of bubbles of gaseous reaction products in the coagulant within range of contact with the tacky filamentary material while carried in the liquid. The conditions of turbulence, when there is poor bubble elimination, are apparently intensified with increased denier of the yarn. In producing tows comprising, e. g., 12,000 filaments from a single spinneret, broken filaments and/or splinters which apparently result from the above mentioned conditions, readily become a recognizable hazard to the maintaining of good processing conditions and the quality of the ultimate staple fiber products.

Another consideration contributing to evolution of the present invention is the desire to spin the larger type strands described above at higher linear rates. One arrangement which has worked well for increasing the spinning rates of the smaller strands comprises a spinning tube disposed relative to the face of the spinneret to receive the extruded product thereof and the liquid coagulant from the region surrounding the spinneret; the coagulant is supplied at sufficient pressure to produce a desired ratio of the liquid speed with respect to the yarn speed through the tube. However, when a strand typified by a tow of several thousand filaments is spun through a tube, the production of splinters and broken filaments is not materially lessened.

Moreover, the spinning tube is not easily adaptable for fulfilling requirements of commercial staple fiber products from filamentary tows because of the need for using the same equipment for the production of different types of staple fibers. That is to say, the trade demands staple fiber products which vary as to their condition of crimp, denier, etc. For each denier of each type of staple, it has been found that a certain length or time of immersion in the coagulant is necessary in order to produce fibers having the desired characteristics. These characteristics may be the presence of crimp, high tensile strength, high or low elongation, the shape of the fiber cross section, the presence or absence of skin, and others. In order that a given piece of commercial equipment may be used at different times to produce different deniers and types of fibers, it is necessary that the length or time of

immersion be easily varied. The structure of the spinning tube does not permit this.

Thus, an important object of the invention is to provide a method and an apparatus for spinning filamentary strands, and particularly the heavier types of strands, such as tow, substantially free of adhered and broken filaments.

Another object is to provide apparatus for eliminating turbulence of the coagulant along the portion of that path traversed by a freshly spun filamentary strand while still in a tacky condition.

Still another object is to promote the separation of gaseous materials carried on, or in the liquid immediately adjacent thereto, a freshly spun strand, or between the filaments thereof, and to direct such gaseous material away from the path followed by the strand while accomplishing the foregoing objects.

It is another object to provide apparatus for accomplishing the foregoing objects by which the length of immersion of the strand in the coagulant may be varied in accordance to that required to obtain a desired filamentary product.

It is also an object to provide apparatus in which filamentary strands of heavier denier and high quality may be spun from a single spinneret at a higher linear rate than is customary in conventional spinning equipment.

Other objects, features, and advantages will become apparent from the following description of the invention and the drawings relating thereto in which:

Fig. 1 is a shortened side elevation of a preferred embodiment of the invention;

Fig. 2 is an end view of the tube-trough shown in Fig. 1;

Fig. 3 is a fragmentary elevation of spinning equipment incorporating the apparatus of Figs. 1 and 2 as sectioned along line III—III of Fig. 4;

Fig. 4 is a fragmentary plan view of the equipment shown in Fig. 3;

Fig. 5 is a side elevation of a strand guide included as a portion of the apparatus of Figs. 1 and 2; and

Fig. 6 is an elevation of a modified guide for use in the apparatus of the invention.

Broadly speaking, this invention consists of apparatus adapted to control the passage of liquid and a running strand suspended in the liquid in accordance with a desired manner of treatment. The essential portion or device of the apparatus to which the invention relates is hereinafter called a "tube-trough" since the device may be divided into two portions which are most aptly described by respective portions of the term. In a preferred embodiment, the tube-trough comprises a venturi-shaped tube portion joining without interruption in contour with a trough portion. The trough portion has spaced sidewalls which extend upwardly from a linear projection of the venturi-tube portion which constitutes a lower section of the trough portion. In operative position, the flared end of the tube-trough provided by the tube portion is disposed in spaced coaxial relation with the face of a spinneret within a bath of liquid coagulant supplied at sufficient pressure or height to substantially fill the tube-trough.

Proceeding now to consideration of the invention in detail, Figs. 1 and 2 illustrate a tube-trough 5 which comprises a tube portion 6 extending from the extreme left end of the device as shown in Fig. 1 to approximately a plane extending transversely with respect to the length of the device and defining the outer surface of the end wall 7 of the trough. The tube-trough is further constituted of a trough portion 8 which extends from such transverse plane just referred to, to the extreme right end of the device. The division of the device in this manner is merely arbitrary and provides for convenience in de-

scribing the tube-trough. Actually the lower section of the trough portion, i. e., the arcuate section which joins with the lower extremities of the straight lateral walls **9** and **10** of the trough portion is a symmetrical continuation of the venturi shape of the tube portion **6**, and in another manner of describing the apparatus, this arcuate section might be properly considered a portion of the tube since at this lower section, the trough portion connects with the tube portion without substantial change in cross section or contour, and continues the flare of the tube portion extending from its cross section of shortest diameter at **12**.

An essential purpose of the interior surface of the tube portion **6** is to promote streamline or viscous flow and to avoid turbulent flow. Such interior surface is preferably, as shown, a surface of revolution of which the generatrix is a curved line which is convex on the side thereof facing toward the axis of the surface generation.

The straight sidewalls **9** and **10** extend away from the circular section **8***a* in diverging directions to provide a space through which the strand may be drawn from the tube-trough in a direction that is transverse with respect to its length. However, the liquid which accompanies the strand through the tube portion **6** passes on through the trough portion and is discharged at its end in a direction that is a continuation of the length of the tube-trough. The space enclosed by the trough section is especially adapted for gently decelerating the velocity of the liquid proceeding through the tube portion of the device so as to minimize the disruption of the filaments of the strand as it changes its direction of passage along the axis of the tube portion to a direction laterally therefrom approximately midway between the sidewalls of the trough portion.

The inner contour of the trough portion **8** is admirably suited to support one or more guides **15** around which a strand may pass in advancing toward an exteriorly positioned guide or strand-forwarding device. The guide **15** has a generally trapezoidal portion which closely fits, but preferably not tightly, between the straight sidewalls **9** and **10** of the trough, and laterally extending portions which fit the inner surfaces of the lower arcuate section **8***a* of the trough. The guide has a U-shaped surface **16** defined by its laterally extending portions over which a strand proceeding through the tube portion **6** passes. The surface **16** is convexly rounded in cross section taken parallel to the length of the device **5** as shown in Fig. 5 to minimize abrasion of the strand. The guide **15** may be positioned at any point within the trough section along the region of juncture of the straight sidewalls **9** and **10** with the arcuate section **8***a*, e. g., at stations A, B, or C. The guide **15** is shown positioned in station B. Each station is provided with pairs of holes **17** in the walls **9** and **10** through which guide-positioning pins **18** and **19** may be inserted. To eliminate the holes **17** and the pins **19**, the guide may be constructed as illustrated in Fig. 6 wherein the guide **15***a* comprises a trapezoidal portion **20** and a generally arcuate portion **21** connected together by a wing-headed stud **22**. The side surfaces of the trapezoidal portion **20** wedge tightly against the inner surfaces of the sidewalls **9** and **10**. Surfaces **23** and **24** of the arcuate portion **21** tightly engage the inner surface of the arcuate trough section **8***a* upon tightening of the stud **22**.

When used with a spinneret which has a three inch face section with 12,000 holes therethrough, a tube-trough having satisfactory proportions for receiving the 12,000 filament tow extruded from the spinneret had an overall length of 28 inches, an inside diameter at the entrance end of the tube portion at E of 4 inches, and an inside diameter of 2¼ inches at the discharge end of the arcuate section **8** of the trough portion at D. The inside diameter of the narrowest portion was 1⅛ inches at a point **12** along the length of the tube portion 6½ inches from the entrance end. The endwall of the trough portion nearest the entrance end was roughly 18 inches therefrom. The height of the trough walls above the axis of the tube-trough was approximately 5 inches. This axis is defined as the center line with respect to which the surfaces of the tube portion and the arcuate section **8** of the trough portion are concentric.

Satisfactory spinning of a 12,000 filament tow in accordance with the principles hereinbefore discussed was obtained by passing the tow through a tube-trough having the above dimensions. The speed of the tow as withdrawn from the spinneret and while passing through the tube-trough was approximately 45 meters per minute. The tow may thereafter pass into a stretching system wherein its linear speed may be increased to, e. g., 85 meters per minute. The liquid was passed through the tube-trough at speeds measured within the necked portion at **12** of 1.5 to 2.0 times the velocity of the strand, i. e., in the range of about 65 to 90 meters per minute. The velocity of the liquid measured at any point in either lengthwise direction from the necked portion is, on account of the changing cross section of the tube-trough, less than that at **12**. The velocity of liquid at the discharge end of the tube-trough was found to be slightly less than one half of the tow speed. This manner of operation is merely illustrative of one set of conditions in accordance with which the apparatus may be operated. The apparatus is capable of substantially higher rates of tow and liquid transfer therethrough.

Figs. 3 and 4 are elevation and plan views respectively, of an installation of the tube-trough hereinbefore described within a spinning apparatus. Such apparatus comprises an elongate tank **25** capable of supporting a large plurality of tube-troughs **5** in fixed position. As shown, the tube-troughs extend obliquely as viewed from overhead with respect to the longitudinal direction of the tank **25**. This tank is divided by a partition **26** which separates the fresh coagulant from the used coagulant held by the tank; the fresh coagulant being supplied to the compartment **27** by one or more inlet ducts **28**. The coagulant is preferably supplied in such a manner as to maintain a fixed head or pressure thereof with respect to the device **5** through which the bulk of the coagulant will pass into the drainage compartment **29**. The level of the liquid in the drainage compartment is established at height **31** by the height to which the drain pipe **32** is adjusted. However, to maintain a fixed difference in height or pressure of the liquid between the two compartments, it is necessary to supply an excess of liquid in compartment **27** over the amount of liquid which will flow through the device **5** during normal spinning operations. Accordingly, the compartment **27** may be provided with overflow ducts **34** which allow excess liquid to flow out of the compartment back into the coagulant supply system which comprises, for example, a supply tank **33**, the supply ducts **28**, and a circulating pump **35** connecting the tank **33** with the ducts **28**.

As shown in Fig. 3, a godet **36** or other guide means is disposed within a vertical plane passing preferably equidistantly between the sidewalls of the trough portion to receive a strand **37** from the guide **15** within the trough portion. A spinneret **38** is supported adjacent the entrance end of the tube portion of each device **5** with its face in coaxial relation with the longitudinal axis of the tube. The spinneret is positioned with ample clearance between it and the support **39** therefor, and the inner periphery of the end surface of the device **5** for the passage of liquid thereinto.

The partition **26** will normally comprise lead or other corrosion resistant material to which the device **5** may be attached for its sole support. When the partition comprises lead, the tube trough is preferably fabricated from lead so that it may be projected through the partition and attached by conventional lead-burning technique. As

shown, the body of each device extends through the partition with the material thereof joined and sealed to, and around, the outer surface of the device. As the devices 5 are, to a large extent, balanced at the point of support by the partition, they are deemed to be amply supported. However, additional support such as standards mounted under the end portions of the device 5 may be provided if desired.

The tube-trough 5 is preferably positioned within apparatus, such as the spinning tank 25, so that the longitudinal axis of the tube portion is horizontal or inclines upwardly from the entrance end at E toward the discharge end at D. Such alignment assures that bubbles of gas separating from the incipient strand passing through the tube portion 6 will ascend within the liquid toward the uppermost portion of the inner periphery of the tube portion. The bubbles are carried along such upper peripheral surface until they pass by the juncture of the end walls 7 with arcuate wall of the device; the bubbles then ascend upwardly to the surface of the liquid within the compartment 29 along a path or region closer to the end wall than the path taken by the yarn 37 in passing upwardly from the guide 15.

Spinning equipment of the character as described, is found to be highly advantageous in the spinning of heavy denier bundles of filaments from the standpoint of eliminating broken filaments and adhered filaments. The spinning units described are believed to promote the separation of gaseous by-products formed in the coagulation of viscose material occurring as a single bundle of many thousands of filaments. Furthermore, the device is readily adjustable to provide different lengths of immersion of the filamentary material in the coagulant for the rapid changing or adaption of the equipment in the manufacturing of filamentary products of different characteristics.

While preferred embodiments of the invention have been shown and described, it is to be understood that changes and variations may be made without departing from the spirit and scope of the invention as defined in the appended claims.

I claim:

1. In combination with a means for supplying a running filamentary strand; a device comprising a tube portion and a trough portion connected in end-to-end relationship for transferral of a liquid lengthwise through the device, said portions having arcuate bottom sections joined together without substantial change in cross section, the trough portion having sidewalls extending upwardly in diverging directions away from the lengthwise direction of the tube portion, means for supporting the device, guide means extending transversely of the trough portion with a strand-engaging surface thereof disposed transversely to the longitudinal direction of the device and facing away from the region enclosed by the diverging sidewalls, said surface and means for supplying the strand being disposed to define a path for the strand therebetween extending longitudinally through the tube portion and into the trough portion; means for supplying a liquid coagulant to the region surrounding the end of the tube portion most remote from the trough portion at sufficient pressure to flood the interior of the device and to introduce a current of the liquid therethrough which is discharged through the trough portion; and means disposed outside the device for advancing the strand along said path and a continuation of such path extending from the guide means outwardly in a direction that is lateral with respect to said path.

2. The combination as defined in claim 1 comprising container means surrounding the trough portion, and overflow means for the container means disposed at a predetermined height above said path.

3. In combination, a spinneret, means for supporting the spinneret, a device comprising a tube portion and a trough portion connected in end-to-end relationship for transferral of a liquid lengthwise through the device, said portions having arcuate bottom sections joined together without substantial change in cross section, the trough portion having sidewalls extending in diverging directions away from the lengthwise direction of the tube, means for supporting the device with the end thereof provided by the tube portion in generally coaxial spaced relation with the face of the spinneret, guide means extending transversely of the trough portion with the surface thereof for engaging the strand disposed in intersecting relation with a straight line extending lengthwise through the interior of the tube portion, means for supplying a liquid coagulant to the region surrounding the spinneret and said end of the device at sufficient pressure to flood the interior of the device and be discharged through the trough portion, and means disposed outside of the device for advancing a strand along a path extending from the spinneret and around said guide surface and thence out of the device between the sidewalls of the trough portion.

4. In combination, a spinneret, means for supporting the spinneret, a device comprising a venturi tube portion and a trough portion connected in end-to-end relationship for transferral of a liquid lengthwise through the device, said portions having arcuate bottom sections joined together without substantial change in cross section, the trough having sidewalls extending in diverging directions away from the lengthwise direction of the tube, means for supporting the device with the end thereof provided by the tube portion in generally coaxial spaced relation to the face of the spinneret, such end being defined by an annular flared end section of the tube portion having an inside diameter substantially larger than the spinneret face and portions of the supporting means immediately adjacent thereto, a guide means extending transversely of the trough portion with the side thereof for engaging the strand disposed in approximately intersecting relation with the axis of the tube portion, means for supplying a liquid coagulant to the region surrounding the spinneret and said end of the device at sufficient pressure to flood the interior of the device and be discharged through the trough portion, and means disposed outside of the device for advancing a strand along a path extending from the spinneret to and around said guide surface and thence out of the device between the sidewalls of the trough portion.

5. In combination, a spinneret, means for supporting the spinneret, a device comprising a tube portion and a trough portion connected in end-to-end relationship for transferral of a liquid lengthwise through the device, the trough portion having a bottom section comprising a coaxial projection of the tube portion except for an elongate slot extending lengthwise therein, and sidewalls extending in diverging directions away from the opposing longitudinal portions of the periphery of the slot, the trough portion having at least one endwall for joining the ends of the sidewalls nearer the tube portion, means for supporting the device with the end thereof provided by the tube portion in generally coaxial spaced relation at the face of the spinneret, guide means extending transversely of the trough portion with a surface thereof for engaging the strand disposed in approximately intersecting relation with the axis of the tube portion, means for supplying a liquid coagulant to the region surrounding the spinneret adjacent said end of the device at sufficient pressure to flood the interior of the device and be discharged through the trough portion, and means disposed outside of the device for advancing a strand along a path extending from the spinneret to and around said guide surface and thence out of the device between the sidewalls of the trough portion.

6. In combination, a spinneret, means for supporting the spinneret, a device comprising a tube portion and a trough portion connected in end-to-end relationship for transferral of the liquid lengthwise through the device, the trough portion having an arcuate bottom section ex-

tending as a projection of the tube portion except for an elongate slot extending lengthwise therein, and sidewalls extending from the longitudinal edges of the bottom section defining said slot in diverging directions away from the lengthwise direction of the tube portion, movable guide means having peripheral surfaces arranged to engage, and in guiding relation with, portions of the inner surfaces of the sidewalls adjacent said edges and arcuate portions of the inner surface of said bottom section adjacent said edges, said guide means having a concave guide surface facing and extending transversely with respect to the axis of the tube portion, means for securing said guide means within the trough section in any position within a range of positions occurring lengthwise of said slot, and means for securing the guide means at various points lengthwise along the slot.

7. The combination as defined in claim 6 wherein the wall of the trough portion has a plurality of apertures spaced lengthwise of the slot and adjacent thereto, and pins adapted to be inserted into said apertures to engage a surface of the guide means facing lengthwise of the device.

8. The combination as defined in claim 6 wherein the guide means comprises a lower arcuate portion having an inner concave guide surface for engaging a strand and outer arcuate spaced convex surface for engaging the inner surface of the bottom section of the trough portion at either side of the slot, the guide means having another portion of trapezoidal cross section for resting between and engaging the inner surface of both sidewalls adjacent the slot, and adjustable means for connecting both portions of the guide means, said upper portion of the guide means being of such length in the direction thereof extending from wall to wall as to wedge between the walls before engaging the lower portion.

9. In combination, a spinneret, means for supporting the spinneret, a device comprising a venturi tube portion and a trough portion connected in end-to-end relationship for the transferral of a liquid lengthwise through the device, said portions having arcuate bottom sections joined together without substantial change in cross section, means for supporting the device with the end thereof provided by the tube in generally coaxial horizontal relation with the face of the spinneret, thereby inclining the uppermost longitudinal portion of the inner periphery of the tube portion extending from the narrowest section thereof to the trough portion in an upward direction, the trough having sidewalls extending upwardly in diverging directions away from the lengthwise direction of the tube, guide means supported within the trough portion having a concave surface extending transversely of the trough portion and facing downwardly, said guide surface being positioned with respect to the spinneret to dispose a path for a strand from the spinneret to the guide surface at a progressively greater distance from said upper inner peripheral surface portion of the tube as the strand advances from the narrow section of the tube portion, means for supplying a liquid coagulant to the region surrounding the spinneret and said end of the device at sufficient pressure to flood substantially the interior of the device and be discharged through the trough portion, and means disposed outside of the device for advancing the strand along a path extending from a spinneret and around said guide surface and thence out of the device between the sidewalls.

10. In combination, a spinneret having a face arranged generally concentric with respect to an axis, means for supporting the spinneret with the axis of its face extending generally horizontally, a device comprising a venturi tube portion and a trough portion connected in end-to-end relationship for transferral of a liquid lengthwise through the device, said portions having arcuate bottom sections joined together without substantial change in cross section, the trough portion having sidewalls extending upwardly in diverging directions away from the lengthwise direction of the trough portion and to a level substantially above the tube portion, means for supporting the device with the end thereof provided by the tube portion in generally coaxial spaced relation with the face of the spinneret, guide means supported in the trough portion having a concave surface extending transversely with respect to the axis of the tube portion and facing downwardly, a compartment for supporting a bath of liquid around the spinneret and said end of the device, another compartment for supporting a bath of liquid around the trough portion of the device, means for separating said compartments except for communication between the compartments through said tube portion, overflow means in the second compartment extending at a level below the top of the sidewalls of the trough portion, means for supplying a liquid coagulant to the first compartment at sufficient pressure to flood the device in the second compartment to the level of said overflow means, and means disposed above the device for advancing the strand along a path extending from the spinneret to and around said guide surface and thence out of the device between the sidewalls of the trough portion.

11. A device for concurrently conducting a stream of liquid and a running strand supported therein comprising a tube portion and a trough portion connected in end-to-end relationship adapted for transferral of the liquid and strand lengthwise through the device, said portions having arcuate bottom sections joined together without substantial change in cross section, the trough portion having sidewalls extending in diverging directions away from the lengthwise direction of the tube portion, guide means extending transversely within the trough portion with respect to the lengthwise direction of the tube portion, and guide means supported within the trough portion and having a strand-engaging surface disposed transversely to the longitudinal direction of the device and facing away from the region enclosed by the diverging sidewalls, said surfaces being disposed to define a path extending from the open end of the tube portion to the surface and then outwardly of the device between said walls.

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