

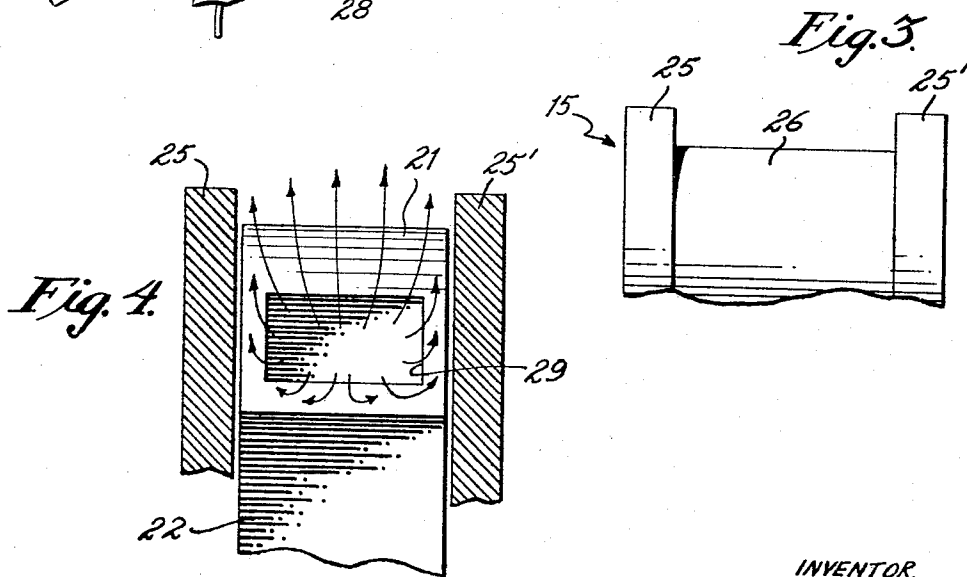
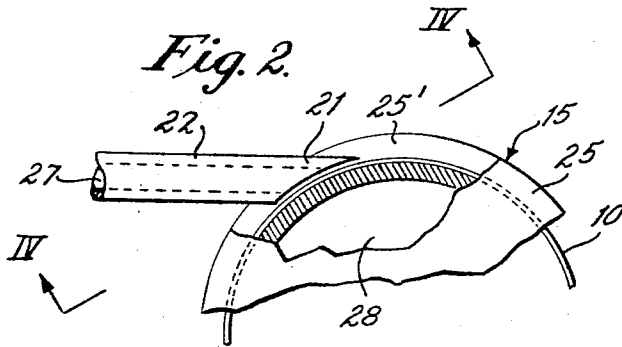
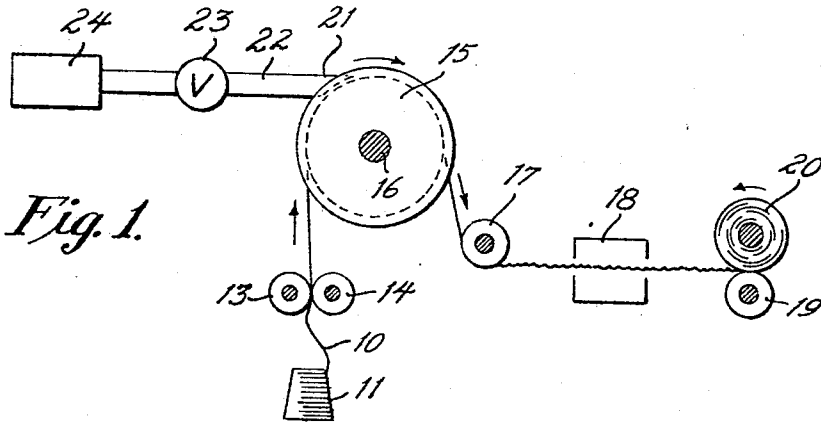
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STRAND TREATMENT

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STRAND TREATMENT

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8 Claims. (Cl. 28—72)

ABSTRACT OF THE DISCLOSURE

This invention relates to treatment of textile strands, concerning especially strand-crimping. A process is provided for directing hot fluid obliquely onto one side of a textile strand, the opposite side of which is maintained relatively cool. The strand so treated subsequently assumes a crimped configuration upon being forwarded away from the treating location.

In addition to edge-crimping, gear-crimping, jet-crimping, stuffer-crimping, and twist-crimping it is known to crimp textile strands of at least partially oriented (molecularly) linear polymeric material by setting up a temperature gradient transversely of the strand, whereupon the strand assumes a helically crimped configuration under low (or no) tension after cooling of the heated side. In the last mentioned method the heating of the one side of the strand may be accomplished by contact with a hot solid, liquid, or gas; the opposite side is maintained cool by conductive contact with a solid surface at appropriate temperature. Resulting processing and product characteristics leave a good deal to be desired, however.

A primary object of the present invention is improved transverse temperature-gradient treatment of textile strands.

Another object is provision of improved helical crimp in textile strands.

A further object is provision of apparatus for accomplishing the foregoing objects.

Other objects of this invention together with means and methods for attaining the various objects, will be apparent from the following description and the accompanying diagrams.

FIG. 1 is a side elevation, partially schematic, of apparatus according to the present invention; and

FIG. 2 is a side elevation, on an enlarged scale, of a detailed portion of FIG. 1.

FIG. 3 is a front elevation of a roll component of the preceding views; and

FIG. 4 is oblique sectional view taken at IV—IV on FIG. 2.

In general, the objects of the present invention are accomplished in treatment of a textile strand wherein the strand is heated on one side and maintained relatively cool on the opposite side, by subjecting the strand on that first side during the heating thereof to a stream of hot fluid incident onto the strand at an oblique angle and having a velocity component in the running direction greater than the strand velocity.

More particularly the invention comprehends a strand-crimping process comprising forwarding a plasticizable molecularly oriented textile strand of linear polymeric material into a treating zone, heating the strand on one side only to its plasticization temperature by directing thereonto a stream of hot fluid having a velocity component in the forwarding direction, maintaining the opposite side of the strand cooler than the plasticization temperature, and cooling the strand substantially tension-free, whereupon it assumes a crimped configuration.

FIG. 1 shows, in side elevation and partly schematically, strand 10 being withdrawn from supply package 11 by pair of nip rolls 13, 14 from which it passes at least a

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half turn about flanged cool roll 15, to the recessed peripheral surface of which is juxtaposed jet end 21 of pipe 22 for hot fluid supplied from source 24 through valve 23 in the pipe. From the cool roll the strand is withdrawn and is forwarded about part of the roll 17, which is driven or not driven as desired, then past heater 18, and is traversed onto windup package 20 driven by surface contact with traversing drive roll 19. The cool roll rotates on axle 16 (shown sectioned).

FIG. 2 shows, also in side elevation but partly in section and considerably enlarged, a portion of cool roll 15 and adjacent elements. Part of near flange 25 of the roll is broken away, revealing the otherwise concealed corresponding portion of opposite flange 25' as well as jet end 21 and the adjacent length increment of strand 10. The roll has hollow 28 inside, which is supplied conventionally with cooling fluid (not shown). Jet end 21 is concave in the plane of the view, in juxtaposition to the recessed arcuate peripheral surface of the roll, with sufficient clearance for strand 10 to pass therebetween. The jet outlet is aligned with bore 27 in pipe 22, and the emitted hot fluid (not shown) is incident at an oblique angle onto the exposed side of the strand, which runs about the roll in essentially non-slipping surface with that recessed peripheral surface thereof. The supply pressure of the hot fluid is such that the velocity component thereof in the direction of strand travel exceeds the rate of travel of the strand.

FIG. 3 shows, in front elevation on the same scale as in FIG. 2, a portion of cool roll 15, without strand 10 on recessed peripheral surface 26 thereof, which is flanked by pair of flanges 25, 25'. This view is what would be seen upon looking leftward from a position to the right of cool roll 15 in the preceding views before the strand is strung thereon.

FIG. 4 shows, also in front elevation and partly in section, the elements visible looking obliquely leftward at IV—IV in FIG. 2. Jet end 21 with outlet opening 29 therein is visible end-on, with part of pipe 22, and flanked by part of flanges 25, 25' (shown sectioned) of cool roll 15, which is not otherwise visible. Arrows from the outlet opening denote the flow of hot fluid therefrom which is predominantly upward in this view, corresponding to movement in the running direction of the strand rather than otherwise. The roll flanges serve to channel the flow parallel to that direction instead of permitting it to be dissipated in any great part by a transverse velocity component.

The temperature of the hot fluid should be sufficiently above the plasticization temperature of the strand composition to soften the exposed side of the strand in the relatively brief time it is exposed thereto. For nylon the fluid temperature preferably is at least about a couple hundred degrees Centigrade. The cool roll should be maintained well below the strand composition plasticization temperature, preferably not more than about twice room temperature in degrees Centigrade.

As the hot fluid impinges onto the exposed side of the strand, softening thereof occurs. Because the velocity component of the fluid in the running direction of the strand is greater than the strand velocity, preferably from several to about ten times as great, the softened side of the strand is subject to being extended thereby in the direction of travel relative to the opposite side, which is maintained cool.

The resultant configuration of the strand after cooling of the temporarily heated side, chiefly by conduction while still on the cool roll, is generally helical, giving the strand a bulky or fluffy appearance, especially when composed of quite a few filaments. The effect upon a mono-filament is similar though perhaps less extreme in overall effect because of the lack of other contorted filaments in the same

strand. More than one strand may be treated side by side on the same roll if desired, especially where the strands are monofilaments or contain few filaments apiece.

Strands may be treated according to this invention either under tension or essentially tension-free. In the first instance the rate of strand withdrawal from the package, as by nip rolls 13, 14 or the equivalent, is maintained sufficiently lower than the surface speed of cool roll 15 to impart the desired degree of tension to the strand therebetween, and roll 17 is preferably driven at the same surface speed; the windup rate is lower to enable the strand to relax at least partially before being wound up. In the second instance the surface speed of nip rolls 13, 14 may be the same as that of cool roll 15, and roll 17 may be undriven. In both instances the cool side of the strand passes in essentially non-slipping contact with the peripheral surface of the cool roll.

Although only imperfectly understood, the resulting helical crimp in the temporarily tensioned strand may be at least partly attributable to a heat-induced molecular disorientation of the exposed side of the strand such as to preclude subsequent recovery thereof from the increased length imparted thereto by the previously applied tension, whereas the opposite side, which retained its molecular orientation and consequent elasticity, retracts to become relatively shorter. The difference in length along the respective sides forms the strand into helical configuration.

When a strand is treated in essentially tension-free condition the similar result is probably not attributable to the same phenomenon of differential retraction from applied tension, although a strand considered essentially tension-free may have internal strains capable of providing a similar though lesser effect under the treating conditions. Instead it appears that a principal influence is relative lengthening of the softened exposed side of the strand, as the hot fluid impinges thereon with a velocity component in the direction of strand travel, without imparting molecular orientation thereto such as usually results upon extension of a strand composed of linear polymeric material. The resulting difference in relative lengths of the respective opposite sides of the strand, apparent under low tension as a helical configuration, is similar to that obtained when the strand is treated under tension, although usually less marked. Treatment essentially tension-free has the advantage of eliminating the necessity for carefully controlling applied tension, as is essential in the tensioned instance because failure to do so with considerable precision is conducive to undesirable irregularity of helical configuration or crimp in the product.

Heat relaxation of the strand in either instance may be performed by exposure of the cooled strand to an intermediate temperature in heater 18, through which it passes at relatively low tension, or may be deferred until later if desired. The heat-relaxed strand exhibits a more tightly coiled helical configuration, as may be desirable.

The composition of the hot fluid may be selected for reasons of cost, heat-capacity, chemical plasticizing effect upon the strand composition, or other reasons. Gases are preferred because of the tendency of most liquids to wet the cool roll or the strand or both, which usually is undesirable. Hot air is quite useful accordingly, with or without the admixture of steam, for example. Some steam usually is helpful because of having a plasticizing effect, but excessive steam is usually undesirable because of problems arising from condensation of water on the apparatus. Combustion gases may be employed, such as acetylene or hydrogen with air or oxygen. Other examples of suitable hot fluids will occur to persons ordinarily skilled in the art in the light of the present teaching.

For best results the radius of the cool roll, in centimeters, should not exceed the cube root of the strand denier. Thus for a 1040 d. strand of carpet yarn, the

preferred maximum roll diameter is about 20 cm., and for a 15 d. monofilament about 5 cm.

No attempt will be made to list here the considerable variety of strand compositions subject to successful treatment according to the present invention. No reason is known to rule out any plasticizable strand having a generally linear polymeric composition and at least partially molecularly oriented with respect to the strand axis by predrawing or even by orientation during its formation by extrusion, for example. If desired, the strand may be oriented during or immediately preparatory to the jet heating thereof according to the present invention, as by so relating the speed of the cool roll to exceed that of the preceding nip rolls sufficiently to impart to the strand great enough tension to draw it to increased length, as compared with a lower tension sufficient only to extend it temporarily without exceeding its elastic limits. Cross-linked or three-dimensional polymers, whether organic or inorganic also may be suitable. One or more additional rolls may be added, in contact with the cool roll or between it and the nip rolls to preclude slippage for the purpose of ensuring or drawing simply as a precautionary measure.

Although a preferred embodiment of this invention has been described above and illustrated in conjunction therewith, the above suggested or other modifications therein, as by adding, combining, or subdividing parts or steps, may be made while retaining all or some of the benefits of the invention, which is defined in the following claims.

The claimed invention:

1. In treatment of a running textile strand wherein the strand is heated on one side and is maintained relatively cool on the opposite side, the improvement comprising subjecting the strand on that first side during the heating thereof to a stream of hot fluid incident onto the strand at an oblique angle and having a velocity component in the running direction greater than the strand velocity.

2. The process of claim 1 wherein the hot fluid is superheated steam.

3. The process of claim 1 wherein the running strand is maintained relatively cool on its opposite side by essentially non-slipping contact with a moving solid surface maintained at a temperature lower than the temperature of the hot fluid.

4. The process of claim 3 wherein the solid surface is curved and the radius of curvature thereof in centimeters is at most the cube root of the strand denier.

5. The process of claim 3 wherein the strand in contact with the solid surface is substantially tension-free.

6. Strand-crimping process comprising forwarding a plasticizable molecularly oriented textile strand of linear polymeric material into a treating zone, heating the strand on one side only to its plasticization temperature by directing thereonto a stream of hot fluid having a velocity component in the forwarding direction, maintaining the opposite side of the strand cooler than the plasticization temperature and cooling the strand substantially tension-free, whereupon it assumes a crimped configuration.

7. The process of claim 6 wherein the crimped strand is subsequently heated substantially uniformly under tension insufficient to straighten out the crimp.

8. The process of claim 6 wherein the hot stream of gas incident on the one side of the strand disorients and extends the strand on that side relative to the opposite side.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,374,514

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Charles A. McClure

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 24, "surface" should read -- contact --.

Signed and sealed this 12th day of August 1969.

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

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Commissioner of Patents