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METHOD FOR TEXTURIZING YARN

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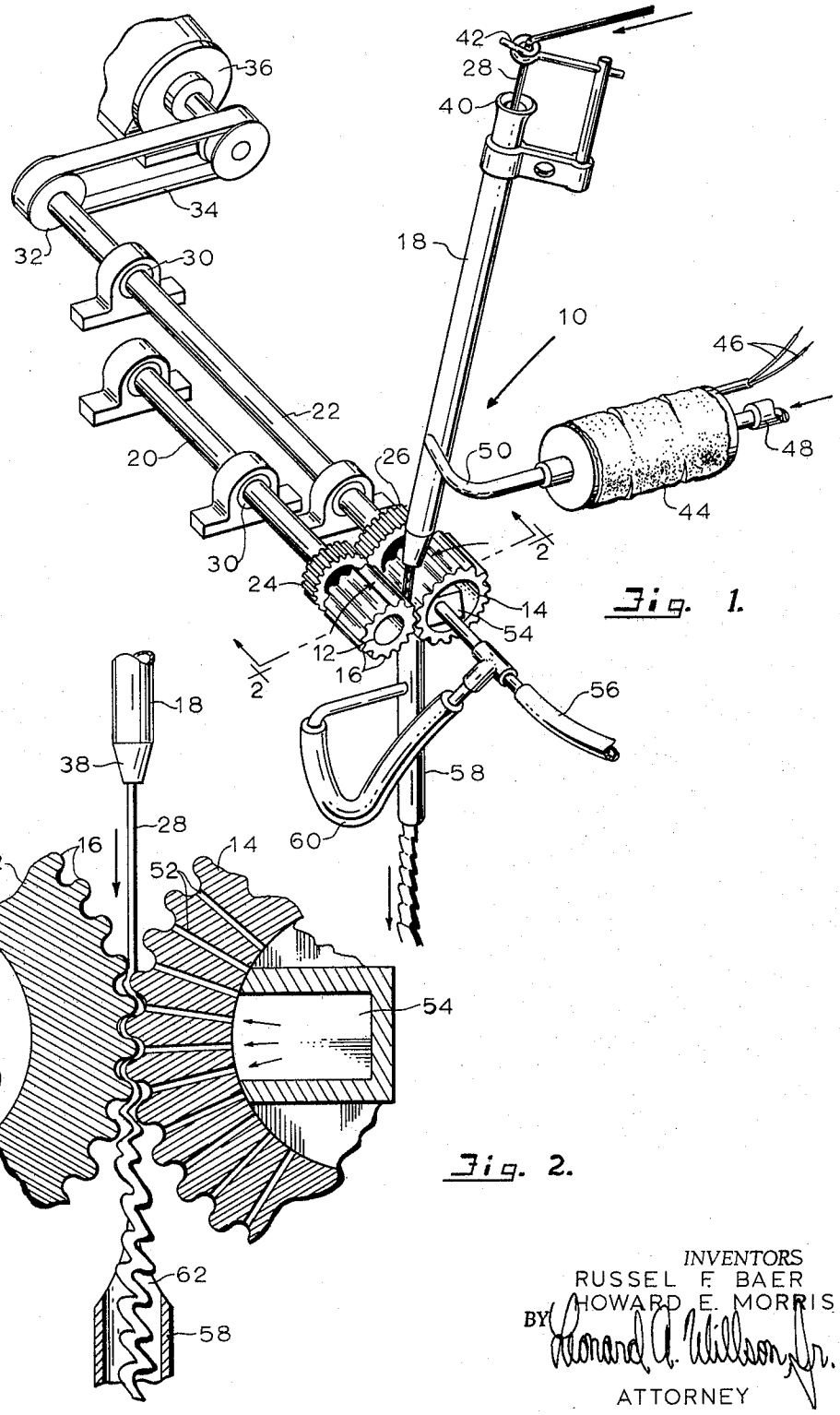


Fig. 1.

Fig. 2.

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METHOD FOR TEXTURIZING YARN

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3 Claims. (Cl. 28—72)

This application constitutes a division of our copending application Serial Number 267,751, filed March 25, 1963.

This invention relates to a method for producing a textured yarn and more particularly, to a method for treating a continuous filament, thermoplastic yarn or tow in such a way that the surface configuration of its components parts are modified so as to impart increased mass or bulk per unit length to such yarn.

A substantial portion of the textile industry is presently directed toward the preparation and production of yarns and fabrics from synthetic filaments and fibers. Such synthetic filaments have a number of highly desirable characteristics, such as low cost, long wear, and exceptional tensile strength. However, due to the nature of the synthetic modes incident to their production, certain physical characteristics common to the natural fibers, such as wool and cotton, are not present in these synthetic filaments. As an instance, the fibers of wool in their natural form containing a plurality of crimps consisting of waves which are approximately sinusoidal in form with the number of crimps per inch in the individual fibers varying widely within the different grades of wool. It has been determined these crimps are primarily responsible for the softer hand, greater warmth and ability to absorb moisture in wool as the crimps tend to hold the individual fibers in a wool yarn apart. Furthermore, the peculiar elastic qualities of wool are thought to stem in great degree from these crimps in that, when such fibers are stretched, the crimps are subjected to a straightening influence and in the straightened condition internal stresses are set up the net effect of which are to urge the fibers to assume their original crimp configuration.

Many constructions have been proposed for providing such crimps or waves in synthetic filaments, one of the most common of which comprises a rotary means such as a pair of cooperating, toothed rolls with intermeshing teeth which advance and deform the filaments into the particular crimp pattern or crimp density desired. Generally, the filaments, which may be in the form of an elongated rope or tow, are initially heated and moistened prior to entering the crimping rolls in order to bring the filaments to a plastic state during which they are subjected to the action of the crimping agent. Thus, upon cooling, the crimps are permanently set in the filaments.

Uniform crimping in a predetermined pattern is generally difficult to attain in such prior crimping arrangements as the degree of plasticity of the filaments can not be controlled accurately and the amount of moisture added to the tow, as well as the temperature existing in that portion of the tow being crimped, are characterized by wide variations giving a crimped pattern of poor uniformity. Furthermore, where the heating and moistening of the filamentary tow that is to be subjected to the crimping rolls is accomplished by conventional steaming, speed of processing becomes a problem due to the limitations in rapidity of heat transfer between the steam and the tow.

A further aspect of the problem in uniformity of the crimp imparted to the tow by such prior art apparatus

employing the use of crimping rolls is that of a variation in the extent of engagement of individual filaments across the cross-section of the tow with the teeth of the crimping rolls, wherein those filaments interior of the tow are subjected to a different crimping influence as compared to those filaments occupying the outer regions of the tow cross-section.

It is therefore apparent that, where it is desired to impart a crimp to continuous filament yarns by employing a mechanical crimping means, particularly crimping gears, whereby such yarns take on the attributes of staple yarns and natural fibers, problems are encountered with regard to limitations in the line speed and the degree of uniformity and permanence of crimp. A major limitation in the matter of line speed is the rate at which a yarn may be heated to a plasticized condition prior to being subjected to the crimping means. The problem of a variation in the degree of crimp across the yarn bundle, for reasons above referred to, has yet to be overcome in high speed operations. Also, it has been found that, as a newly commenced run proceeds, there occurs a gradual heat build-up in the crimping rolls with the result of a variation in crimp characteristics along successive lengths of the yarn being treated which variation indicates a need for some means of stabilizing the temperature conditions at the crimping rolls. It has also been found desirable in many crimping operations to make provision for quenching or setting the yarn or tow immediately after it emerges from the crimping means, which setting is normally accomplished by subjecting the tow to a fast-acting cooling medium.

As a further aspect of texturizing continuous filament yarns, it has been found that increased bulk, warmth, fineness of hand, etc. is obtained where the crimps are formed to lie in diverse planes containing the axis of the yarn, resulting in the highly desirable three-dimensional crimp evidenced by natural fibers. The configuration of such three-dimensional crimping may be visualized in the form of a substantially sinusoidal wave helically spiralling along the filament axis, wherein the individual filaments appear radially staggered when viewed transversely of the mean longitudinal axis of the filament. Besides having a finer hand and increased bulk, a yarn crimped in such fashion possesses a higher degree of filamentary entanglement by virtue of the significant increase in discrete points of contact between adjacent filaments, recutting in improved handling without the necessity of excessive twist.

With the foregoing observations and limitations in mind it is one object of the present invention to provide a method for crimping thermoplastic textile yarns, whereby the texture thereof is beneficially modified to take on increased bulk.

Another object of our invention is to provide an improved method for imparting bulk to thermoplastic continuous filament yarn by crimping same in a high speed, continuous operation to impart a three-dimensional crimp thereto.

Still another object of our invention is to provide a new and improved method of crimping a bundle of filamentary material in which such material is formed with a crimped pattern uniform throughout the cross-section of the bundle while virtually eliminating any breaking or cutting of the filaments during the crimping operations.

Still another object of our invention is an improved method of mechanically texturizing thermoplastic filamentary tow by simultaneously heating and distoring such tow at a point immediately upstream from its point of engagement by a mechanical crimping means, preferably crimping gears, which crimping gears are provided with a means to maintain temperature stabilization. This sequence of steps may in turn be followed by a quench-

ing or settting operation which, as herein disclosed, may be practiced in conjunction with preceding steps in a continuous fashion. The result is a three-dimensional yarn of high crimp uniformity, both lengthwise and cross-section wise of the yarn bundle.

According to the present invention, the foregoing and other objects are attained in the practice of an improved method which comprehends the expedient of simultaneously heating and opening a continuous filament yarn or tow by subjecting same to a vortex generating apparatus, immediately thereafter crimping the yarn, preferably by means of crimping gears, followed by an immediate quencing and setting of the yarn. The practice of such method has been found to result in significant increases in the degree of uniformity, both axially and transversely, of the yarn bundle and also increased rates of production, while providing a tri-dimensionally crimped yarn. The process is facilitated by an improved apparatus for texturizing continuous filament, thermoplastic tow or yarn, which apparatus is generally characterized by a mechanical crimping means, preferably a pair of intermeshing crimping gears, at least one of which may be provided with radial slots by way of which a cooling medium is communicated to the tooth portion of such gears, a quench chimney or equivalent setting means located immediately down stream of such crimping gears, and a tubular guide provided immediately upstream of such crimping means which tubular guide is provided with a fluid-actuated vortex generating means, which means is operative to introduce a tangential stream of air relative to said tubular guide or sleeve, which air or other gas is heated within a predetermined range to thereby simultaneously open, flutter and otherwise distort the yarn while it is being heated. It has been found that such an arrangement provides a more rapid rate of heat transfer to the yarn, resulting in higher production rates, because of the opening of the yarn or tow, which opening has the concomitant advantage of presenting a more efficient bundle to the crimping means in the sense that such an opened bundle will experience a greater uniformity of crimp transversely thereof. Also, because the individual filaments comprising the yarn bundle have been distorted from their normal relative orientation when engaged by the crimping means, relaxation of the bundle after crimping allows the individual filaments to assume their original orientation whereby the crimps formed therein will be caused to be in diverse planes about the filament axis, resulting in a three-dimensional crimp.

The novel features and steps which are believed to be characteristic of our invention are set forth with particularity in the appended claims. An illustrative embodiment of the invention, itself, however, both as to its organization and method of operation, may be better understood by reference to the following description taken in conjunction with the accompanying drawing in which:

FIG. 1 is a perspective view of the overall arrangement of one possible embodiment of our crimping apparatus, and

FIG. 2 is a fragmentary, partially sectionalized view taken on line 2—2 of FIG. 1 and showing the details of the crimping gears.

Referring now in greater detail to the drawings and more particularly to FIG. 1, there is shown a crimping apparatus, generally indicated by arrow **10**, which apparatus includes a pair of rotatably mounted, axially parallel wheel members or crimping gears **12, 14** having a plurality of uniformly circumferentially spaced and longitudinally extending tooth portions **16** that mesh in closely spaced adjustment, said crimping gears being spaced a short distance below tubular sleeve or guide **18**, as best viewed in FIG. 2. The crimping gears **12** and **14** are keyed to shafts **20** and **22**, respectively, or are integral therewith. To drive said crimping gears in unison, there are provided externally contacting spur gears **24, 26** having parallel axes, which spur gears mesh and are mounted on shafts **20, 22**, respectively. As the teeth **16** mesh, the filamentary tow or yarn **28** is subjected to laterally applied strains increasing and decreasing in intensity as the yarn approaches and leaves the plane defined by the two parallel axes of rotation of the crimping gears, at which point there is maximum meshing of the teeth. At this point it may be noted that, should it be desired to have the tow or yarn make more than one passage between the crimping gears, a spacer bar, not illustrated may be provided, which bar would extend in a skewed direction with respect to the axes of rotation of the crimping gears and about which bar the yarn, as it exits from the nip of the crimping gears, may be directed. The yarn or tow is thence redirected about one of the crimping gears, and so on, for the desired number of turns to provide the desired incidence of engagement of the crimping gears with such tow or yarn. By virtue of the spacer bar being skewed, the multiple wraps of yarn will assume a condition of uniform spacing axially of the crimping gears with the result that the yarn will enter the nip of the crimping gears at one axial point and exit therefrom at an axially spaced point.

The crimping gears **12, 14**, their associated spur gears **24, 26** and shafts **20, 22** may be conveniently mounted by conventional journal bearings **30** in such fashion as to allow one of the shafts, illustrated as shaft **22**, to function as a drive shaft, wherein that end of drive shaft **22** remote from the crimping gear **26** is provided with pulley **32** which is engaged by a flexible belt **34** driven by a suitable variable speed electric motor **36**, partially indicated.

Referring, now, to a feature of particular significance to our invention, the tubular sleeve or guide **18** previously mentioned is mounted with respect to the crimping gears **12, 14** so that one end thereof terminates in a closely spaced relationship with the nip of the crimping gears, which end may be tapered as at **38** to provide improved yarn control. The opposite end of the sleeve **18** is conveniently flared as at **40** to facilitate reception of the yarn or tow **28** from a source of supply, not shown, by way of pigtail **42**. At the lower half of the tubular sleeve **18**, as viewed in FIG. 1, there is provided a vortex generator which is operative to introduce a high velocity, heated fluid stream tangentially within the sleeve, which tangential stream acts upon the yarn or tow passing through such sleeve to open, and otherwise distort the yarn and to heat it to a plasticized state just prior to the yarn being contacted by the crimping gears. Such a generator may take the form of a conventional electric resistance heater **44**, which heater may be of a convenient cylindrical shape and which communicates with a source of electric current by way of leads **46**. A source of pressurized air or other desired fluid medium is conveyed through and heated by the resistance heater by means of conduit **48**. The air, on emerging from the resistance heater, enters feed tube **50**, which tube tangentially intersects the tubular sleeve **18** to communicate with the interior thereof. It will be appreciated that, upon supplying a pressurized fluid medium to the resistance heater **44**, such medium will be heated and its pressure head converted to a velocity head as it is exhausted tangentially into the interior of tubular sleeve **18** to thereby generate a vortex which acts upon the yarn passing through the tubular sleeve to open, flutter, distort and otherwise spread apart the filamentary components of such yarn or tow. It is to be emphasized that the illustrated embodiment of the means to generate the vortex within the tubular sleeve is only functionally symbolical, there being many refinements that will readily come to mind. For example, it may be desired to exhaust the air in such direction as will generate a component directed axially of the tubular sleeve **18** to thereby urge the yarn downwardly therethrough, rendering the sleeve capable of self-feeding. Further, it may be found desirable in order to provide

greater control over the effects of the vortex upon the yarn or tow to exhaust the heated fluid medium into an interiorly mounted plenum chamber from which such medium is then bled into the tubular sleeve **18** in the desired direction, whereby turbulence may be better controlled. The only essential is that a component of the fluid exhausted into sleeve **18** will be in a plane transverse to the axial dimension of such sleeve so as to generate a high velocity vortex therewithin.

A further feature of our invention is the provision of a means to quench or set the yarn or filamentary tow immediately upon its final exit from the nip of the crimping gears **12, 14**, which means also accomplishes temperature stabilization of the crimping gears. In practice, it has been found that, after a run has continued for some length of time, there is an undesirable rise in temperature, which has the effect of varying the crimp characteristics along the length of the yarn when two widely spaced points are compared. It has therefore been found beneficial to provide a means to effect a controlled cooling of the gears in order to maintain their temperature constant so as to effect a uniform crimping action over great lengths of tow. Such a means, as best shown in FIG. 2, may take the form of radial ports **52** formed in one or both of the crimping gears to communicate between the hollow interior and the addendum circle of the gears, which ports cyclically communicate with manifold chamber **54** which, in turn, communicates with a source of cooled air by way of tubing **56**. To effect quenching or setting of the tow after it has departed the crimping gears there is provided a quench chimney **58** supplied with cooling air or other desired fluid by way of branched tubing **60**. The upper extremity of the quench chimney, as viewed in the drawing, is shaped to have opposing concave surfaces intervened by upstanding ears **62** to facilitate a non-entangling, non-jamming take-up of the crimped tow from the crimping gears. By controlling the velocity and temperature of the quenching medium, varying and desirable effects may be obtained.

In the operation of the above described apparatus, the vortex generator is first activated by introducing a source of pressurized air or other fluid to the heater **44**, thence to be exhausted by way of feed tube **50** into the interior of sleeve **18** in a tangential fashion to thereby generate a vortex which may desirably have an axial component. On training a source of tow or yarn over pigtail **42** and through flared end **40** of the sleeve **18**, the action of the vortex will serve to self-thread the tube in sucking the yarn or tow therethrough and exhausting same at the nip of the crimping gears, as best viewed in FIG. 2. As the yarn or tow passes through the sleeve **18** and is subjected to the influences of the heated vortex air or other fluid medium, the material is opened, entangled, and otherwise distorted from its normal internal orientation just prior to being engaged by the crimping gears **12, 14**. It will be appreciated that at the point of engagement of the yarn or tow with the crimping gears, it has been distorted from its normal conformance, to which it will have a tendency to return. However, because of the proximity of the vortex to the nip of the crimping gears, which vortex has disrupted the normal configuration and subjected the yarn to a rapid rise in temperature the yarn has not the opportunity to immediately return to its normal configuration. The dynamics of the situation may best be visualized, though with some sacrifice of accuracy, by considering the tow or yarn to have been urged into a randomly twisted condition, crimped in this condition then allowed to return to its original conformance. After the yarn has passed through the crimping gears, this tendency to return to the normal orientation will result in a three-dimensional crimp by virtue of the substantially sinusoidal crimp imparted by the crimping gears, on the one hand, and, on the other hand, the spiraling of the individual filaments of the tow or yarn in their tendency to return to their normal orientation. The sequence of the spiraling-crimping-unspiraling results in the formation of crimps which come to lie in diverse planes, which type crimp has been found to impart a silkier hand, increased absorption and greater heat insulating powers.

When the crimping gears are in operation, a cooling medium, preferably air, is supplied to manifold **54** to be exhausted through radial ports **52** as the latter cyclically register with the manifold. The exhausting of a cooling medium through the crimping gear or gears in such fashion serves to stabilize the operating temperature of such gears while supplementing the quenching operation primarily performed by the cooling air exhausting downwardly through the quench chimney **58**, which cooling air may be supplied from a source common to that of the manifold **58**, as by way of tubing **56**.

The above described apparatus represents one possible system which may be employed to practice the method of the present invention, which method broadly comprehends the steps of simultaneously heating, opening, fluttering and otherwise deranging the tow or yarn from its normal conformance, subjecting such deranged yarn or tow immediately to the influence of crimping rolls or gears, optionally followed by quenching.

The method of the present invention is applicable to a wide variety of continuous filamentary yarn and tows, it being preferred that the yarn be made from a thermoplastic material, such as a glass or fiber-forming resin, which may or may not be capable of being extended by drawing to induce increased molecular orientation along the filament axis. The yarns may be formed by well known techniques, such as melt or wet spinning. As examples of fiber-forming synthetic polymers which are included in the thermoplastic, fiber-forming resins, there may be mentioned polyethylene, polypropylene, polyurethane, copolymers of vinyl acetate and vinyl chloride, the copolymers of vinylidene chloride and a minor proportion of mono-olefinic compounds copolymerizable therewith, such as, for example, vinyl chloride; homopolymers of acrylonitrile, copolymers of acrylonitrile and a minor proportion of at least one mono-olefinic compound copolymerizable therewith and polymer blends containing combined arcylonitrile in a major proportion; copolymers of vinyl chloride and acrylonitrile; linear polyesters of aromatic dicarboxylic acids and dihydric compounds, such as polyethylene terephthalate and the polyester derived from terephthalic acid and bis-1,4(hydroxymethyl) cyclohexane; linear polycarbonamides such as, for example, polyhexamethylene adipamide, polyhexamethylene sebacamide, polymeric monoamino monocarboxylic acids, such as polymeric 6-amino caproic acid; and other fiber-forming thermoplastic polymers. Mixtures of such fiber-forming synthetic polymers also can be used.

While the present process is suitable for treatment of yarn whose filaments have a normal cross-section, such as that produced where a spinneret having circular shaped orifices is employed during the manufacture thereof, unusual effects may be obtained by processing yarns having a non-circular cross-section or having an axial passage internally thereof in accordance with the present invention. For example, when yarn composed of a plurality of continuous filaments having a body section and a plurality of finned sections or legs integrally joined to said body and radially disposed upon the surface of and extending longitudinally of the body, such as a yarn of X- or Y-shaped cross-section, is subjected to the treatment in accordance with the instant invention, the resulting yarn has increased covering power, resiliency, and a crisp hand. The number of fins may be 2 to 4, or more, and yarns having such fins are prepared by conventional methods, such as by employing a spinneret adapted to produce filaments having the desired number of fins or legs.

Twisted yarn can be as well processed as untwisted yarn. Substantial pretwisting of the yarn is generally unnecessary and, for economic considerations, is preferably avoided. The main consideration to bear in mind is that the yarn, whether of high or low twist, or of substantially zero twist, is, when processed according to the present invention, helically distorted about its longitudinal axis while simultaneously being heated, thence, immediately subjecting such deranged yarn to the action of a crimping means, such as the crimping rolls illustrated in the drawings. The denier of the thermoplastic yarn can vary considerably, as well as the denier of the individual filaments, the ordinary deniers of commercially available yarns being entirely suitable. Yarns having different compositions and deniers can be blended and otherwise combined before being processed to produce novel effects.

The temperature at which the yarn heating means is operated depends upon many factors including the type of yarn, the yarn linear speed, and the construction thereof. The temperature of the yarn should be elevated preferably to a temperature below that at which adjacent filaments will stick during the process. However, the temperature should be sufficiently high so that the yarn will be substantially permanently deformed from its normal, substantially straight condition without undue filament breakage. The temperature to which the yarn is subjected ordinarily will be in the range of 150° C. to 250° C. when nylon 66 is processed, for example. Obviously, the temperature of the fluid medium employed to swirl open and heat the yarn or tow will depend on many factors, such as the denier and speed of the yarn being processed, a temperature range of 1200 to 1300° F. having been found to be most suitable in the great majority of instances encountered.

By employing the above described apparatus and process, one produces a potentially or latently crimped yarn or tow which can be easily changed into a bulked, or highly crimped, stretchable continuous filamentary yarn. "Bulk" refers to the relative volume occupied by a given weight of yarn. Hence, yarn having increased bulk, such as that produced in accordance with the present invention, has greater covering power and warmth. "Crimped" refers to the fact that the filaments contain many crimps, crinkles, curls and the like which bend in and out in a sinusoidal pattern along the length of the individual filaments and which may be in diverse planes, resulting in a three-dimensional crimp made possible by the practice of our invention. "Stretchable" refers to the fact that the yarns produced in accordance with this invention are elastic and have the ability to accept a slight longitudinally applied stretch and thereby to become easily extended a considerable length without permanent deformation. For example, yarn treated according to the present invention can be elongated 10 percent to 100 percent or more from its untensioned or relaxed length and immediately recover from this elongation in the nature of a so called "stretch-yarn." It is preferred for some end uses to develop the potential crimpability of the yarn after same has been converted into a textile fabric or other article. For instance, the stretched and deformed yarn, prior to the final heat treatment, may advantageously be tufted into a carpet followed by the heat treatment. The tufts of yarn disposed on the face of the carpet will bulk to a notable extent, thereby imparting more luxurious appearance to the carpet. In such a manner, the potential crimpability in the yarn which is on the back of the carpet and in the backing material, being that it is tightly held at these points, will not be as fully developed, thereby providing an overall more economical utilization of the yarn. It will be noted also that the tufting operation is made more convenient when the crimp is subsequently developed.

Obviously numerous modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

What is claimed is:

1. A method for texturizing continuously running lengths of thermoplastic, filamentary tow to impart a three-dimensional crimp of improved uniformity thereto comprising the steps of passing said tow through a heated fluid vortex to thereby simultaneously heat and momentarily distort said tow, immediately gear-crimping said tow while in such momentary distorted condition.

2. A method of texturizing continuously running lengths of thermoplastic, filamentary tow to impart a three-dimensional crimp of improved uniformity thereto comprising the steps of passing said tow through a heated fluid vortex to thereby simultaneously heat and impart a momentary lateral and helical distortion to said tow, immediately gear-crimping said tow while in such momentary distorted condition, quenching and relaxing said tow.

3. The method as defined in claim 1 wherein the gear crimping step is further characterized by temperature stabilization of the crimping gears.

References Cited by the Examiner

UNITED STATES PATENTS

2,668,430	2/1954	Laros	28—72
2,668,564	2/1954	Laros	28—72
2,972,798	2/1961	Stanley et al.	28—72
3,041,706	7/1962	Bromley et al.	28—1

FOREIGN PATENTS

862,?14	3/1961	Great Britain.

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