

Jan. 26, 1971

R. O. DENYES ET AL

3,558,757

FALSE TWISTING

Original Filed July 2, 1964

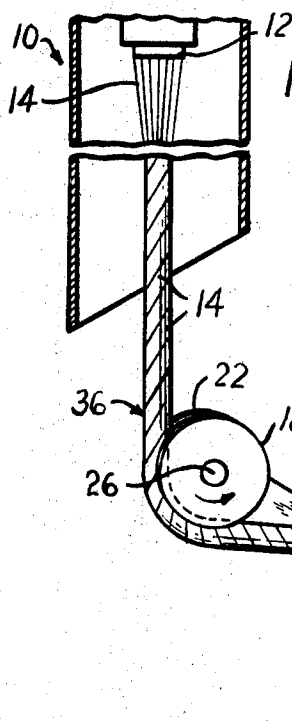


FIG. 1.

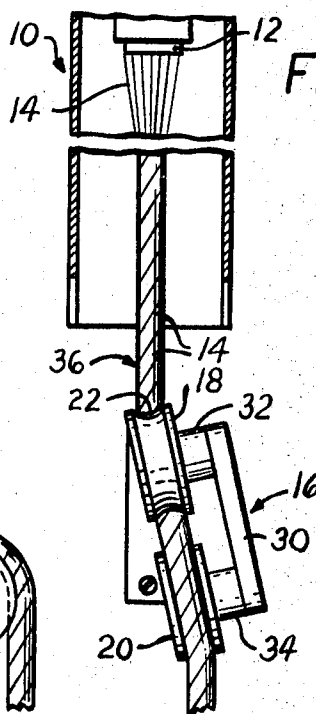


FIG. 2.

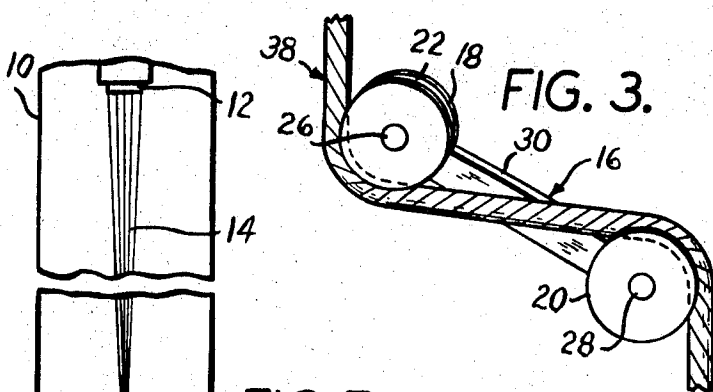


FIG. 3.

FIG. 4.

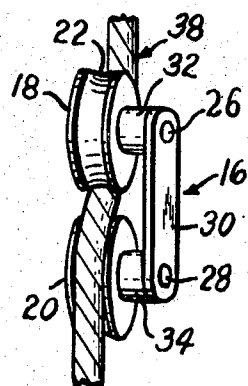


FIG. 7.

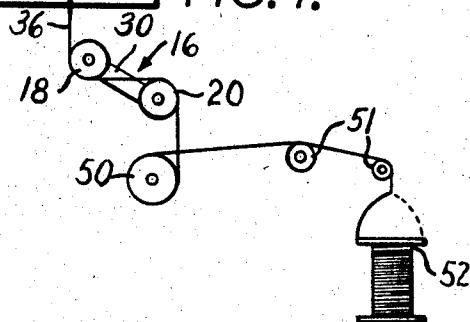


FIG. 5.

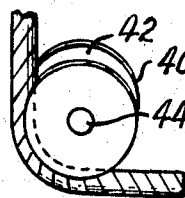
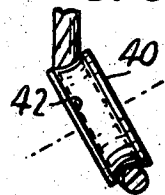


FIG. 6.



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FALSE TWISTING

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Original application July 2, 1964, Ser. No. 379,878, now Patent No. 3,470,583, dated Oct. 7, 1969. Divided and this application Apr. 29, 1969, Ser. No. 841,173

Int. Cl. D02g 1/20

U.S. Cl. 264—103

10 Claims

ABSTRACT OF THE DISCLOSURE

The process includes extruding a liquid fiber-forming material through a spinnerette into a spinning cabinet containing a gaseous medium to form a multiplicity of tacky filaments. The filaments are withdrawn from the spinning cabinet through an outlet remote from the spinnerette. The filaments are then passed in guiding contact with a guide means, preferably moveable, so positioned that the direction of movement of the filaments is changed from the original line of movement to a path of travel lying substantially in a plane intersecting the original line of movement at a small angle.

Our invention relates to an improved method for facilitating the spinning of multifilament yarn. More particularly our invention relates to a moving guide system which greatly facilitates the spinning of a tacky yarn.

This application is a divisional application of Ser. No. 379,878 filed July 2, 1964 now U.S. Pat. No. 3,470,583 issued Oct. 7, 1969.

Generally, multifilament yarns are produced by extruding a polymer forming material through a die member having a plurality of orifices, a spinnerette, and then converging the plurality of filaments thus formed into a non-twisted bundle. This bundle then moves to a take-up means such as a bobbin. This description is broadly applicable to any of the well known techniques employed in the art, e.g., melt spinning, wet spinning and dry spinning. When forming a relatively stiff synthetic fiber such as, for example, in the dry spinning of cellulose acetate, the multifilament yarn obtained from the spinnerette is usually converged and exited from the bottom of the spinning cabinet by passing it through a stationary guide fabricated from materials such as Al Si Mag, porcelain, Henium or another similar hard material. Due to the low coefficient of friction of these relatively stiff yarns, the yarn passes over the surface of the stationary guide with ease. When spinning yarns of comparatively soft synthetic fibers, particularly in the dry spinning of elastomeric yarns such as, for example, the essentially linear, segmented, elastomeric fibers obtained from the copolymers described in U.S. Pat. 2,871,218 and employing the same equipment as used with the stiff fibers, the individual filaments, which are separated in the spinning cabinet, contact the walls of the cabinet and become snarled with the other filaments within the cabinet resulting in an interruption of the spinning operation. It is believed that this contact with the cabinet walls and snarling with other filaments is the result of snubbing of individual filaments on the stationary guide. Snubbing may be described as the slowing down or even stopping of the travel of one or more individual filaments as a result of the frictional drag of the stationary guide on the filaments thus causing a reduction in the rate of removal or a complete stoppage in the removal of one or more individual filaments from the cabinet. As can readily be understood, this results in a

back up of one or more individual filaments within the cabinet and gives rise to the snarling.

Furthermore, such elastomeric yarns when exited from the spinning cabinet over a stationary guide tend to become flat due to the individual filaments coalescing into a ribbon. Also, some of the filaments exited from the cabinet are not completely coalesced making subsequent textile operations extremely difficult due to filament entanglement.

It is an object of our invention to provide a means for exiting such tacky filaments having a high coefficient of friction from a spinning apparatus without snubbing of the individual filaments on the guide means.

It is another object of our invention to avoid snubbing of the tacky filaments while using a solid guide means.

It is also an object of our invention to provide a means for facilitating the exiting of such tacky filaments from the spinning apparatus which produces a yarn in the desirable form of a circular, partially coalesced, compact bundle.

One aspect of our invention comprises a process for spinning tacky fibers into a gaseous medium. The process includes extruding a liquid fiber-forming material through a spinnerette into a spinning cabinet containing a gaseous medium to form a multiplicity of tacky filaments. The filaments are withdrawn from the spinning cabinet through an outlet remote from the spinnerette. The filaments are then passed in guiding contact with a guide means, preferably moveable, so positioned that the direction of movement of the filaments is changed from the original line of movement to a path of travel lying substantially in a plane intersecting the original line of movement at a small angle. The shape of the guide may preferably be convex or cylindrical. The effect of this change in direction of movement of the filaments is to impart a false twist to the filaments. The false twist travels backwardly along the filaments against their direction of movement and into the spinning cabinet where it is received by the filaments while they are in a substantially tacky state. The false twist must extend back into the spinning cabinet to a point at which the filaments are in a sufficiently plasticized state to adhere to each other, such state being termed "tacky," thereby coalescing the filaments into a false twisted, circular, compact bundle within the spinning cabinet. Generally, the false twist extends backward into the cabinet from about 25% to about 50% of the distance of travel of the filaments through the cabinet.

In our process the movable guide means is the first structure with which the filaments come in contact after leaving the spinnerette. Furthermore, in the operation of our process due to the fact that the filaments have been twisted into a compact, circular bundle and coalesced in this conformation within the spinning cabinet, the filaments come into contact with the guide means as a coalesced, twisted, compact bundle rather than as a loose bundle of individual, tacky, uncoalesced filaments. The result is that the problem of snubbing is obviated since the individual filaments have been coalesced together. Additionally, the obviation of snubbing permits the use of a simple, inexpensive, solid guide means rather than necessitating the employment of expensive, special equipment to handle the tacky filaments such as, for example, jet twisters utilizing the torsion of a vortex of air to manipulate the tacky filaments.

Preferably, the movable guide means is surface driven by the passage of the filaments in contact therewith. In such instance not only is the need for an external drive means for the guide eliminated but there is no necessity for making adjustments to the guide means each time the rate of extrusion or the draft ratio is changed. Moreover, the guide means will always be travelling at approximately the same rate of speed as the bundle of filaments even

during transient variations in the rate of movement of the filaments which might accidentally occur.

After leaving the guiding contact of the movable guide means, the travel of the yarn can be continued for a length sufficient to permit at least partial untwisting of the false twist before coming in contact with the next structural element, such as a yarn forwarding means or draw roll. After this partial untwisting, the filaments remain coalesced to each other in the form of a circular, compact bundle of multifilament yarn. After leaving the guiding contact of the movable guide means, the filaments can also be passed in contact with a forwarding roll under sufficient tension to counteract the twisting force applied by the guide means thereby removing the false twist and permitting the coalesced multifilament yarn to be wound up in the form of a circular, compact bundle.

The process of our invention is suitable for use with any of the well-known fiber-forming, segmented, elastomeric copolymers such as, for example, the polyesterurethane copolymers described in U.S. Pat. 2,871,218.

It can readily be seen, therefore, that there are several advantageous results obtained through the operation of our process. First of all, the filaments are twisted into the preferred form of a circular, compact bundle while still within the spinning cabinet and are coalesced in this form. Thus, the possibility of excessive splaying of one or several filaments is precluded thereby preventing such filament or filaments from contacting the walls of the spinning cabinet. Next, the still somewhat soft and tacky filaments are exited from the spinning column coalesced in a circular, compact bundle thereby preventing individual fibers from snubbing and providing a yarn not subject to filament entanglement during subsequent textile operations. Furthermore, the particular apparatus employed in our process provides a structural element which positively imparts the false twist to the filaments, and, due to the fact that it can be surface driven by the filaments, does not require adjustments due to variations in the extrusion rate and/or the draft ratio.

To effect the improvement of our invention we employ a novel movable guide means in the spinning apparatus. The guide means comprises an endless movable means adapted for guiding contact with the filaments after their extrusion along at least a portion of the surface of the guide means. The portion of the guide means adapted for contact with the filaments is shaped so as to provide a path of travel for the filaments which may be substantially planar or curved. It is essential that the guide means be positioned so that the plane of the path of travel of the filaments about the guide is disposed at an angle relative to the line of movement of the filaments from the spinnerette to the guide means prior to contact with the guide means.

The movable guide means of our invention can be in the form of an endless belt movable about a movable or stationary guide member having a convex or cylindrical configuration, such as, for example, an endless belt sliding about a stationary cylindrical or semi-cylindrical member wherein an arcuate portion of the cylindrical or semi-cylindrical member defines the configuration of the guide means and the movable endless belt provides the movable surface adapted for contact with the filaments. Similarly, the guide means can be an endless belt movable about an idler wheel. The guide means can also be a circular wheel mounted for rotation about an axis perpendicular to the desired plane of the path of travel of the filaments. Preferably, the movable guide means of our invention comprises a pair of spaced apart circular wheels each of which is mounted for rotation about an axis perpendicular to the desired plane of the path of travel. In this preferred embodiment the wheels are movable in contra-rotating directions.

Advantageously, when employing the preferred embodiment of the apparatus of our invention for the spinning of tacky multi-filament yarns, the pair of wheels or pulleys are located at the end of the spinning cabinet remote from

the spinnerette and are positioned intermediate the spinnerette and any take-up means or other manipulative apparatus such as draw rolls. The pulleys are preferably idlers which are surface driven in contra-rotating directions by the passage of filaments about the pulleys. In addition to disposing the pulleys such that the plane of the path of travel of the filaments about the pulleys is at an angle to the line of movement of the filaments from the spinnerette to the pulleys, it is also preferred that the line of movement of the filaments from the pulleys to the take-up means or other rolls be substantially parallel to the line of movement from the spinnerette to the pulleys. In addition to the particular embodiments of our invention mentioned above, it will be realized that a variety of other mechanical devices can also be employed within the scope of our invention, e.g., a pin, preferably a rotating pin.

For ease of providing instructions for the placement of the particular mechanical device employed as the guide means such as, for example, a rotatable pin, the relative positioning of the plane of the path of movement can also be expressed as providing a means rotatable about an axis disposed at other than a right angle to the line of movement of the filaments from the spinnerette to the guide means.

When employing our invention in the spinning of multifilament yarns, the amount of twist imparted to the filaments is determined by the angle between the plane of the path of travel and the original line of movement—the greater the angle, the greater the twist imparted. We have found that an angle of about 2 to 5 degrees is adequate to impart sufficient twist to the filaments within the column in order to converge the filaments into a twisted, circular, compact bundle and to prevent snubbing on the guide means. We have further found that such an angle is adequate to cause the false twist to travel far enough back into the cabinet, usually at least 25% of the cabinet length, so that the false twist is received by the filaments while they are in a sufficiently plasticized state so as to adhere readily to one another. It will also be recognized by those skilled in the art that variations in the angle can be employed depending upon the denier of the filaments—a greater angle being employed with a higher denier filament.

Our invention is particularly useful in the spinning processes in which the fiber is spun directly into a gaseous medium such as in dry spinning and melt spinning. In dry spinning, a solution of a fiber-forming material in a volatile solvent therefor is extruded through a spinnerette into a spinning cabinet. A gas, usually heated, is circulated through the cabinet and acts to volatilize the solvent from the solution as it is extruded to form the individual filaments. Normally, the solvent is not completely removed from the filaments at least during their initial progress through the cabinet. The result is that for a significant portion of the travel of the filaments through the cabinet the filaments are in a highly plasticized state or tacky condition and they will adhere readily to each other or to any solid body with which they make contact. In melt spinning, a fiber-forming material, maintained in a liquid state by means of an elevated temperature, is extruded in the liquid form through a spinnerette into a spinning cabinet. Again, a gaseous medium is circulated through the spinning cabinet which medium is effective to cool the individual filaments down to a temperature within their melting range. As with the dry spinning, the filaments are not completely solidified upon leaving the spinnerette and proceed for a significant distance through the spinning cabinet in a highly plasticized or tacky state. It will readily be seen that our invention is equally applicable to both dry and melt spinning processes. It should also be noted that our invention is equally applicable to the spinning of a monofilament, as well as the spinning of a plurality of filaments as described previously.

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In order to illustrate our invention more completely, reference is made to the attached drawing in which:

FIG. 1 is an elevational view of an embodiment of our invention.

FIG. 2 is a right side view of the embodiment shown in FIG. 1.

FIG. 3 is an elevational view of the embodiment of our invention shown in FIGS. 1 and 2 illustrating another method of operation in accordance with our invention.

FIG. 4 is a right side view of the embodiment as illustrated in FIG. 3.

FIG. 5 is an elevational view of another embodiment of our invention.

FIG. 6 is a right side view of the embodiment shown in FIG. 5.

FIG. 7 is a schematic elevational view showing an exemplary spinning and take-up system wherein the guide means of our invention are utilized.

FIGS. 1 and 2 show a vertical spinning column 10 with a spinnerette 12 located at its upper end and a multiplicity of filaments 14 moving downwardly from the spinnerette 12. Located immediately below the open bottom of spinning column 10 is a moveable guide means 16 of our invention. To facilitate illustration, the size of the components of the guide 16 and the filaments 14 have been exaggerated relative to the size of the spinning column 10 and the spinnerette 12.

The guide means 16 comprises an upper pulley 18 and a lower pulley 20 provided with concave or grooved peripheral channels 22 and 24, respectively. The pulleys 18 and 20 are rotatably mounted on parallel axles 26 and 28, respectively, (not seen in FIG. 2) which in turn are connected to opposite ends of arm 30. Also mounted on axles 26 and 28 between the pulleys 18 and 20 and the arm 30, are spacer members 32 and 34, respectively, (not seen in FIG. 1). The spacer members 32 and 34 function to maintain the pulleys 18 and 20 parallel to the arm 30 and also to prevent the pulleys 18 and 20 from bearing against arm 30 as they are rotated about axles 26 and 28.

In operation a loose bundle of filaments 14 is initially threaded about the pulleys 18 and 20 such that the initial point of contact of the bundle with pulley 18 is centrally of the vertical axis of the bundle and the path of travel of the filaments 14 is generally downward out of the bottom of spinning column 10, around and under upper pulley 18 lying in a portion of the grooved channel 22 thereof, transversely from the under portion of pulley 18 to the upper portion of lower pulley 20, around and over the lower pulley 20 lying in a portion of the grooved channel 24 thereof, and generally downward from pulley 20 in a direction substantially parallel to its path of movement downwardly from spinning column 10. The filaments 14 are then attached to a take-up means or yarn forwarding means (not shown), such as a feed roll. As the take-up means is put into operation, the filaments 14 are drawn out of the column and around the pulleys 18 and 20 in the manner just described, thereby causing the pulleys 18 and 20 to rotate in contra-rotating directions, as shown by the arrows. It can be seen from FIGS. 1 and 2 that the path of travel of the filaments about pulleys 18 and 20 is substantially in a common plane from the point of initial contact of the filaments 14 with grooved channel 22 of pulley 18 through to the final contact of the filaments 14 with the grooved channel 24 of pulley 20. As most clearly shown in FIG. 2, the plane of this path of travel is at an angle θ with the line of movement of the filaments 14 out of the bottom of spinning column 10. The effect of the filaments passing around pulleys 18 and 20 when disposed at such angle is to impart a Z twist to the filaments 14. This twist travels backwardly along the filaments into spinning column 10 where it is received by the filaments 14 twisting them into a circular, compact bundle 36 within the spinning column 10. As illustrated in FIGS. 1 and 2, the filaments 14 have been twisted into the bundle 36 and the bundle 36 extends downwardly

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from within spinning column 10. The compact bundle 36 also passes about the pulleys 18 and 20 and extends downwardly from the lower pulley 20.

Referring now to FIGS. 3 and 4 the same guide 16 as shown in FIGS. 1 and 2 is illustrated in a different position relative to the movement of the filaments 14 downwardly out of the spinning column 10. For purposes of illustration, it can be imagined that the guide 16 as shown in FIGS. 1 and 2 was rotated counterclockwise about an axis perpendicular to the length of arm 30 and at right angles to the axes of axles 26 and 28 in order to obtain a value greater than 0 for θ . In FIGS. 3 and 4 the guide 16, in effect, was rotated counterclockwise about an axis along the length of arm 30, thereby again placing the plane of the path of travel of the filaments 14 about pulleys 18 and 20 at an angle with the line of movement of the filaments and downwardly out of the spinning column 10. Thus, as the filaments 14 pass around pulleys 18 and 20 disposed in the manner shown in FIGS. 3 and 4, an S twist is imparted to the filaments thereby creating the circular, compact bundle 38. Again, in FIGS. 3 and 4, as in FIGS. 1 and 2, the filaments 14 are shown after having the twist imparted to them. Thus, the bundle 38 is shown moving downwardly from the spinning column and passing about pulleys 18 and 20.

In FIGS. 5 and 6 another embodiment of our invention is shown in which but a single pulley 40 having a concave or grooved peripheral channel 42 is employed. Pulley 40 is also mounted for rotation on an axle 44. Again, in this figure the plane of the path of travel of the filaments about pulley 40 is at a slight angle to the line of movement of the filaments from the spinning column. As mentioned previously, another manner of expressing the relationship between the initial line of movement of the filaments and the path of travel about the guide is that the axis of rotation of the guide, in this figure axle 44, be at an angle other than a right angle with the initial line of movement of the filaments. In effect then it can be imagined that if the axis of rotation of axle 44 and pulley 40 were perpendicular to and lying in a plane parallel to the line of movement of the filaments from the spinning column and the axis of rotation of axle 44 and pulley 40 were maintained in the plane parallel to the line of movement while the axis was rotated counterclockwise, then the axle 44 and the pulley 40 would be in the position relative to the line of movement shown in FIGS. 5 and 6. The particular embodiment shown in FIGS. 5 and 6 can be employed advantageously when it is desired to change the direction of movement of the filaments from the spinning column, for example, from the vertical to the horizontal, as illustrated in FIGS. 5 and 6.

In FIG. 7, a typical spinning system is illustrated wherein the guide means of FIGS. 1 and 2 are employed. The bundle of filaments 14 pass about the pulleys 18 and 20 and then pass around godet roll 50 which is driven at a uniform speed by means not shown. From godet roll 50 the filaments pass over the usual guide rolls 51 and are finally wound onto a bobbin 52.

When employing an embodiment of our invention of the type comprising a pair of spaced apart pulleys as shown in FIGS. 1 through 4, the pulleys 18 and 20 are usually about 1 inch in diameter and of sufficient width to accommodate the grooved channels 22 and 24 which exemplarily may be about $\frac{3}{32}$ inch wide and about $\frac{3}{16}$ inch deep. As shown in the drawing, the grooved channels are arcuate in cross-section and have a radius of curvature at least equal to one-half the width of the channel. With pulleys 18 and 20 of such dimensions it is usually adequate to have the pulleys 18 and 20 spaced about 2 inches apart. We have found that a guide means of such size is suitable for use with an elastomeric yarn from about 2 up to about 200 denier and containing up to about 200 individual filaments. As a general rule the

width of the grooved channel should be about 2 times the diameter of the yarn while the depth of the channel should be about 2 to 4 times the diameter of the yarn.

The embodiments shown in the drawing, both the single and double pulley systems, are of such shape as to provide a path of travel for the filaments which is substantially planar, convex and curvilinear. We have found that such a path of travel is best suited for imparting false twist in accordance with our invention and lends itself most readily to further manipulation of the filaments.

In the embodiments of our invention described previously and shown in the drawing, the guide means can be fabricated from any material which possesses the simple characteristics of being sufficiently rigid to provide adequate guidance to the filaments, having a sufficiently high melting point or softening point so as not to deform when in contact with the filaments, and being chemically inert to the filaments under the conditions of contact. In addition, the guide means when fabricated, must present a substantially smooth surface for contact with the filaments. Among the suitable materials from which the guide means can be constructed are most metals and metal alloys, such as stainless steel; ceramics and glass; and moldable plastics and resins having the properties mentioned above, such as nylon or other polyamides, polyacetal resins, and polyoxymethylene polymers and copolymers of the type described in U.S. Pat. No. 3,027,352 to Walling et al. The guide means may also be treated with a lubricating material in order to facilitate movement of the filaments around said means.

The following example will further illustrate the embodiment of our invention.

EXAMPLE

A polyesterurethane copolymer of the type described in U.S. Pat. 2,871,218 and obtained by reacting hydroxyl terminated poly (tetramethylene adipate) (molecular weight=850; hydroxyl number=130.4; acid number=0.89), butanediol - 1,4 - and diphenyl methane-p,p'-diisocyanate in a molar ratio of about 1.0:0.3:1.3, respectively, was employed in this example. A 30% solution in acetone of this copolymer was employed to dry spin an elastomeric fiber using the apparatus and its general operation as described above in connection with FIG. 7. The filaments were passed through the column where the solvent was substantially evaporated therefrom by contact with hot air introduced at a temperature of 150° C.

The filament exiting from the spinning column were passed in guiding contact with a guide means comprising an upper pulley 18 and a lower pulley 20 each 1 inch in diameter and having grooved channels about $\frac{3}{32}$ inch wide and $\frac{1}{16}$ inch deep. The pulleys 18 and 20 were rotatably mounted on parallel axes 26 and 28, respectively, which in turn were connected to opposite ends of arm 30. The filaments passed from the guide means to godet roll 50, thence to guide rolls 51 and finally were wound onto bobbin 52.

The above-described procedure and apparatus yielded compact bundles of filaments without any snubbing occurring on the guide means.

Any departure from the above description which conforms to the present invention is intended to be included within the scope of the invention as defined by the following claims.

Having thus described our invention, what we desire to secure and claim by Letters Patent is:

1. A process for spinning a tacky multifilament yarn which includes extruding a polyesterurethane polymer in a liquified state through a spinnerette into a spinning cabinet containing a gaseous medium to form a multiplicity of tacky filaments, withdrawing the filaments from the spinning cabinet through an outlet remote from the spinnerette, and then passing the filaments in guiding con-

tact with a moveable guide means shaped to provide a substantially planar path of travel for the filaments in contact therewith and disposed to change the direction of travel of the filaments from the original line of movement to the plane of the path of travel which plane intersects the original line of movement at a small angle thereby imparting a false twist to the filaments.

2. The process of claim 1 wherein the false twist twists the filaments into a circular, compact bundle and runs backwardly along the filaments against their direction of movement into the spinning cabinet where it is received by the filaments while they are in substantially tacky state to coalesce the filaments into a circular, compact bundle within the cabinet, and the guide means is the first structure with which the filaments come in contact after leaving the spinnerette.

3. The process of claim 1 wherein the filaments passing in guiding contact with the moveable guide means surface drive the moveable guide means.

4. The process of claim 1 wherein the small angle is from about 2 to 5°.

5. In the spinning of a tacky multifilament yarn which includes extruding a polyesterurethane polymer in a liquid state through a spinnerette into a spinning cabinet containing a gaseous medium to form a multiplicity of tacky filaments, and withdrawing the filaments from the cabinet through an outlet remote from the spinnerette, the improvement which comprises passing the filaments in guiding contact with a moveable guide means shaped to provide a substantially planar path of travel for the filaments in contact therewith and disposed to change the direction of travel of the filaments from the original line of movement to the plane of the path of travel which plane intersects the original line of movement at a small angle thereby imparting a false twist to the filaments.

6. The improvement of claim 5 wherein the false twist twists the filaments into a circular, compact bundle and runs backwardly along the filaments against their direction of movement into the spinning cabinet where it is received by the filaments while they are in a substantially tacky state to coalesce the filaments into a circular, compact bundle within the cabinet, and the guide means is the first structure with which the filaments come in contact after leaving the spinnerette.

7. The improvement of claim 5 wherein the filaments passing in guiding contact with the guide means surface drive the moveable guide means.

8. The improvement of claim 5 wherein the small angle is from about 2 to 5°.

9. A process for dry spinning a tacky, elastomeric, multifilament yarn which includes extruding a solution comprising essentially a polyesterurethane polymer in a solvent therefor through a spinnerette into a spinning cabinet wherein the solvent is substantially removed by a circulating gaseous medium to form a multiplicity of tacky filaments, withdrawing the filaments downwardly from the spinning cabinet through an outlet remote from the spinnerette and then changing the direction of movement of the filaments from the original line of downward movement to a path of travel lying in a plane intersecting the original line of movement at a small angle by passing the filaments in guiding contact with a surface driven moveable guide means shaped to provide a substantially planar, convex, curvilinear path of travel for the filaments thereby imparting a false twist to the filaments, the false twist twisting the filaments into a circular, compact bundle and running backwardly along the filaments against their direction of movement into the spinning cabinet where the twist is received by the filaments while they are in a substantially tacky state to coalesce the filaments into a circular, compact bundle within the cabinet, and the moveable guide means is the first structure with which the filaments come into contact after leaving the spinnerette.

10. The process of claim 9 wherein the surface driven

guide means is surface driven by the passage of the filaments in contact with said surface.

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