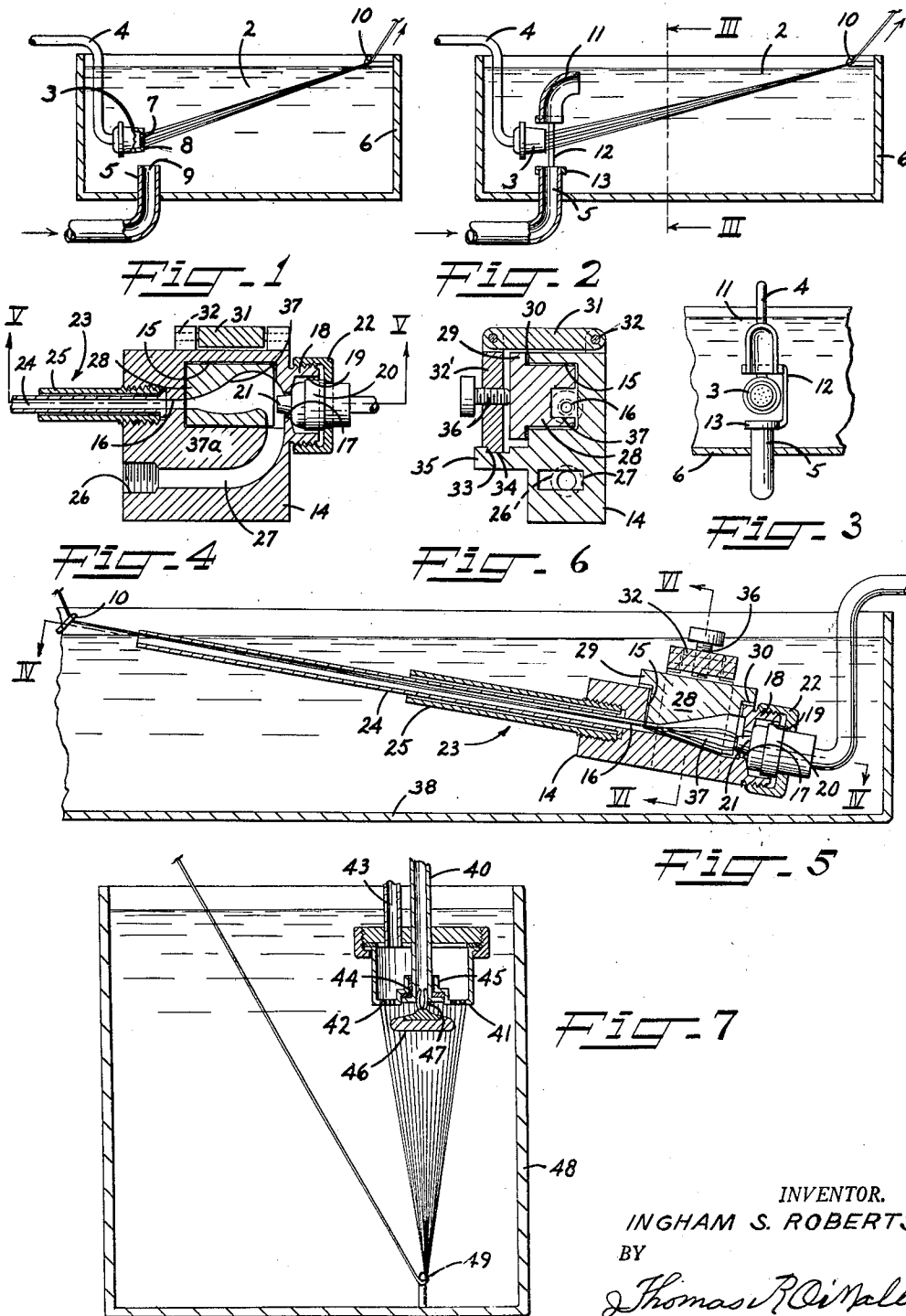


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METHOD AND APPARATUS FOR WET SPINNING
OF ARTIFICIAL FILAMENTS
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METHOD AND APPARATUS FOR WET SPINNING OF ARTIFICIAL FILAMENTS

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1 It has heretofore been suggested to improve spinning conditions immediately around the spinneret by directing the coagulating liquid to flow around the spinneret so that it flows generally in the same direction as the filaments as they leave the spinneret. It has been found, however, that when spinning under these conditions at high velocities, air or gas tends to settle out on, and remain in contact with, the face of the spinneret in the coagulating liquid. Such air or gas may be derived from that dissolved in the coagulating liquid or spinning material as it is supplied to the spinning station or it may result from the reaction occurring upon contact of the spinning material with the coagulating liquid, such as viscose with aqueous sulfuric acid. The accumulation of gas may be local or general over the spinneret face and results in irregular filament quality and/or filament breakage right at the spinneret.

Unexpectedly it has now been found that spinning can be greatly improved by directly a stream of the coagulating liquid under viscous flow conditions (i. e., non-turbulent conditions) across the face of the spinneret so that the liquid in immediate proximity to all orifice-containing areas in the spinneret face is forced to move at a substantial velocity transversely of the bores of the orifices, thereby sweeping past the filament-forming material even as it is first extruded from the orifices.

As illustrated in the accompanying drawing, various embodiments may be employed for effecting my invention.

Figure 1 is an elevation partly in section, of one embodiment for executing the invention.

Figure 2 is a similar elevation, partly in section, illustrating a modification.

Figure 3 is a section taken on line III—III of Figure 2.

Figure 4 is a horizontal section through a modification.

Figure 5 is a section on line V—V of Figure 4, illustrating the position occupied by the device of Figure 4 in the spinning bath.

Figure 6 is a section on line VI—VI of Figure 5, and

Figure 7 is a section through still another embodiment.

In Figure 1 there is shown a coagulating bath 2, a spinneret 3 within the coagulating bath, a supply pipe 4 for delivering spinning material to the spinneret, and means comprising a conduit 5 for delivering a coagulating liquid to the container 6. As shown, the spinneret 3 has a plu-

2 rality of orifices 7 in its face 8 and the conduit 5 has a discharge opening 9 so arranged that a stream of coagulating liquid is directed transversely of the face 8 of the spinneret. The streams of filament-forming material discharged through the orifices 7 pass transversely into the stream discharged from conduit 5 so that the coagulating liquid passes around all of such streams substantially immediately after they leave the orifices thereby assuring contact of the spinning material right after issuance from the spinneret with a coagulating liquid of substantially full concentration and full temperature. The coagulating liquid discharged from conduit 5 passes transversely of the spinneret face in direct contact therewith so that there is no opportunity for air or other gas to settle out and accumulate upon the face of the spinneret. This assures that there will be no disruption of the filament-forming streams at the spinneret face by virtue of the development of gas bubbles. Since the coagulating liquid passes across the entire spinneret face before it is allowed to mingle with the general body of liquid in the container 6, substantially the full concentration of the effective element or elements in such liquid acts upon the entire group of filaments regardless of the relative position of such filaments in the spinneret face. The coagulating liquid in the stream passing over the spinneret face not only remains at substantially its full effective concentration throughout its passage across the spinneret face, but it also accumulates a practically negligible amount of contaminating decomposition products as it passes along the face since in such passage it makes contact with but a restricted length of the filaments.

As the filaments leave the region in front of the spinneret face where they pass through the transverse stream of the coagulating medium, they enter into the general body of the coagulating bath where further setting up occurs. As they pass through the general body of the coagulating bath, the portion of the bath in immediate proximity to the filaments tends to move in the same direction as a result of the dragging action of the filaments thereon. The filaments may pass from the coagulating bath around guide 10 upward to a godet or other drawing wheel or device.

The embodiment of Figures 2 and 3 illustrates a modification in which the stream of coagulating liquid after passing over the face of the spinneret is deflected such as by an arcuate deflector 11, which may be supported by a bracket 12 se-

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cured to a ring 13 which fits about the upper end of the conduit 5. In this embodiment, the deflector 11 prevents the coagulating liquid stream from welling up at the surface of the coagulating bath above the spinneret. It also tends to cause the coagulating liquid to flow generally in the direction of travel of the filaments in the upper zone of the coagulating bath comprising the region through which the filaments pass on their way to the guide 10.

While Figures 1 to 3 show a horizontal spinning arrangement in which the spinneret face is disposed approximately in a vertical plane, the face may be disposed in a horizontal plane and then spinning either downwardly or upwardly within a coagulating bath, or the face may be disposed at any angle to a horizontal or vertical plane.

In Figures 4 to 6 there is disclosed an embodiment which, besides controlling the temperature and composition of the coagulating liquid supplied to the spinneret, also provides for an extremely efficient utilization of the coagulating medium for maintaining it as a relatively narrow confined stream flowing in the direction of the filaments so that the liquid after passing transversely of the spinneret does not have the opportunity (as in the embodiments of Figures 1 to 3) to intermingle with a relatively dilute and different-temperated liquid medium before contacting the filaments as they leave the region near the spinneret. This system is efficient not only in the amount of liquid required to contact each filamentary bundle but also in the capacity of equipment needed to recondition, purify, and/or refresh the coagulating medium for recirculation.

As shown, the spinneret is provided with an attachment containing suitable passages or channels to direct the coagulating liquid transversely across the face of the spinneret and then to deflect the coagulating liquid through a narrow channel in alignment with the spinneret so that it passes with the filament bundle through such channel at a controlled rate of speed relative to such filaments. The relative speed in the channel may either be greater, less or the same as that of the filaments, depending upon the qualities desired in the final product. For most purposes demanding both a high strength and a high extensibility, it is preferred to minimize the extent of bath drag upon the filaments which may be done by imparting to the coagulating liquid passing through the discharge channel a velocity substantially the same as that of the filaments or somewhat greater. By the present invention, it is possible to spin the filaments at extremely high speeds, such as 180 to 200 or more meters per minute while avoiding excessive bath drag.

The attachment comprises a block 14 containing a lateral recess 15. There are also provided two approximately aligned bores 16 and 17 which communicate with the recess 15. A threaded extension 18 projects concentrically with the bore 17 and is provided with a recess 19 adapted to receive a spinneret coupling 20 so that a spinneret 21 projects through the bore 17. A union 22 engages the thread on the extension 18 and retains the spinneret assembly in place.

The bore 16 has an enlarged portion toward the outside of the block which is adapted to receive a conduit system 23 for discharging filaments and coagulating liquid from the assembly. While this conduit system may comprise a single long tube fitted within the large portion of bore 16, a preferred form is shown in which a glass tube 24 is seated within the bore and held in place

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by a protecting sleeve 25 of hard resin such as Bakelite, hard rubber, vinyl resin, polystyrene, Lucite, or the like. The glass sleeve may be replaced by porcelain or other wear and corrosion-resistant material which does not exert abrasive action upon the filaments. As shown, the sleeve 25 may extend only part of the full length of the central tube 24, but if desired, it may extend the full length of the tube 24.

A bore 26 is provided to receive a coupling to any suitable conduit for supplying the coagulating liquid to the attachment. The bore 26 communicates with a passage 27 which communicates with the recess 15 adjacent the spinneret 21. Bore 27 is preferably curved gradually to minimize turbulence as the stream of liquid passes through it. Within recess 15 there is provided a plug 28 having an enlarged end 29 adapted to be seated against a gasket 30 placed around the open end of the recess 15. The plug 28 is secured in position by means of a screw clamp comprising a strap 31 hinged upon the block 14 at 32 and pivotally connected to a link 32' provided with an inclined faced groove 33 adapted to dovetail with a corresponding face of a groove 34 in a projecting lug 35 upon the block 14. A screw 36 threadedly engages a bore in the link 32' and bears against the plug 28.

The plug is provided with a groove 37 which is in alignment with the bores 16 and 17 in the block 14 and has a lateral extension 37a communicating with the passage 27 in block 14. As shown, the groove 37, when plug 28 is fitted within the recess 15, provides a small chamber with one end thereof in proximity to the spinneret face. The lateral wall of this chamber is curved to deflect as non-turbulently as possible the coagulating liquid which passes beyond the spinneret face from the passage 27. As shown particularly in both Figures 4 and 5, this chamber gradually diminishes in cross-section with its distance from the spinneret face so that it merges gradually with the bore 16. Preferably, the cross-section inside tube 24 is less than that of passage 27 and the intermediate chambers 37a and 37 so that a high longitudinal velocity may be achieved in tube 24 while extremely high velocities transverse of the spinneret face are avoided.

This jet assembly may be placed within a receptacle 38 (Figure 5) so that liquid discharged from the end of tube 24 is received in that receptacle for recirculation, a reclaiming or fortifying system being provided if desired. If desired, the block 14, plug 28, and tube assembly 23 may be made of transparent materials, such as glass, Lucite, methyl methacrylate resins, etc., to allow observation of the spinning performance.

As shown, it will be observed that the coagulating liquid proceeds through the passage 27 transversely across the face of the spinneret 21 and is then deflected so that it passes through the channel comprising the bore 16 and the tube 24 in substantial alignment with the spinneret. This confining of the coagulating liquid in a relatively narrow channel as it proceeds to and from the spinneret assures the most efficient use of the liquid, avoids accumulation of gas upon the spinneret face with resultant breakage of filaments, provides for contact of all of the filament-forming streams immediately after emergence from the spinneret orifices with coagulating liquid of full strength and at the proper temperature whether this be above or below normal room temperature. In addition, the coagulating liquid in contact with the filaments as they proceed from

the transverse zone in front of the spinneret face is of relatively high strength because it is prevented from mingling with comparatively spent coagulating liquid such as would be present if the conduit system 23 were eliminated.

Figure 7 illustrates a modification in which a conduit 40 for supplying coagulating liquid is disposed centrally of the face of a spinneret 41. The effective area of the face of the spinneret is annular and contains a plurality of rows of orifices 42. A conduit 43 supplies spinning material to the chamber within the spinneret in customary fashion, a gasket 44 being provided between conduit 40 and the inside flange 45 of the spinneret. A deflecting knob 46 is carried upon a bracket comprising several spring legs 47 adapted to be forced into the bore of conduit 40. In this arrangement, the coagulating liquid proceeds transversely of the spinneret face from its center as a radiating sheet and after leaving the zone adjacent the spinneret, the filaments proceed through the general bath in the receptacle 48 about a guide 49 and then upwardly out of the bath to a suitable withdrawing godet or the like.

It is to be understood that the specific embodiments shown are illustrative only and 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. The method of spinning artificial filaments comprising the steps of forcing a stream of coagulating liquid to flow at a substantial velocity under conditions of viscous flow transversely of the entire face of a spinneret and extruding the filament-forming material through orifices in the spinneret face directly into the stream substantially at right angles to the general direction of the stream, then deflecting the entire body of the liquid coagulating stream into a straight channel in approximate alignment with the spinneret orifices, and passing the filaments through the deflected stream at a controlled velocity relative to that of the stream.

2. The method of spinning artificial filaments comprising the steps of forcing a stream of coagulating liquid to flow at a substantial velocity under conditions of viscous flow transversely of the entire face of a spinneret and extruding the filament-forming material through orifices in the spinneret face directly into the stream substantially at right angles to the general direction of the stream, then deflecting the entire body of the liquid coagulating stream into a straight channel in approximate alignment with the spinneret orifices, and passing the filaments through the deflected stream at a controlled velocity relative to that of the stream, the velocity of the coagulating stream transverse of the spinneret face being less than its velocity through the channel.

3. The method of spinning artificial filaments comprising the step of forcing a stream of coagulating liquid to flow through a definite, confined, relatively narrow channel at a substantial velocity under conditions of viscous flow transversely of the entire face of a spinneret and extruding the filament-forming material through orifices in the spinneret face directly into the stream substantially at right angles to the general direction of the stream, then deflecting the entire body of the liquid coagulating stream through a definite, confined, relatively narrow, straight channel in approximate alignment with the spinneret orifices, and passing the filaments

through the deflected stream at a controlled velocity relative to that of the stream.

4. The method of spinning artificial filaments comprising the steps of forcing a stream of coagulating liquid to flow at a substantial velocity under conditions of viscous flow transversely of the entire face of a spinneret and extruding the filament-forming material through orifices in the spinneret face directly into the stream substantially at right angles to the general direction of the stream, then deflecting the entire body of the liquid coagulating stream through a straight channel in approximate alignment with the spinneret orifices, and passing the filaments through the deflected stream at a controlled velocity relative to that of the stream, said velocity being greater than that of the stream.

5. The method of spinning artificial filaments comprising the steps of forcing a stream of coagulating liquid to flow at a substantial velocity under conditions of viscous flow transversely of the entire face of a spinneret and extruding the filament-forming material through orifices in the spinneret face directly into the stream substantially at right angles to the general direction of the stream, then deflecting the entire body of the liquid coagulating stream into a straight channel in approximate alignment with the spinneret orifices, and passing the filaments through the deflected stream at a controlled velocity relative to that of the stream, said velocity being the same as that of the stream.

6. The method of spinning artificial filaments comprising the steps of forcing a stream of coagulating liquid to flow at a substantial velocity under conditions of viscous flow transversely of the entire face of a spinneret and extruding the filament-forming material through orifices in the spinneret face directly into the stream substantially at right angles to the general direction of the stream, then deflecting the entire body of the liquid coagulating stream into a straight channel in approximate alignment with the spinneret orifices, and passing the filaments through the deflected stream at a controlled velocity relative to that of the stream, said velocity being less than that of the stream.

7. Apparatus for spinning artificial filaments comprising a container for a coagulating liquid, a spinneret in the container, a plurality of orifices in the face of the spinneret, means for introducing coagulating liquid into the container, said means comprising a conduit having its discharge outlet disposed adjacent to one side only of the spinneret and to direct a stream of the liquid transversely of the entire face of the spinneret, deflecting means disposed laterally of the spinneret opposite the position of introduction of the liquid to the zone in front of the spinneret, and a straight conduit having its channel in approximate alignment with the spinneret face.

8. Apparatus for spinning artificial filaments comprising a container for a coagulating liquid, a spinneret in the container, a plurality of orifices in the face of the spinneret, and means for introducing coagulating liquid into the container, said means comprising a conduit having its discharge outlet disposed adjacent to one side only of the spinneret and to direct a stream of the liquid transversely of the entire face of the spinneret, and a discharge conduit in alignment with the spinneret having an entrance opening to receive the stream of coagulating liquid containing the filaments, the walls of the container extending from the outlet of the first-mentioned con-

duit to the entrance opening of the discharge conduit and being streamlined therebetween for continuously directing the entire body of the liquid stream entering the container through the discharge conduit.

9. Apparatus for spinning artificial filaments comprising a container for a coagulating liquid, a spinneret in the container, a plurality of orifices in the face of the spinneret, and means for introducing coagulating liquid into the container, said means comprising a conduit having its discharge outlet disposed adjacent to one side only of the spinneret and to direct a stream of the liquid transversely of the entire face of the spinneret, a discharge conduit in alignment with the spinneret, and a confining chamber communicating with said conduits having its cross-section gradually merging into that of the discharge conduit.

10. Apparatus for spinning artificial filaments comprising a container for a coagulating liquid, a spinneret in the container, a plurality of orifices in the face of the spinneret, and means for introducing coagulating liquid into the container, said means comprising a conduit having its discharge outlet disposed adjacent to one side only of the spinneret and to direct a stream of the liquid transversely of the entire face of the spinneret, a discharge conduit in alignment with the spinneret, said discharge conduit having smaller cross-section than the first-mentioned conduit, and a confining chamber having one end about the spinneret face communicating with the first-mentioned conduit and the other end opposite the spinneret face communicating with the discharge conduit.

11. Apparatus for spinning artificial filaments comprising a container for a coagulating liquid, a spinneret in the container, a plurality of orifices in the face of the spinneret, and means for introducing coagulating liquid into the container, said means comprising a conduit having its discharge outlet disposed adjacent to one side only of the spinneret and to direct a stream of the liquid transversely of the entire face of the spinneret, a discharge conduit in alignment with the spinneret, said discharge conduit having smaller cross-section than the first-mentioned conduit, and a confining chamber having one end about the spinneret face communicating with the first-mentioned conduit and the other end opposite the spinneret face communicating with the discharge conduit, said confining chamber having its wall gradually sloped to merge with the conduits.

12. Apparatus for spinning artificial filaments comprising a container for a coagulating liquid, a spinneret in the container, a plurality of orifices in the face of the spinneret, and means for introducing coagulating liquid into the container, said means comprising a conduit having its discharge outlet disposed adjacent to one side only of the spinneret and to direct a stream of the liquid transversely of the entire face of the spin-

neret, a discharge conduit in alignment with the spinneret, said discharge conduit having smaller cross-section than the first-mentioned conduit, and a confining chamber having one end about the spinneret face communicating with the first-mentioned conduit and the other end opposite the spinneret face communicating with the discharge conduit, said confining chamber having its wall gradually sloped to merge with the conduits, the cross-section of the chamber gradually reducing in size from a maximum near the spinneret to a minimum at its end opposite the spinneret.

13. A coagulating device for spinning artificial filaments comprising a block having a recess in one side thereof, a plug fitting in the recess, said plug being cut away from its innermost wall to provide a chamber extending completely through the recess between opposite end walls thereof when the plug is inserted, bores through the opposite end walls of the block communicating with the chamber, means for holding a spinneret in one of said bores, a discharge tube secured in the other bore, and a conduit through the block opening into the recess adjacent the spinneret for directing a liquid laterally into the end of the chamber adjacent the spinneret and transversely of the spinneret face.

14. A coagulating device for spinning artificial filaments comprising a block having a recess in one side thereof, a plug fitting in the recess, said plug being cut away from its innermost wall to provide a chamber extending completely through the recess between opposite end walls thereof when the plug is inserted, generally aligned bores through the opposite end walls of the block communicating with the chamber, means for holding a spinneret in one of said bores, a discharge tube secured in the other bore, and a conduit through the block opening into the recess adjacent the spinneret for directing a liquid laterally into the end of the chamber adjacent the spinneret and transversely of the spinneret face, the block and plug being made of transparent materials.

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