Dec. 19, 1967 H. S. WOODBERY 3,358,322

PROCESS AND APPARATUS FOR SPINNING BI-COMPONENT MICRO-DENIER FIBERS

Filed June 10, 1965 2 Sheets-Sheet 1

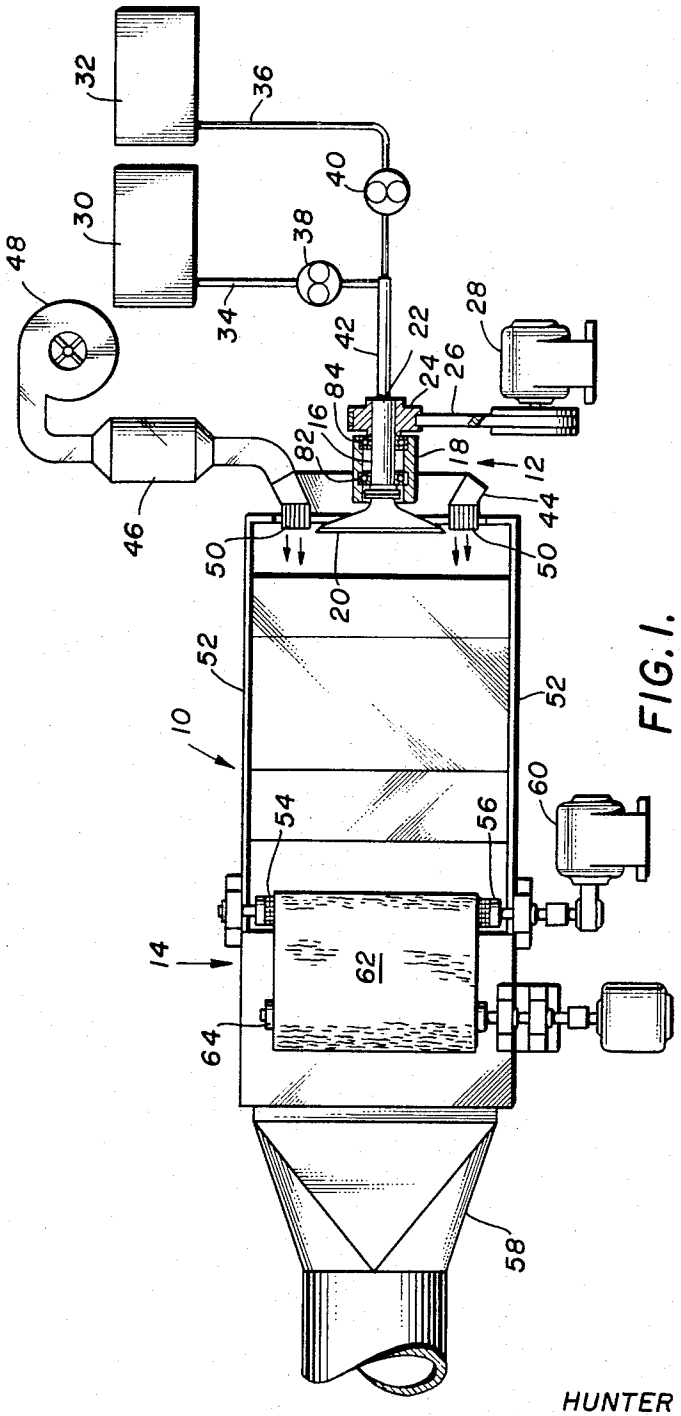


FIG. 1.

INVENTOR.
HUNTER S. WOODBERY

BY George P Chandler
ATTORNEY

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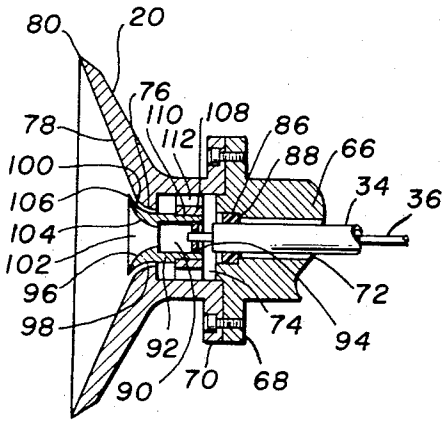


FIG. 2.

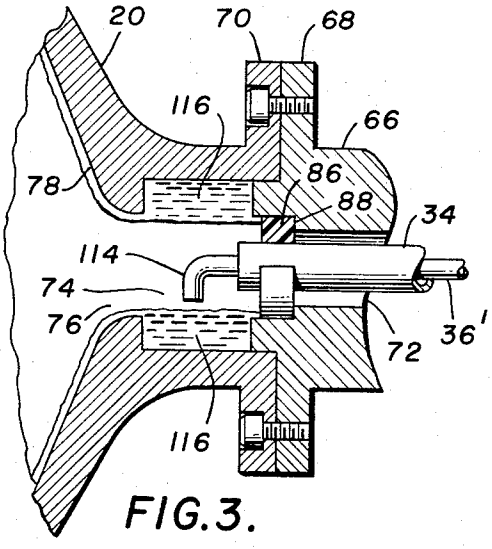


FIG. 3.

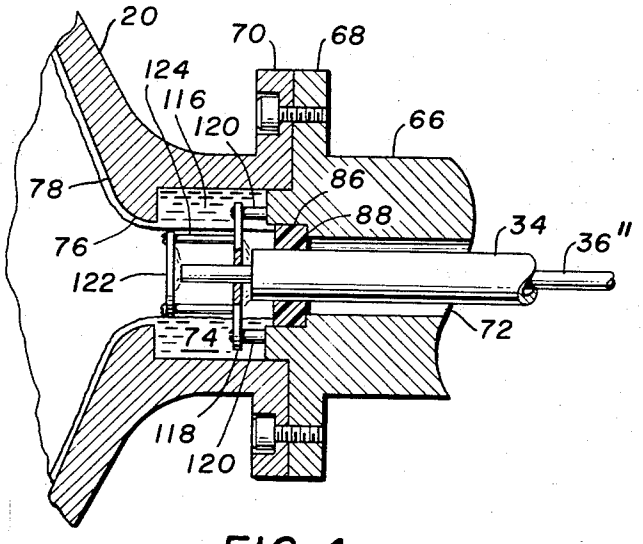


FIG. 4.

INVENTOR.
HUNTER S. WOODBERY

BY George P Chandler
ATTORNEY

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3,358,322

PROCESS AND APPARATUS FOR SPINNING BI-COMPONENT MICRO-DENIER FIBERS

Hunter S. Woodbery, Decatur, Ala., assignor to Monsanto Company, St. Louis, Mo., a corporation of Delaware

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8 Claims. (Cl. 18—2.5)

This invention relates to a method and apparatus for producing conjugate micro-denier synthetic fibers and more particularly relates to the use of a rotating cone spinnerette for producing conjungate micro-denier synthetic fibers.

Natural staple fibers such as wool have an inherent curl or crimp which impart to them certain desirable characteristics. For example such a crimp provides resistance to longitudinal movement relative to adjacent fibers and hence is productive of a yarn having good tensile strength. Due to the nature of the method of spinning, man-made fibers do not have a natural crimp and such must therefore be artificially introduced.

Several methods are utilized for introducing a crimp to man-made fibers. One method is to pass a heated tow of filaments between a pair of meshed gears to permanently bend or crimp them. Another method is the use of a "conjugated filament." In the latter, a plurality of filaments spun from solutions that will produce fibers having different shrinkage characteristics are spun together to form a single bi-component filament. When heated, as in an annealing step, such a bi-component filament will curl or kink into a crimped fiber.

The "conjugate filament" method of introducing a crimp to man-made fibers of the more usual deniers has been utilized in various forms for some time. It has, however, not been heretofore possible to produce conjugate filaments where micro-fibers are produced by a process generally referred to as centrifugal spinning. In this process, a fiber-forming material is introduced onto the surface of a rotating cone-shaped spinning element. The rotating material is moved to the edge of the cone by centrifugal force and slung in thin streams or droplets into a path of high-velocity air directed toward a collecting screen where it is deposited as a fibrous batt. During travel from the cone to the collecting screen, the fiber forming material is changed into a plurality of fibers having diameters from 0.5 to 25 microns or, as they are commonly known, micro-fibers or micro-denier fibers.

In one embodiment of the instant invention, two spinning solutions are combined on the surface of the rotating cone by means of concentric supply passages and travel together as bi-component filaments to the collecting screen along the route previously described. Other embodiments of the invention utilize a chamber at the outlet end of the solution supply system within which one of the solutions is superimposed on the other to provide a bi-component solution on the surface of the rotating cone which, as explained above, will be collected on a screen as a conjugate filament.

Accordingly, it is an object of the invention to provide a method and apparatus for producing conjugate micro-fibers.

Another object of the invention is to provide a method and apparatus for producing conjugate micro-fibers utilizing rotating cone spinning.

A further object of the invention is to provide a method and apparatus for producing conjugate micro-fibers utilizing the rotating cone spinning method in which the components travel across the face of the cone together.

These and other objects and advantages of this invention will be more apparent upon reference to the following specification, appended claims and drawings wherein:

FIGURE 1 is a partly sectional side view of micro-denier fiber rotating cone spinning apparatus according to the instant invention;

FIGURE 2 is a cross-sectional detailed view of the rotating cone spinning member according to one embodiment of the instant invention;

FIGURE 3 is a view similar to FIGURE 2 but showing another embodiment of the cone spinning member; and

FIGURE 4 is a view similar to FIGURES 2 and 3 showing still another embodiment of the cone spinning member.

In order to better understand the construction and use of this novel device, it will be described in relation to the production of conjugate fibers. It is to be understood, however, that various other uses may be found for this novel filament spinning apparatus. For example, one component could consist of the more usual material while the second component could be any of a number of substances such as water, air, pigment, a slurry of magnetic particles and solvent, and others obvious to those skilled in the art.

With continued reference to the accompanying figures wherein like numerals designate similar parts throughout the various views, and with initial attention directed to FIGURE 1, reference numeral **10** designates generally apparatus for producing conjugate micro-fibers according to the invention. Reference numeral **12** designated generally spinning apparatus for converting a plurality of spinning solutions into fibers while reference numeral **14** denotes a mechanism for collection of the fibers.

The spinning apparatus **12** includes a distributing element **16** rotatably mounted in a supporting collar **18**. One end of the distributing element **16** is flared outward to form a cone-shaped portion **20** while the other end **22** is secured to a pulley **24** which is driven through a belt **26** by an electric motor **28**. Obviously, the rotary output of the motor **28** is translated into a like movement of the distributing element **16** around an axis of rotation passing through the element and determined by the position of the supporting collar **18**.

Two separate sources of spinning solutions mixed with a suitable solvent are illustrated diagrammatically at **30** and **32**. These solutions are caused to flow through tubes **34** and **36** or other suitable supply means by pumps **38** and **40** into the end **22** of the distributing element **16**. As the tubes **34** and **36** enter the distributing element **16**, they are formed concentrically as shown at **42** to maintain solution separation well into the interior of the element **16** for a purpose to hereinafter be more fully explained.

A manifold **44** surrounds the distributing element **16** proximate the outermost edge of the cone-shaped portion **20**. Air or any other suitable gas or fluid is supplied at an elevated temperature to the manifold **44** through a heat exchanger **46** by a centrifical blower **48**. A plurality of baffles **60** serve to distribute the air evenly around the edge of the element **16** and direct it toward the collecting mechanism **14** through an enclosure formed by walls **52**.

An endless, moving screen **54** extending across the enclosure between a pair of rollers **56** (only one of which is shown) intercepts the fibers as they pass through the enclosure toward an exhaust vent **58**. As the fibers collect on the screen, a relatively thick batt is found at a point opposite the spinning apparatus **12**. Inasmuch as the screen is continuously moving under the influence of the motor **60** driving the roller **56**, the batt is formed into an elongated fabric-like web **62** which is separated from the screen **54** and wound on a take-up roll **64** driven by motor **66**.

Details of the distributing element **16** are shown in

FIGURES 2, 3, and 4 illustrating three embodiments of the invention. In all emodiments element **16** includes a body portion **66** secured through a flange **68** to a flange **70** on the cone-shaped portion **20**. An opening **72** extends through the center of the body portion **66** and communicates with an enlarged annular chamber **74** formed in the cone-shaped portion **20**. An outwardly flared aperture **75** provides a passageway from the chamber **74** to a face **78** generated on the cone-shaped portion **20** as the outer surface of a right circular cone with its apex cut away by the aperture **76** and the periphery of the base at its outer edge **80**.

The axis of symmetry of the face **78**, the cone-shaped portion **20** and the body portion **66** all coincide with the longitudinal center lines of the chamber **74** and the opening **72** which, if extended, would also coincide. As stated before, the distributing element **16** is rotatably mounted. The mounting, including bearing members **82** and **84**, is arranged so that the axis of rotation of the element **16** also coincides with the lines and axes described above.

Tube **34** extends through and is centrally located in the opening **72** in all of the embodiments illustrated in FIGURES 2–4. The tube **34** extends into the chamber **74** which is isolated from the opening **72** by a ring-shaped seal **86** closely fitted into a recess **88** in the body portion **66**. Obviously, as the distributing element rotates, the tube **34** remains stationary with its outer surface sliding relative to the seal **86**. If desired the tube **34** can be eliminated and the opening **72** used to supply one of the spinning solutions.

In the embodiment illustrated in FIGURE 2, tube **36** extends concentrically through tube **34** and terminates within a cavity **90** formed in a dispensing member **92** mounted in the chamber **74**. A ring-shaped seal **94** tightly fitted to a wall of the cavity **90** prohibits the intermixing of the solution present in the cavity **90** with the solution found in the chamber **74**, but will rotatably slide across the outer surface of the tube **36** so that the tube **36** remains stationary as the element **16** rotates.

A portion **96** of the dispenser **92** extends through the aperture **76** and is curved along its outer face **98** so as to be spaced everywhere equidistant from the surface of the aperture **76** and face **78** to form an outlet **100** from the chamber **74** to the face **78**. A passageway **102** having a surface **104** curved so as to intercept the outer surface **98** at a point **106** extends outwardly from the cavity **90**.

The dispenser **92** is held in position by a disc-shaped mounting member **108** press fitted, welded, brazed or otherwise suitably secured both to the outer wall of chamber **74** and in a recess **110** on the exterior surface of the dispenser. A plurality of passageways **112** are provided in the mounting member **108** in order that the flow of spinning solution through the chamber **74** will not be materially impeded.

In the embodiment illustrated in FIGURE 3, the tube **36'** passes concentrically through tube **34** similarly to tube **36** in FIGURE 2 but is curved at its outer end **114** to direct one of the spinning solutions outwardly at a 90° angle from the axis of rotation of the distributing member **16** toward the outer wall of the chamber **74**.

A similar result is obtained in the embodiment illustrated in FIGURE 4 by the use of a pair of baffles. A first baffle **118** is secured to the body portion **66** by suitable fastening elements **120** such as, for example, a threaded bolt, across the open mouth of the tube **34**. A second baffle **122** is disposed across the mouth of the tube **36''** and secured to the first baffle **118** by suitable fastening elements **124**.

As best shown in FIGURE 4, the tube **34** extends only a short distance into the chamber **74** before terminating in a mouth closely spaced to the first baffle **118**. The tube **36''** extends into and through the baffle **118** almost to the outermost extent of chamber **74** before terminating and, again, a small clearance is provided between its

mouth and the baffle **122**. Obviously, baffles **118** and **122** may have any suitable configuration but are preferably circular, solid discs symmetrical about the axis of rotation of the distributing element **16**. As illustrated, the diameter of the baffle **118** is slightly greater than the diameter of the aperture **76** while the diameter of the baffle **122** is slightly less so that a spinning solution pumped through tube **34** will form a reservoir in the chamber **74** overlaid by solution forced through tube **36''**. Other baffle to baffle and baffle to aperture size relationships may be utilized as long as a smooth flow of material and a uniform overlay is maintained.

In forming a conjugate micro-fiber utilizing the apparatus shown in FIGURE 2, the distributing element **16** is rotated at a high speed and a first spinning solution is caused to flow through the tube **34** into the chamber **74**, through passageway **112** and the outlet **100** onto the face **78** where it spreads into a thin film under the influence of the stresses caused by the rotary motion. Similarly, a second spinning solution having shrinkage characteristics differing from those of the first is forced through the passageway **102** onto the curved face **104** where it also spreads as a thin film. At point **106** the two films join into a bi-component liquid film which moves across the face **78** to the edge **80** where it is slung into the stream of heated air emitted from the manifold **44**. The air stream evaporates the solvent causing a bi-component micro-fiber to be formed which, as it is heated, will curl to a crimped or textured fiber. As described before the stream of air also carries the fibers to a collecting screen **54**.

Conjugate micro-fibers are formed by the apparatus of FIGURE 3 in the following manner. A first spinning solution is introduced into the chamber **74** through the tube **34** and due to the rotary motion of the distributing element **16** forms a toroidal shaped reservoir **116** which will overflow through the aperture **76** and spread as a thin film across the face **78** as more solution is pumped in. At the same time a second spinning solution is spread on the surface of the reservoir through tube **36'** in a thin film and is carried through the aperture **76** on the surface of the first spinning solution as it spreads onto the face **78**. Thus, a bi-component film is formed which when slung from the edge **80** is converted into conjugate micro-fibers in the manner described above in connection with FIGURE 2.

Similarly to the apparatus illustrated in FIGURE 3, in the embodiment illustrated in FIGURE 4, a first spinning solution is introduced into the chamber **74** through the tube **34** and due to the rotary motion of the distributing element **16** forms a toroidal shaped reservoir **116**. The second spinning solution is introduced into the chamber **74** through the tube **36''**. In this embodiment, however, the first solution emerges from the tube **34** and spreads, under the influence of rotary motion, across the baffle **118** and into the reservoir **116**. The second solution emerges from the tube **36''** onto the surface of the baffle **122** and spreads outwardly to form an overlay on the surface of the reservoir **116**. As the reservoir **116** overflows through the aperture **76** it carries the second solution on its surface and both spread as a thin film across the face **78**. Again, a bi-component film is formed which when slung from the edge **80** is converted into conjugate micro-fibers in the manner described above. These baffles **118** and **122** act to transfer the first and second spinning solutions to the reservoir **116** and as an overlay on the reservoir respectively, with a minimum of turbulence, and thus, prevent intermixing.

A practically infinite number of combinations of rotational speeds, solution flow rates and air flow rates can be utilized with the apparatus of the invention to achieve the desired spinning performance. Thus, fiber denier, degree of crimp and other characteristics can be varied as required.

It will be apparent that there has been herein disclosed

a method and apparatus for producing conjugate micro-denier fibers using a spinning cone, an accomplishment not heretofore possible. Thus, it will now be practical to produce on a large scale, relatively inexpensive, high quality, textured fibers in the micro-denier range.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. An apparatus for spinning conjugate micro-fibers comprising a frame; a hollow frustoconical member rotatably mounted on the frame and having therein a circular central opening, means for rotating said member about its axis, said member having in communication with the central opening thereof an annular chamber having a diameter greater than the diameter of said central opening for receiving a spinning solution, said solution being held in the chamber by centrifugal force when said member is rotated, a pair of inlet lines extending through said central opening for feeding two different spinning solutions through said opening and into said chamber, said spinning solution overflowing from said chamber outward through the central opening and onto the inner face of said frustoconical member, and means surrounding said member for directing a stream of heated air past said member to carry away fibers formed by rotation of said member.

2. The apparatus of claim 1 wherein each of the inlet lines is provided with a baffle spaced from the end of said line for directing the spinning solution outward into said chamber.

3. The apparatus of claim 1 wherein the apparatus is provided with a dispenser mounted in said chamber, said dispenser having therein a cavity, one of said inlet lines terminating in said cavity to feed one of the spinning solutions thereto, said dispenser having a conical central opening for feeding said one spinning solution outward onto said frustoconical member, said dispenser being spaced from the wall of said circular central opening to allow the other solution to flow therebetween from the chamber.

4. The apparatus of claim 3 wherein the conical central opening of the dispenser is formed by a hollow frustoconical element.

5. The apparatus of claim 3 wherein the cavity is annular in configuration, said annular cavity having a diameter greater than the diameter of the central opening in said dispenser.

6. Apparatus according to claim 1 in which one of said inlet lines terminates within a cavity in a dispenser mounted in said chamber.

7. Apparatus according to claim 1 in which one of said inlet lines terminates in said chamber in a curved portion directed toward the outer wall of the chamber.

8. Apparatus according to claim 1 in which a baffle is spacedly mounted across the mount of each of said inlet lines for directing the spinning solution toward the outer wall of said enlarged chamber with a minimum of turbulence.

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WILLIAM J. STEPHENSON, *Primary Examiner.*