June 27, 1967 W. K. WYATT 3,327,461

APPARATUS AND METHOD FOR PRODUCING FALSE TWIST IN YARN

Filed June 17, 1965 2 Sheets-Sheet 1

FIG. 1

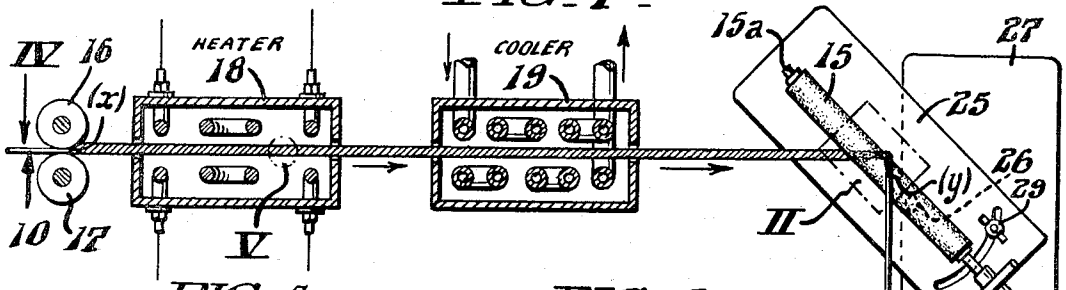
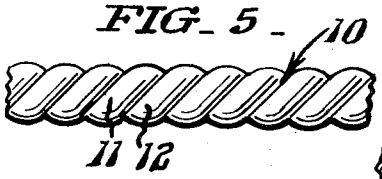


FIG. 4



FIG. 5



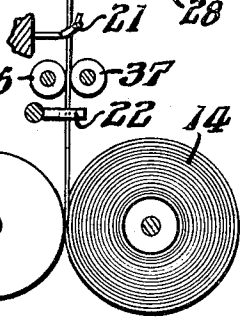


FIG. 2

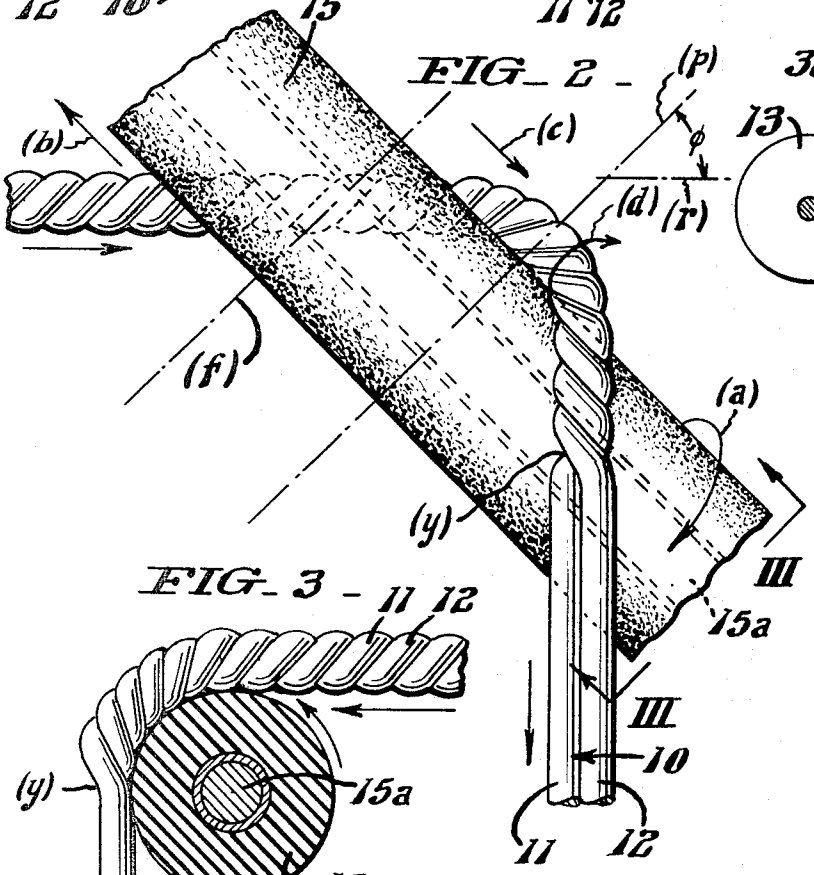


FIG. 3

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FIG. 7

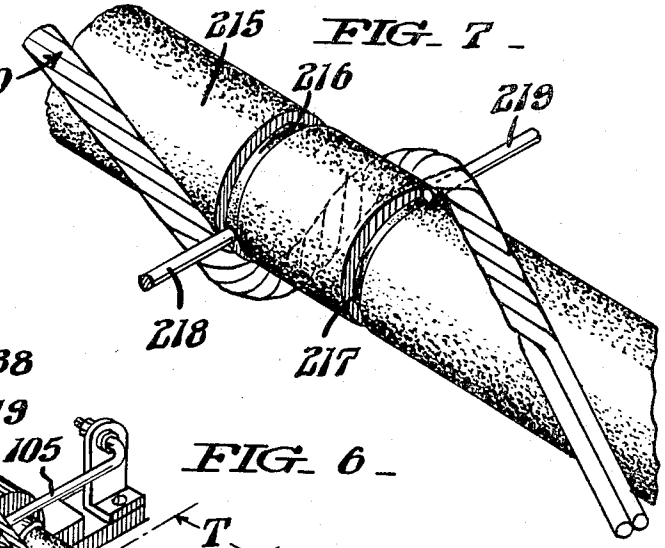


FIG. 6

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United States Patent Office 3,327,461 Patented June 27, 1967

3,327,461

APPARATUS AND METHOD FOR PRODUCING FALSE TWIST IN YARN

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Filed June 17, 1965, Ser. No. 464,714
5 Claims. (Cl. 57—34)

This invention relates to apparatus for and a method of producing false twist in heat-settable yarn.

An important object is to provide a simplified and relatively inexpensive apparatus and method for producing false twist in a single end of heat-settable yarn. The apparatus and method are, however, also applicable to plural ends of yarn as well.

The yarn must be of the type which is subject to heat-setting, and is usually composed of thermoplastic material. In a typical case it may consist wholly or at least predominantly, of continuous filament synthetic thermoplastic material.

In the patent to G. A. Carruthers 3,091,908, issued June 4, 1963, an apparatus and method is shown for false twisting yarns which comprises twisting two yarns one about the other, heat-setting and cooling these yarns in a twisted condition, and then withdrawing the yarns separately one from the other. In the method of the Carruthers patent, at least two ends of yarn are pretwisted in order to obtain the highly advantageous crimping or texturizing action that is achieved. In accordance with the present invention, it is desirable and highly advantageous to provide an apparatus and method giving the same excellent product that is obtained from the Carruthers patent, without requiring two ends.

Moreover, when yarn in the apparatus of the Carruthers patent breaks, it is often necessary to shut down the apparatus and pretwist a considerable number of turns, before starting up. It is another advantageous attribute of the present invention that neither initially nor in the event of a yarn break is it necessary to start up the apparatus by pretwisting a large number of turns of separate yarns one around the other.

In accordance with the present invention, untwisted or lightly twisted thermoplastic yarn is pulled angularly around the frictional surface of an angularly-disposed roller mounted for either free or driven rotation on its own axis. The surface of the roller is preferably soft resilient rubber, but may be other material which provides suitable frictional engagement with the yarn. It is the action of the frictionally-surfaced angularly-disposed rotating roller that imparts the false twist to the yarn.

Where the roller is driven, rather than being merely free to rotate, it is desirable to drive the roller at a speed such that its surface velocity is equal to the speed at which the yarn is moving. The yarn approaches the roller at an angle relative to the roller axis, follows a helical path on the roller surface, and then leaves the roller at an angle. The number of turns of false twist introduced into the yarn per unit length thereof, in the region upstream from the roller, is determined by the helix angle of the yarn on the roller, where the helix angle is defined as the angle between the yarn path on the roller surface and a line normal to the roller axis. The yarn is in engagement with the frictional surface of the roller for at

least 90° of the roller surface, and in some cases for two or three times 360°. A twist barrier is placed upstream from the friction roller and heater means and a cooling zone are provided between the twist barrier and the friction roller. By this simple and inexpensive arrangement, a false twist providing a permanent texturizing may be introduced into a single end of heat-settable yarn. The apparatus and method are, however, also applicable to the false twisting of double-end or multiple ends of yarn.

The invention will be more clearly understood from a consideration of the following description of preferred embodiments selected for illustration in the drawing in which:

FIG. 1 is a diagrammatic showing of one form of apparatus embodying the present invention in which the friction roller is not driven except by the yarn being twisted;

FIG. 2 is an enlarged view of the rectangular area II of FIG. 1, being that portion of the angularly-disposed frictionally-surfaced roller with which the yarn is in engagement;

FIG. 3 is a view in section along the line III—III of FIG. 2 looking in the direction of the arrows;

FIG. 4 is an enlarged view of the untwisted yarn at the point indicated in FIG. 1 by the symbol IV upstream from the feed nip rolls which function as the twist barrier;

FIG. 5 is an enlarged view of the twisted yarn in the heating and cooling regions, as indicated by point V in FIG. 1;

FIG. 6 is an illustration of a presently preferred form of the invention in which the angularly-disposed friction roller is positively driven and used to pull the yarn; and

FIG. 7 illustrates a further modification in which guide fingers are employed to maintain the helical path of the yarn on the friction roller.

For convenience of illustration, and to facilitate an understanding of the invention, the various figures of drawing depict a single end of yarn **10** assumed to be formed of two continuous filaments **11** and **12** of synthetic thermoplastic filamentary material.

In the embodiment of FIG. 1, the single end of yarn **10**, untwisted as supplied from the source, is shown being pulled in the direction of the arrows under and then over an angularly-disposed frictionally-surfaced roller **15**, as seen more clearly in the enlarged view of FIG. 2. The yarn supply is not shown but lies, in FIG. 1, to the left of the non-driven feed nip rollers **16**, **17**, one of which may be assumed to be spring pressed toward the other by spring loading means not shown. These nip rolls function as the twist barrier, preventing the twist from running upstream toward the source.

Located in the twist zone between the nip rollers **16** and **17** and the angularly-disposed frictionally-surfaced roller **15** are a heating zone and a cooling zone formed, in FIG. 1, by the heater **18** and the cooler **19**. Located beyond the twist zone, i.e. downstream from the angularly-disposed friction roller **15** are a fixed guide eye **21**, a pair of drive nip rolls **36**, **37**, a traversing guide eye **22**, a spring-loaded take-up roller **14**, and a driven drive roller **13**. Roller **13** frictionally engages the yarn on the peripheral surface of the take-up roller **14**, the diameter of which increases as the yarn accumulates thereon. The yarn drive and take-up means illustrated are merely representative of one form of means for pulling the yarn from the source

angularly over the friction roller **15**. It should be understood that other suitable means may be used, so far as the present invention is concerned.

The two filaments **11** and **12** of the single end of yarn **10** may preferably have zero twist as delivered from the supply package, but as a practical matter will probably have a small amount of producers twist, which may be of the order of ½ turn per inch.

The operation of the apparatus of FIG. 1 will now be described. Assume that the single end of yarn **10** has been threaded through the feed nip rolls **16**, **17**, through the heater and cooler **18**, **19**, under and over the roller **15**, down through the fixed eye **21**, the drive nip rolls **36**, **37**, the reciprocating traversing guide **22**, and on to the take-up roll **14**. It should be understood that insofar as the present invention is concerned, the yarn **10** could be pulled over and under the angularly-disposed friction roller, rather than under and over as shown in the illustration; and if the roller were disposed at a complementary angle, the yarn could be pulled up rather than down, the important point being that the yarn follow a helical path on the roller.

At start-up of the operation, when the two filaments **11** and **12** of the single end of yarn **10** are, in FIG. 1, pulled down about the angularly-disposed frictionally-surfaced twist roller **15**, the roller **15** is caused to rotate on its axis **15***a*, due to the frictional engagement of its rubber (or other) frictional surface with the yarn. The direction in which twist roller **15** of FIG. 1 is caused to rotate is indicated in FIG. 2 by the arrow *a*. Rotation of roller **15** introduces a force which, in the absence of other opposing forces, would tend to cause the incoming end of yarn **10** to climb helically up the frictionally-surfaced twist roller **15**, in the direction indicated by the arrow *b* in FIG. 2. The yarn **10** is, however, prevented from climbing helically up the twist roller **15** by the downward force exerted by the downward pull on the yarn, this force being indicated in FIG. 2 by the arrow *c*, and so long as the velocity of the yarn remains the same the yarn is held at substantially the same helical position on the twist roller **15**. Since the roller **15** is, in FIG. 1, being rotated due to the frictional engagement of the yarn with the surface of roller, the yarn **10** is rotated on its own axis, in a direction opposite to that in which twist roller **15** is rotating. In FIG. 2, the direction of rotation of yarn **10** on its own axis is indicated by the arrow *d*.

In the manner just described, the two filaments **11** and **12** of the single end of yarn **10** are twisted about each other. This twist runs upstream toward the source of supply but terminates at the nip rolls **16**, **17**, which function as a twist barrier for twist running against the direction in which the yarn **10** is moving. For convenience, the nip point of rollers **16**, **17**, will be referred to as point *x* and the tangent point of departure of the yarn from the angularly-disposed twist roller **15**, will for convenience, be referred to as point *y*. These points are indicated in FIGS. 1 and 2 of the drawing.

At start-up, twists of opposite hand are introduced downstream beyond point *y*, in the direction of the take-up roller **14**, but these twists of opposite hand exist only so long as the number of turns of twist per unit length being introduced into the upstream twist area *x*–*y* is increasing. Once, the number of turns per unit length of yarn in the *x*–*y* area has reached its maximum value, there is no twist introduced into the yarn beyond the exit tangent point *y* of the angularly-disposed friction roller **15**.

The angle of the twist introduced, and hence the number of turns of twist per unit length of yarn introduced, into the yarn in the *x*–*y* area is a function of the helix angle of the yarn on the friction roller **15**. This helix angle is indicated in FIG. 2 by the angle ϕ and may be defined as the angle between the yarn path *r* on the roller and a line *p* perpendicular to the roller axis. Increasing the angle ϕ will tend to increase the twist angle and hence tend to increase the number of turns of false twist introduced per unit length of yarn; decreasing the angle ϕ will decrease the twist angle and hence decrease the number of turns of twist. It has been found that a most satisfactory helix angle ϕ is 45°. With a helix angle ϕ of 45°, as above defined, the yarn twist angle is also 45° and the filaments take up a position on the roller **15** perpendicular to the axis of the roller, as illustrated in FIG. 2 by the dot-and-dash line *f*.

Any suitable means may be provided for mounting the roller **15** so that the helix angle ϕ may be adjusted. In FIG. 1, the roller **15** is illustrated as mounted on a shaft **15***a* which is journalled at its lower end in a bearing **24** supported on an adjustable plate **25**. Plate **25** is mounted for pivotal movement on a pivot post **26** fixed in an upstanding fixture **27** supported on a base **28**. It will be seen that the angular position of plate **25** is adjustable, as by loosening the wingnut **29**.

The total angle of contact or wrap of the yarn end **10** with the peripheral surface of roller **15** should be at least 90° as viewed looking along the roller axis. Such an angle is illustrated in FIG. 3 of the drawing. In the embodiment of FIG. 6, later to be described, the angle of contact or wrap in the twist imparting region is 180°, or approximately 180°. In some instances, it will be desirable for the yarn end to wrap helically about the peripheral surface of the roller **15** for a total angle in excess of 360°.

Once the full number of twists has been built up into the yarn in the twist region *x*–*y*, as determined by the helix angle of the friction roller **15**, the total number of twists in this region remains fixed. For example, if there are 50 linear inches between the twist barrier **16**, **17** (point *x*), and the friction roller **15** (point *y*), and if the helix angle is such that 100 turns of twist per inch are insertable into the yarn in this region, there will be 5,000 turns of twist in the *x*–*y* region, and this total number of turns of twist will remain unchanging during the operation of the system (assuming that such variables as the helix angle of the yarn on the roller **15**, the velocity of the yarn, etc., are not changed). As the yarn moves forward in its direction of travel, a new twist is introduced just inside the barrier point and a corresponding twist disappears as the yarn moves beyond tangent point *y*.

The twist introduced will be recognized as a false twist. This false twist is set into the yarn in the heating and cooling zones located upstream from the roller **15**, between points *x* and *y*.

As the yarn end **10** leaves the tangent point of departure of the yarn from the twist roller **15** (point *y*), the two filaments **11** and **12** are substantially parallel relative to each other. The filaments **11** and **12** are pulled substantially straight by the force of the take-off means, but when allowed to relax the individual yarn filaments will remember and return to the twisted shape which they had in the setting or cooling zone **19**.

While the apparatus and method of the present invention is applicable to the introduction of false twist into two (or more) separate yarns simultaneously, as by passing two twisted yarns together through the apparatus, the invention has particular advantages when employed to introduce false twist into a single end of yarn. A greater number of turns per inch can be imparted by the same helix angle on the friction roller to a single end of yarn then to a double-end twist. Stated another way, with the same helix angle of twist, the single end of yarn will have a greater number of turns per inch. Such yarn will have greater recovery power; a higher increment of force is required to extend in to a unit length, and a higher increment of force tends to return it to its original length.

It will be understood that, solely for ease of description and ready understanding, I have shown an end of yarn **10** consisting of only two filaments. Actually, the single end of yarn **10** will ordinarily consist of a plu-

rality of say 30 or more continuous thermoplastic filaments. Suitable filaments include, among others, nylon (polyhexamethylene adipamide), Dacron (polyethylene therephthalate), polypropylene, co-polymers of vinyl chloride, and others.

It will be recalled that in the embodiment shown in FIG. 1, rotation of the angularly-disposed friction roller **15** results solely from the frictional engagement between the yarn being twisted at the roller and the roller surface. Stated another way, in FIG. 1, the driving force for the roller is obtained from the yarn filaments during the twisting thereof. This is not, however, a preferred form of drive. The preferred form of drive is illustated in FIGS. 6 and 7.

In the presently preferred form of drive shown in FIGS. 6 and 7, the yarn **110** in the twist region T is relieved of the work of rotating the friction roller **115**. As shown in FIG. 6, the yarn **110** beyond the twist region T, i.e., downstream from the twist region T, is wrapped about the roller **115** before going down to the take-up roll **114**, and the roller **115** is positively driven, as by motor **101** and belt drives **131** and **132**. The rotation of roller **115** causes the yarn **110** in the wrap-around region R to move at a velocity equal to the surface velocity of the roller **115**, thereby pulling yarn from the source at the same velocity. This relieves the yarn **110** in the twisting region T of having to drive the roller **115** and, thus any tendency of the yarn to slip on the roller **115** is substantially eliminated. This allows the apparatus of FIG. 6 to operate at high speed even when the frictional roller **115** is disposed at such an angle relative to the approach path of the yarn **110** that a maximum number of turns per inch is being imparted to the yarn.

It should be understood that so far as the present invention is concerned, any suitable means may be employed for driving the roller **115**, any suitable means may be used for heating and cooling the yarn in the twist region, and any suitable means may be used as a twist barrier preventing the twist from running back to the source. In FIG. 6, solely for purposes of illustrating a workable embodiment, a motor **101** is shown connected by belt drive **131** to a shaft **102** which is coupled by belt drive **132** to the shaft **135** of the friction roller **115**. Shaft **102** is also shown coupled by means of a belt drive **103** to the shaft of a roller **113** which is mounted by means not shown against the peripheral surface of the yarn take-up roller **114**. The yarn **110**, from a source not shown, passes in series through a guide eye **104**, a first tensioning device **116**, a second guide eye **106**, a second tensioning device **117**, then through a heating unit **118**, through an ambient air cooling zone **119**, over a tension or support bar **105**, then on a helical path under and over the friction-surfaced roller **115**, then around a guide spool **107**, then several times about the friction-surfaced roller **115** and finally down through fixed guide eye **108**, traversing guide **109**, to the take-up roller **114**. An arm **120** assures that the yarn **110** remains spread laterally along the roller **115** in the wrap-around region R. The approach angle of the yarn to the roller **115** is adjustable by adjustment of support arm **105**. Heater **118** may be any suitable means. The heater **118** in FIG. 6 is assumed to be supplied by steam through input pipe **138**, as controlled by thermocouple **139**. Reference numeral **140** represents an air bleed.

In FIG. 6, the yarn **110** in the twist region T is in frictional engagement with the surface of roller **115** along a helical path having a length of about 180°. This region T extends from the incoming tangent point *t'* to the exit tangent point *t''*. In this region T, twist is imparted to the yarn in the manner previously described in connection with FIG. 1. This twist runs back through the cooling zone **119** and the heater **118** to the tension pulley **117** which functions as the twist barrier preventing the twist from running back to the source. In the downstream direction, no twist extends beyond the exit tangent point *t''* during the running of the apparatus. It will be understood, of course, that when the yarn taken up on take-up roll **114** is allowed to relax, it will remember and return to the twist which was set in the yarn in the cooling setting region **119**.

The apparatus of FIG. 6 is capable of producing a false-twisted thermoplastic single-end or double-end yarn of superior uniformity and quality due to the fact that, as previously mentioned, slippage of the yarn on the friction roller **115** in the twist region T is substantially eliminated, or at least substantially reduced, as compared with the apparatus shown in FIG. 1. This improvement in slippage results, as also previously indicated, from the fact that the yarn in the twist region T is relieved of the burden of driving the roller **115**, and from the further fact that because of the helical wrap-around arrangement in region R, the yarn is pulled by the roller **115** at a velocity substantially equal to that at which the yarn moves through the helical path in the twist region T.

If even further uniformity of twist is desired, the same may be obtained by means illustrated in FIG. 7. In FIG. 7, the friction roller **215** is provided with peripheral grooves **216** and **217** spaced 180° apart on the preferred helical path of the yarn **210** on the roller **215**. Guide means in the form of fingers **218** and **219**, mounted on means not shown, are provided, the inward ends of the fingers riding in the grooves **216**, **217**. In this manner, the yarn **210** is prevented from digressing from its intended helical path on the roller **215**, as might otherwise happen in the event that some slippage should occur intermittently or otherwise.

What is claimed is:

1. Apparatus for imparting a false twist to a single end of thermoplastic filamentary yarn, said apparatus comprising: a frictionally-surfaced roller mounted for rotation on its axis; drive means, including power means coupled to said friction roller for driving said roller rotationally, for pulling said single end of thermoplastic yarn along a helical path over the surface of said friction roller for a distance of at least 90° for twisting said single end of yarn; twist barrier means in the yarn path upstream from the friction roller; heating means and a cooling zone in the yarn path between said twist barrier means and said friction roller for setting the twist in said yarn; and guide means downstream from said helical path of said yarn on said friction roller for guiding said yarn around said friction roller in wrap-around fashion and for causing said friction roller to pull said yarn along said helical path.

2. Apparatus as claimed in claim **1** characterized in that means are provided for adjusting the angle of the helical yarn path on the friction roller relative to a plane normal to the roller axis.

3. Apparatus as claimed in claim **2** characterized in that said angle adjusting means are so adjusted that the angle between the helical yarn path on the roller and a plane normal to the roller axis is about 45°.

4. Apparatus as claimed in claim **3** further characterized in that said downstream guide means are so positioned that the helical path of the yarn over the surface of the friction roller in the twist region has an angular dimension of about 180° about the periphery of said friction roller.

5. In a method of introducing a false twist into thermoplastic yarn, comprising the steps of: pulling the yarn downstream from a source of supply over a path leading to a delivery point; rolling the yarn diagonally relative to its axis as it is pulled past a first point located intermediate said source and delivery point, thereby imparting a twist to the yarn; providing a twist barrier at a second intermediate point upstream from said first intermediate point, thereby establishing a region between said first and second intermediate points in which said yarn is in a twisted state; and heating and cooling the yarn in said twist region to set the twist; said yarn being pulled

at a point located just beyond said first intermediate point at a velocity which is substantially equal to the surface velocity of the yarn in the direction of its roll as it is rolled diagonally relative to its axis.

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