Oct. 7, 1969 R. O. DENYES ETAL 3,470,583

FALSE TWISTING

Filed July 2, 1964

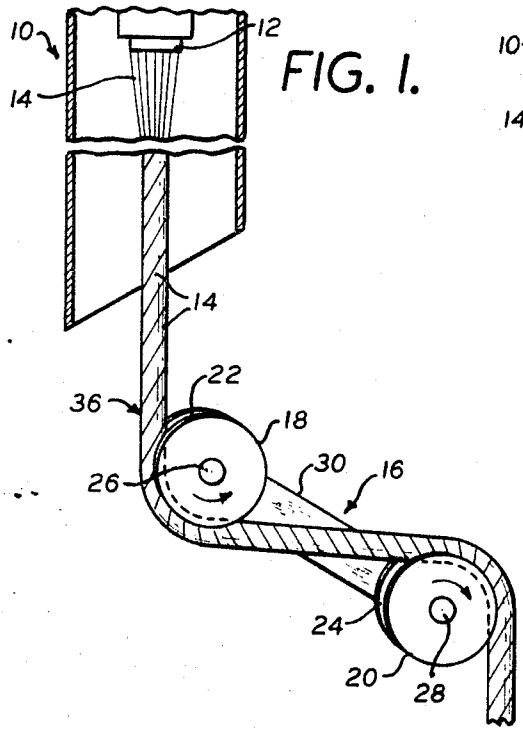


FIG. 1.

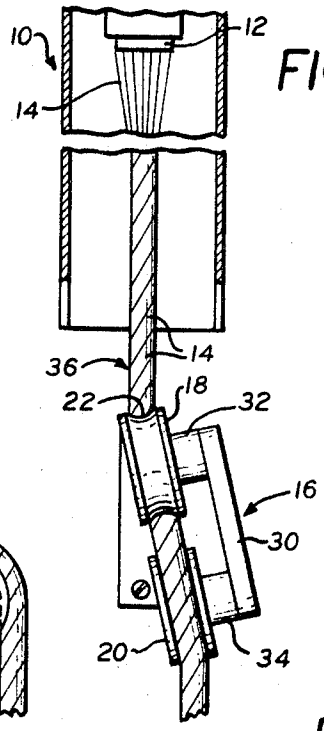


FIG. 2.

FIG. 4.

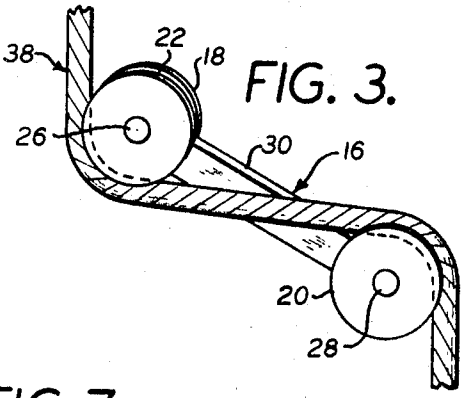
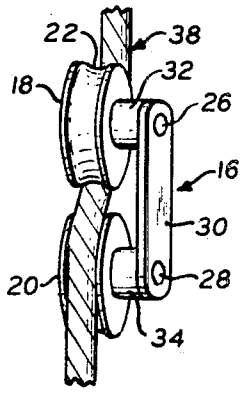


FIG. 3.



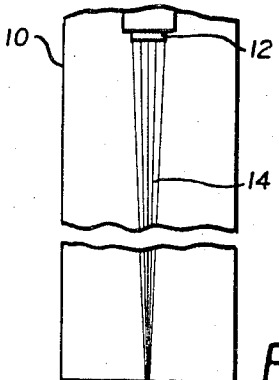


FIG. 7.

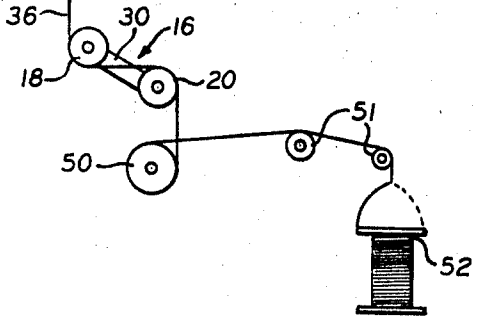


FIG. 5.

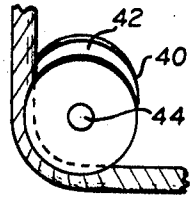
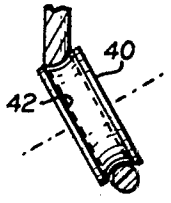


FIG. 6.



United States Patent Office 3,470,583 Patented Oct. 7, 1969

3,470,583

FALSE TWISTING

Russell Owens Denyes, Maplewood, and Joseph Germano Santangelo, Morristown, N.J., assignors to Celanese Corporation, New York, N.Y., a corporation of Delaware

Filed July 2, 1964, Ser. No. 379,878
Int. Cl. D01h 7/08
U.S. Cl. 18—8 2 Claims

ABSTRACT OF THE DISCLOSURE

An apparatus and process for spinning filaments and subsequently false twisting the spun filaments. The false twisting is accomplished by passing the bundle of freshly spun filaments across guide means positioned at an angle to the direction of withdraw of the filaments from the spinning column. The guide means comprises a pair of pulleys disposed such that the path of travel of the filaments about the pulleys is located substantially in a plane intersecting a small angle with the line of movement of the filaments from the spinnerette. The twist imparted by the guide means backs up into the spinning column thereby permanently affecting the freshly spun filaments.

Our invention relates to an improved method and apparatus 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.

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 Alsimag, porcelain, Hennium 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. Patent 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 spinerette. The filaments are then passed in guiding contact with a guide means, preferably movable, 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 filament 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. Patent 2,871,218. Our invention can also be employed when spinning fibers from blends of copolymers such as the blends described in the copending application of Epstein, Rosenthal and Santangelo.

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 multifilament 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 the 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 read-

ily 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.

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

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

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

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

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

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

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

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

FIGURES 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 movable 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 FIGURES 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 FIGURE 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 FIGURES 1 and 2, the filaments **14** have been twisted into the bundle **36** and the bundle **36** extends downwardly 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 FIGURES 3 and 4 the same guide **16** as shown in FIGURES 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 FIGURES 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 FIGURES 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 downwardly out of the spinning column **10**. Thus, as the filaments **14** pass around pulleys **18** and **20** disposed in the manner shown in FIGURES 3 and 4, an S twist is imparted to the filaments thereby creating the circular, compact bundle **38**. Again, in FIGURES 3 and 4, as in FIGURES 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 FIGURES 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 FIGURES 5 and 6. The particular embodiment shown in FIGURES 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 FIGURES 5 and 6.

In FIGURE 7, a typical spinning system is illustrated wherein the guide means of FIGURE 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 FIGURES 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 modable 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. Patent 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. Patent 2,871,217 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 FIGURE 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 $\frac{3}{16}$ inch deep. The pulleys **18** and **20** were rotatably mounted on parallel axles **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. Rotatable guide means in combination with dry spinning means which facilitates the dry spinning of a tacky multifilament yarn extruded through a spinnerette into one end of a spinning column and taken up by a take-up means after exciting from the other end of the column, which guide means comprises a pair of spaced apart pulleys mounted for rotation about parallel axes and located proximate to the other end of the column, the pulleys adapted for guiding contact with the filaments along at least a portion of the periphery of each pulley, thereby providing a path of travel for the filaments about the pulleys, the pulleys disposed such that the path of travel of the filaments about the pulleys is located substantially in a plane intersecting at a small angle the line of movement of the filaments from the spinnerette to the pulleys, the pulleys adapted to be surface driven in contra-rotating directions by the passage of the filaments thereabout, and the pulleys disposed relative to the spinnerette and the means for taking up the yarn such that the line of movement of the filaments from the pulleys to the take-up means is substantially parallel to the line of movement of the filaments from the spinnerette to the pulleys; whereby travel of the filaments about the pulleys imparts false twist to the filaments which twist travels backwardly along the filaments toward the spinnerette and the false twist at least partially untwists as the filaments travel from the pulleys to the take-up means.

2. Guide means according to claim **1** wherein the small angle is from about 2 to about 5°.

References Cited

UNITED STATES PATENTS

1,972,922	9/1934	Dreyfus et al.	18—88 XR
1,935,203	11/1933	Dreyfus et al.	18—8 XR
1,977,611	10/1934	Banigan	18—8
2,265,984	12/1941	Allen et al.	18—8
2,694,915	11/1954	Henry.	
2,811,409	10/1957	Clapp et al.	
2,988,867	6/1961	Quittner	57—35 XR
3,035,396	5/1962	Biggers	57—77.7 XR
3,083,084	6/1962	Smith	57—77
3,094,374	6/1963	Smith.	
3,107,990	8/1963	Heighton.	

FOREIGN PATENTS

916,727	7/1949	Germany.

WILLIAM J. STEPHENSON, Primary Examiner

U.S. Cl. X.R.

18—1; 57—51, 77.3