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METHODS AND APPARATUS FOR SPINNING MULTICOMPONENT FILAMENTS

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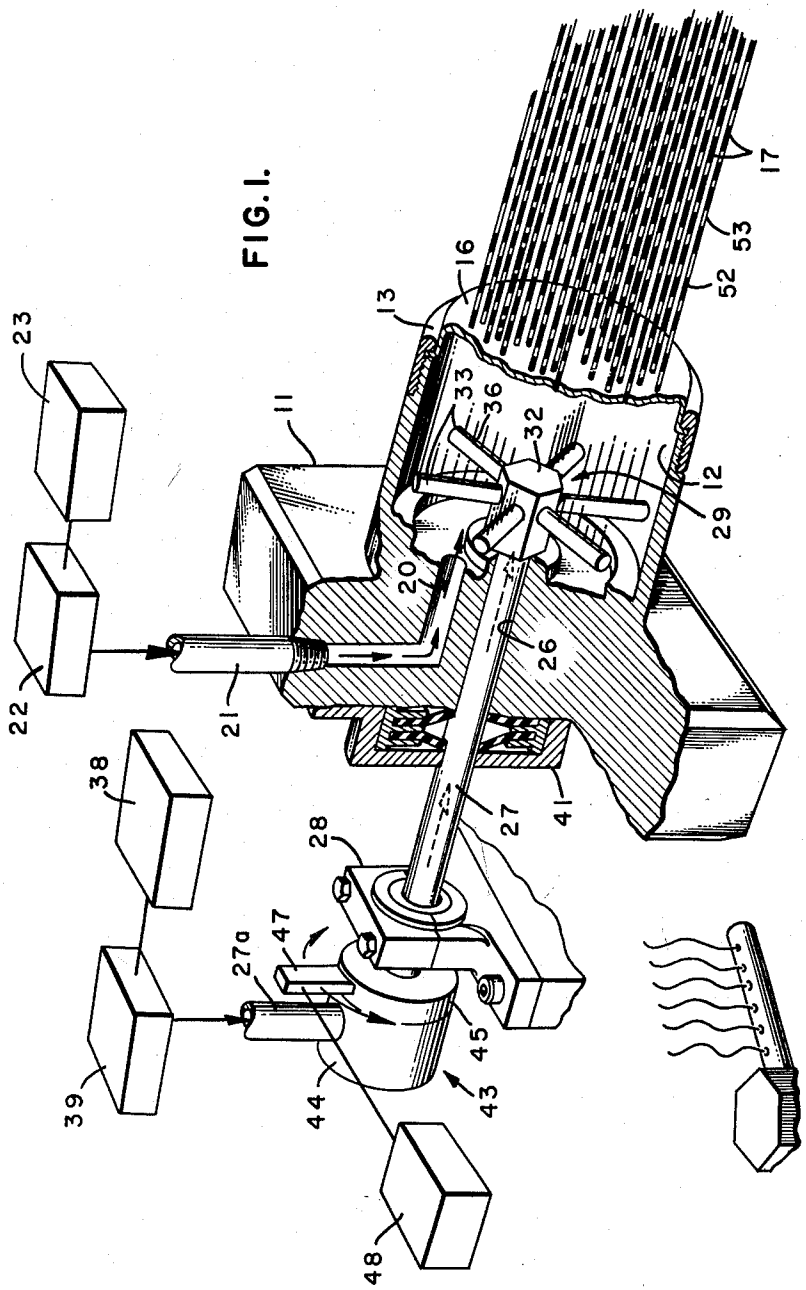

FIG. 1.

FIG. 5.

FIG. 4.

FIG. 3.

FIG. 2

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METHODS AND APPARATUS FOR SPINNING MULTICOMPONENT FILAMENTS

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This invention relates to methods and apparatus for spinning filaments and more particularly to spinnerettes for producing composite filaments.

A fairly recent development in the art of spinning is the production of filaments from two different spinning compositions to form filaments having variegated colors or varying compositions. In some cases, one side of the filaments is of one composition while the other side of the filament is a different composition. In other cases, the two compositions do not flow through the spinnerette hole together but flow through alternately so that portions of the length of the filament is one composition and the remainder of the filament is the other composition. If, in the latter case, compositions of different colors are used the formed filaments will be variegated in color. If the flow of each composition is cut off sharply, the filament will have alternating portions of different colors, with fairly sharp lines of demarcation between adjacent colors. If, however, the flow of each composition is gradually cut off, the filament will vary in color from one extreme to the other as the two colors are mixed during the gradual cutoff of the flow of one of the colors. One of the disadvantages of spinnerettes used in the past for forming multi-color or multi-composition filaments is that control of the flow of each composition has been difficult. With this in mind, one of the objects of this invention is to provide novel and improved methods and apparatus for spinning filaments.

Another object of this invention is to provide methods and apparatus for spinning a filament which varies in color or composition along its length.

A further object of this invention is to provide methods and apparatus for spinning a filament of two colors or compositions wherein the flow of each filament through the spinnerette hole can be controlled.

Still another object of this invention is to provide methods and apparatus for spinning a filament of two colors or compositions wherein streams of one spinning composition are caarried by a stream of a second spinning composition to a spinnerette.

A still further object of this invention is to provide methods and apparatus for spinning filaments wherein substantially sinusoidal streams of one spinning composition are carried by a stream of another spinning composition to a spinnerette.

Yet another object of this invention is to provide methods and apparatus for spinning filaments wherein a movable spinnerette injects streams of one spinning composition into a large stream of another spinning composition leading to a fixed spinnerette.

Still another of this invention is to provide methods and apparatus for spinning filaments wherein an oscillated spinnerette positioned behind a fixed spinnerette injects substantially sinusoidal streams of one spinning composition into a stream of another spinning composition flowing to and through the fixed spinnerette.

A method illustrating one embodiment of the invention comprises moving a first spinning solution in a primary stream along a path and injecting a plurality of discrete secondary streams of a second spinning solution into the primary stream, while at the same time moving the points of injection to vary the configuration of the

secondary streams. Filaments are then formed from the combined streams.

One embodiment of the present invention contemplates a spinning apparatus wherein a spinning solution is forced slowly through a chamber or cavity to a fixed spinnerette. A moving spinnerette positioned in the cavity injects streams of another spinning composition into the cavity so that the spun filaments vary in color or composition along their length. Because of the high viscosity and slow rate of flow of the compositions, the injected streams reach the fixed spinnerette intact, i.e., the flow of the solution is laminar. This results in filaments having the above-described characteristics.

Other objects and advantages of the invention will become apparent when the following detailed description is read in conjunction with the appended drawing, in which

FIGURE 1 is a perspective view of one embodiment of the invention with portions cut away to show the structure of the movable spinnerette,

FIGURE 2 is a perspective view of a fragment of the movable spinnerette showing the configuration of the streams delivered by this spinnerette,

FIGURE 3 is an enlarged view of a portion of one of the filaments showing the configuration of one type of junction of the two compositions in the filament,

FIGURE 4 is an enlarged view of a portion of one of the filaments showing the configuration of another type of junction, and

FIGURE 5 is an enlarged view of a portion of one of the filaments showing the result obtained when the movable spinnerette is so positioned that one of the injected streams flows through one of the spinnerette holes with the larger stream which carries the injected streams.

Referring now in detail to the drawing, a spinning head or body 11 is shown provided with a cylindrical chamber or cavity 12. A cap 13 threaded onto the body 11 holds a spinnerette 16 in a fixed position closing the cavity 12. The spinerette 16 is provided with conventional holes which are adapted to form filaments 17 when a spinning solution or composition is forced through the spinnerette.

A plurality of ports 20 leading to the end of the cavity or chamber opposite the fixed spinnerette 16 are connected through a pipe 21 to a pump 22 which is connected to a source 23 of spinning solution or composition. The pump 22 delivers the spinning solution to the chamber or cavity 12, the solution then moving slowly along the cavity 12 to the spinnerette 16. By adjusting the speed of the pump 22, the speed at which the spinning solution flows through the cavity 12 can be varied. Because of the high viscosity of the spinning solution and the large cross sectional area of the cavity 12, the spinning solution flows through the cavity 12 at a very slow rate of speed.

The block or body 11 is provided with a bore 26 which is concentric with the cavity 12 and in which is rotatably mounted a tube or pipe 27, a bearing 28 being provided for supporting one end of the tube 27. The tube 27 extends into the cavity 12 and has attached thereto a second spinnerette 29 having the configuration best illustrated in FIGURES 1 and 2.

The second, or movable, spinnerette 29 includes a manifold 32 secured to the end of the tube 27 and having extending therefrom a plurality of arms 33. Each of the arms 33 is tubular in configuration and is connected through the manifold 32 to the tube 27. Each of the arms 33 is also provided with a plurality of spaced holes 36 through which a second spinning solution or composition flows into the larger stream flowing from the ports 20 to the fixed spinnerette 16.

The second spinning solution, which is different in color or chemical composition from the first solution, is supplied from a source 38 through a pump 39. By adjust-

ing the speed of the pump 39, the rate at which the second solution flows through the holes 36 into the cavity can be varied. A seal 41 of a well known type is secured to the back of the block 11 to prevent leakage of the spinning solution along the tube 27.

A joint 43 is provided to permit oscillation of the movable spinnerette 29, one side 44 of the joint 43 being connected to a portion 27A of the tube 27 and the other side 43 being connected to the tube 27. A lever 47 connected to the side 45 of the joint 43 is connected to a mechanism 48 of a well known type which oscillates the side 45 and the tube 27, thereby oscillating the movable spinnerette 29.

When the spinnerette 29 is oscillated, the streams leaving the holes 36 will define generally sinusoidal paths. Since the viscosities of both spinning solutions are very high and since the rate of flow of the solutions through the cavity 12 is very low, the streams leaving the holes do not lose their shape or configuration before reaching the spinnerette 16. Thus, the main stream of spinning solution carries a plurality of much smaller but well defined streams of a different composition. The configurations of these discrete smaller streams is illustrated in FIGURE 2. This multitude of small streams carried by the larger stream cause the spun filaments to have alternate portions 52 and 53 of different colors or chemical compositions. The rate of oscillation of the spinnerette 29 will determine the wave length of the sinusoidal paths or streams which will, in turn, determine the lengths of the portions 52 and 53.

FIGURES 3 and 4 illustrate some of the junctions that can be obtained with the apparatus of the present invention. In forming the filament of FIGURE 3, the spinnerette 29 is oscillated at a speed sufficient to cause the small streams to quickly cross the holes in the spinnerette 16. This type of junction can also be obtained by oscillating the spinnerette through a greater amplitude.

In forming the filament of FIGURE 4, the spinnerette 29 is oscillated at a slower rate or through a smaller amplitude, so that the small stream of spinning composition takes a longer period of time to cross the hole in the spinnerette 16.

In forming the filament of FIGURE 5 the spinnerette 29 is held stationary and in a position so that one composition flows through one side of the hole in the spinnerette 16 while the other composition or solution flows through the other side of the hole. This results in a conjugate filament.

From the above it can be seen that this device can be used to form filaments which vary in appearance from those shown in FIGURE 1 to that shown in FIGURE 5. In fact, the device has been used to produce this range of filaments.

The method of the invention involves the injection of discrete, small streams of one spinning solution into a large stream of another spinning solution. Because of the laminary flow of the two solutions, each small stream remains intact until it reaches the point where filaments are formed from the combined streams. By moving the points of injection of the smaller streams, the configurations of these streams can be varied. For example, if these points of injection are rotated about a line normal to the plane at which the filaments are formed, each small stream will define a helix. Oscillation of the points of injection about this line causes the smaller streams to have substantially sinusoidal configurations (actually, the configuration of each small stream is that of a sine wave inscribed on a cylinder).

It is to be understood that the embodiment disclosed herein is merely illustrative and many be altered or amended and that numerous other embodiments can be contemplated which will fall within the spirit and scope of the invention.

What is claimed is:

1. A process for forming filaments, comprising advancing a first spinning solution along a path to form a primary stream, injecting a plurality of streams of a second spinning solution into the primary stream to form secondary streams, said secondary streams being injected into the primary stream at points lying in a plane normal to the direction of flow of said primary stream, continually moving said points of injection to continually change the locations of the secondary streams in the primary stream, and forming filaments from the combined primary and secondary streams.

2. A process for forming filaments, comprising forming a primary stream of a first spinning solution, injecting into said primary stream a plurality of discrete secondary streams of a second spinning solution, said secondary streams being injected at points lying in a plane normal to the direction of flow of the primary stream, oscillating said points about an axis normal to said plane to change the locations of the secondary streams in the primary stream, and forming filaments from the combined primary and secondary streams.

3. A process for forming filaments, comprising forming a generally cylindrical primary stream of a first spinning solution, injecting into said primary stream a plurality of secondary streams of a second spinning solution, said secondary streams being injected at points lying in a plane normal to the axis of the generally cylindrical primary stream, continually oscillating said points about said axis to continually change the locations of said secondary streams in said primary stream, and forming filaments from the combined primary and secondary streams.

4. A process for forming filaments, comprising forming a primary stream of a first spinning solution, injecting into the primary stream a plurality of discrete secondary streams of a second spinning solution, said secondary streams being injected into the primary stream at points lying in a plane normal to the direction of flow of said primary stream, moving said points of injection to change the locations of the secondary streams in the primary stream, adjusting the rates of flow of the primary and secondary streams to vary the size of said secondary streams, and forming filaments from the combined primary and secondary streams.

5. An apparatus for spinning filaments, comprising a body having a chamber therein, a first spinnerette mounted in the body to close the chamber therein, a second spinnerette mounted in said chamber for movement about an axis normal to said first spinnerette, said second spinnerette having a plurality of radially extended arms having holes therein, means for forcing a second spinning solution through the holes in said arms and into the chamber, and means for moving said second spinnerette on said axis.

6. An apparatus for spinning filaments, comprising a body having a chamber therein, a first spinnerette mounted on the body to close the chamber, means for forcing a first spinning solution through the chamber to the first spinnerette, a manifold rotatably mounted in the chamber on an axis normal to said first spinnerette, a plurality of radially extended hollow elements attached to the manifold and having apertures therein, means for forcing a second spinning solution through the manifold and the radially extended elements, and means for moving the manifold through an arc.

7. An apparatus for spinning a filament, comprising a body having a cylindrical recess therein, a spinnerette mounted on the body to close the recess, said body having therein a plurality of ports leading to the end of the recess remote from the first spinnerette, a first source of spinning solution, a first pump for forcing spinning solution from said first source through the ports into the recess, said body also having therein a bore concentric with said recess, a tube rotatably mounted in the bore, a manifold secured to the tube and positioned in the recess adjacent to the ports, a plurality of tubular members secured to the manifold and extending radially there-

from, said tubular members being interconnected with the tube through the manifold and having therein a plurality of apertures facing the spinnerette, a second source of spinning solution, a second pump connected between the second source and the tube for forcing spinning solution from said second source through the tube and the radially extended tubular members, and means connected to the tube for oscillating said tube to oscillate said tubular members.

8. An apparatus for forming multi-component filaments; comprising a first spinnerette; a second spinnerette spaced from the first spinnerette; means surrounding the spinnerettes to form a housing enclosing the space between the spinnerettes, first means for forcing a first spinning composition through the first spinnerette, the space and the second spinnerette in that order; second means for forcing a second spinning composition into said space and through said second spinnerette; and means connected to one of said spinnerettes for moving said one spinnerette about an axis extending through said one spinnerette.

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