

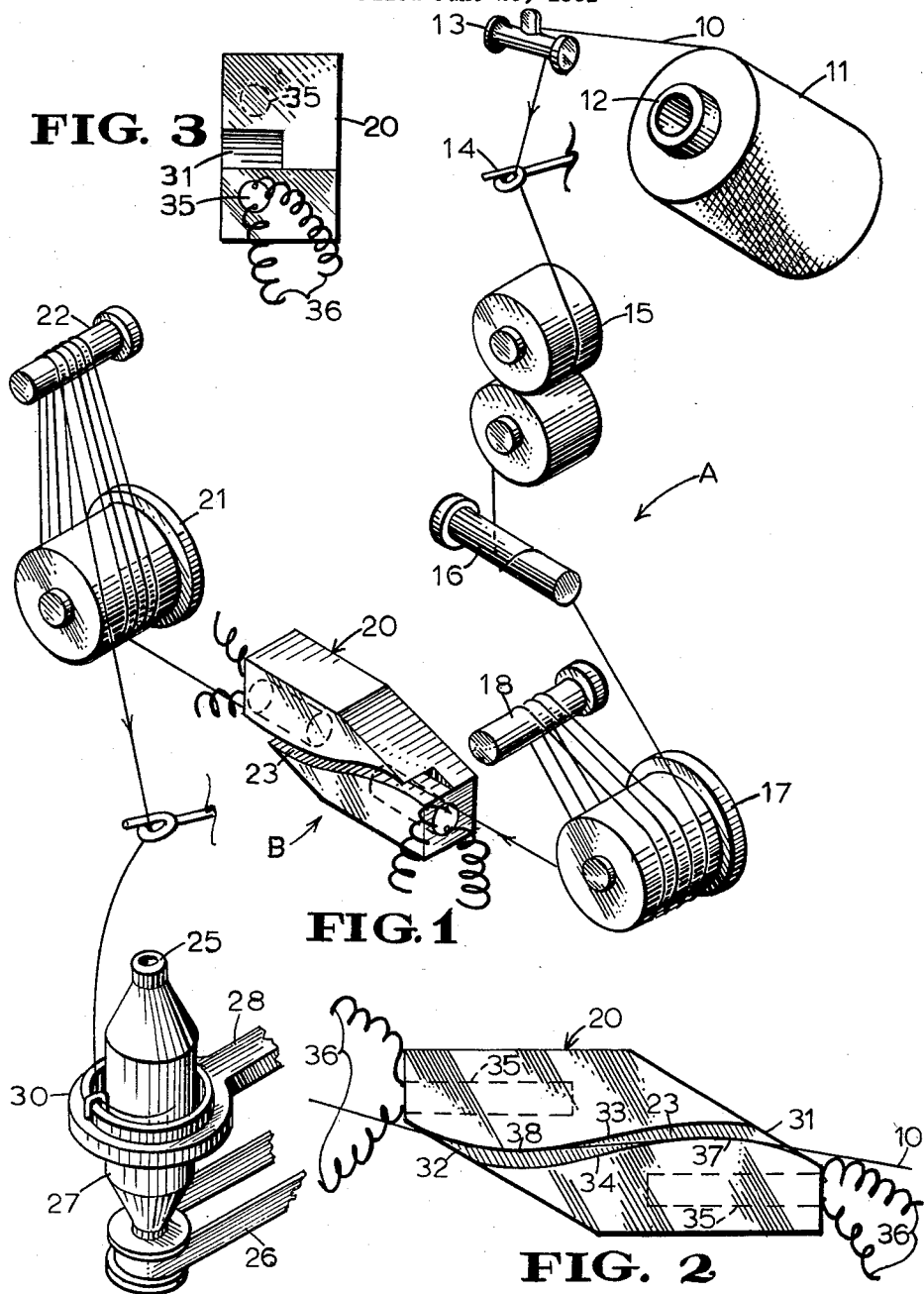
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PROCESS AND APPARATUS FOR HEATING AND STRETCHING FILAMENTS

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PROCESS AND APPARATUS FOR HEATING AND STRETCHING FILAMENTS

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6 Claims. (Cl. 18-3)

This invention relates to a process and apparatus for treating synthetic thermoplastic continuous filament yarn. More particularly, the invention relates to a process and apparatus for heating and stretching synthetic thermoplastic continuous filament yarn such as nylon and the like to improve the physical properties thereof.

Nylon filaments have made a substantial penetration into the tire cord market and other end uses, wherein high tenacity is a demanded property. In conventional production of nylon filaments, spun filaments are stretched in order to orient the molecules thereof more uniformly in the direction of the long axis of the filaments and thereby to increase greatly the strength of the filaments. Normally, stretching of the filaments is accomplished by delivering the filaments at a first rate of speed by feed rolls to a stretch zone in which a draw pin or the like is positioned. The filaments are withdrawn from the stretch zone by means of draw rolls at a speed greater than the speed at which the filaments are delivered, whereby the filaments are caused to be stretched. The purpose of the draw pin is that the pin tends to localize the point of necking down of the filaments, resulting in more uniformly drawn yarn.

A drawback to the use of conventionally drawn nylon filaments in the construction of nylon cord-containing tires for motor vehicles was the tendency of such tires to change undesirably in size during normal use conditions. To minimize this drawback and to meet the increasing demands for higher tenacities "hot-stretch" processes and apparatus have been developed and used commercially during the past few years. Various arrangements have been proposed for thermally conditioning synthetic thermoplastic filaments during the drawing thereof to impart higher tenacity thereto.

It has been suggested that the yarn be heated radiantly by passing the yarn in close proximity to a heat source. While the use of radiant heat may result in less heat degradation to the filaments, bundles of filaments produced for tire cords have such a high total denier that they cannot be heated properly by the radiant method. This is due to the fact that the heat will not penetrate the threadline as much as would be desired at the currently high production speeds. Hence, in conventional "hot-stretch" processes, yarns of high total denier are passed during stretching across the surface of a heater in direct contact therewith. Since the yarn is under considerable tension, the direct contact with the heater surface tends to flatten out the yarn so that a higher rate of production and quicker heating can be attained. The heater surface can be curved, and advantages have been predicated on the use of a heater having a convex contact surface. Unfortunately, the hot-stretch procedures employed heretofore, wherein yarn is brought into direct contact with the heater, have resulted in an undesirably high frequency of breakage of the individual filaments, as well as breakage of the whole threadline. Obviously, in the direct contact method, the filaments are heated on one side only, resulting in a temperature gradient across the filaments. This temperature gradient is believed to set up internal stresses in the filaments, resulting in poor drawing characteristics and yarn quality. Moreover, when a large threadline is brought in contact with the known heaters, some of the filaments in the threadline may not contact

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the heater surface even though the filaments are under considerable tension. Hence, it would be desirable to provide a hot-stretch procedure for processing a large bundle of synthetic thermoplastic filaments wherein temperature gradients across the filaments and uneven temperatures between filaments are minimized.

It is one object of the present invention to provide a process and apparatus for treating synthetic thermoplastic filaments.

Another object of the present invention is to provide a method of heating synthetic thermoplastic filaments while they are being stretched so that the individual filaments are more uniformly heated.

Still another object of the present invention is to provide an apparatus for heating and stretching a bundle of synthetic thermoplastic filaments, whereby the individual filaments are more uniformly heated.

Other objects may become apparent from the following detailed description of the invention.

In general, the objects are accomplished by applying heat to more than one side of the yarn being heat-stretched, thereby improving the quality of the yarn. In accordance with the invention, synthetic thermoplastic filaments capable of being molecularly oriented are fed longitudinally to a heat-stretch zone and are withdrawn therefrom at a predetermined increased rate in a conventional manner, whereby the filaments are attenuated and heated therein. In the said zone, the traveling filaments are passed in contacting engagement with a yarn heater having a serpentine heater surface arranged so that one side of the filaments and then the opposite side of the filaments are sequentially heated by surface engagement with the heater surface.

One form of apparatus for processing the filaments in accordance with the invention includes suitable means for supplying synthetic filaments capable of being molecularly oriented to a heat-stretch zone and suitable means for withdrawing the filaments from the zone at a predetermined increased rate, whereby the molecular orientation of the filaments along their axes is increased. Disposed in the yarn path between the supply means and withdrawing means is a yarn heater block having spaced apart walls defining a serpentine yarn passageway extending through the block which is adapted to receive the filaments. One side of the filaments normally progressing through the block and then the other side of the filaments are sequentially heated by surface engagement with the surface of the walls of the block. Means for heating the block to a predetermined elevated temperature is provided.

The invention is further illustrated by reference to the accompanying drawing wherein:

FIGURE 1 is a schematic view in perspective with principal parts in location illustrating one arrangement of apparatus for stretching synthetic thermoplastic filaments in two stages, wherein the filaments are heat-stretched in the second stage employing the novel yarn heater block;

FIGURE 2 is a side elevational view of the heater block per se, illustrating how the filaments can be heated efficaciously on one side and then on the other; and

FIGURE 3 is a right end view of the heater block.

In FIGURE 1 yarn 10 to be stretched and composed of a bundle of smooth substantially parallel filaments that have not been fully oriented is supplied from a yarn source. The yarn source can be, for example, yarn package 11 previously doffed from a conventional spinning machine. However, the yarn can be supplied directly from the spinning machine without an intermediate take-up. Yarn 10 is passed over and around one end of bobbin 12 or other yarn holder. The yarn 10 is threaded conventionally around snubbing bar 13 which functions as a simple, uncomplex tensioning device to assist in

maintaining an orderly and uniform supply of yarn. From the tensioning device yarn 10 is passed through a yarn guide 14, if needed, and then to a rotatably arranged thread advancing means 15 that is adapted to supply yarn to the first stretch zone A at a first delivery speed. Means 15 can comprise a pair of feed rails, at least one of which is positively driven. The rolls engage each other to nip the yarn sufficiently. From thread advancing means 15 the yarn 10 is led downwardly and around a snubbing pin 16 or like snubbing means. Preferably, the pin is mounted to be non-rotative and has a smooth yarn contact surface made of resistant to wear material.

After being passed around pin 16 a desired number of times, the yarn 10 is directed around rotatably mounted feed roll 17 and its separator roll 18 which is freely rotatably mounted. Roll 17 is positively driven at a peripheral speed such that the yarn is given a predetermined stretch between the roll 17 and means 15 which define the stretch zone A. Roll 17 also functions to feed the yarn to a heat-stretch zone B. It will be understood that the arrangement of apparatus for stretching the yarn in zone A is well known and such arrangement is shown to illustrate a preferred means for stretching the yarn before it is hot-stretched employing the novel yarn heater of the present invention. Obviously, other arrangements of apparatus can be used to stretch the yarn in the first zone. The situation may arise where the yarn need not be pre-stretched before it is processed in accordance with the present invention. However, for producing nylon filaments having excellent properties for use in the construction of tires, the arrangement of apparatus for stretching the yarn in zone A can be used to an advantage.

A heater block 20 providing a source of dry heat for raising the temperature of the yarn while it slides across heated surfaces of the block is disposed in the yarn path between roll 17 and roll 21. The yarn is led around the periphery of roll 21 and its associated roll 22. The peripheral speed of roll 21 is faster than the peripheral speed of roll 17 so that the yarn is stretched a predetermined amount therebetween in the stretch zone B. The block which will be described with more particularity below has a serpentine yarn passageway 23 through which the yarn progresses. As illustrated, the passageway is S-shaped, providing two points of inflection, although the passageway may be shaped so that three, four or more points of inflection are provided. Preferably, the exit convex surface of block 20 is positioned with respect to roll 21 so that the last heated side of the yarn will be the side of the yarn that engages the periphery of roll 21. Quickly cooling the last heated side of the yarn by bringing it into engagement with roll 21 maintained at a temperature notably less than that attained by the yarn results in improved drawing performance of the yarn.

After being heat-stretched, the yarn is taken up in a conventional manner by a suitable form of a package building apparatus such as a ring twisting assembly which comprises a bobbin 25 adapted to be rotated by a driven belt 26 to form a package 27. The assembly further includes a vertically reciprocated ring 28 carrying a traveler 30 adapted to revolve freely around bobbin 25 as the yarn is twisted a desired amount and wound thereon.

With reference now to FIGURES 2 and 3, the heater block will be discussed in greater detail. The block is fixedly mounted, preferably in the position indicated in FIGURE 1. The block can be constructed from a variety of materials and can be of various shapes. The block can be constructed of a suitable metal, alloy of metals, plated metal, bonded ceramic and the like. The important consideration is that the yarn contact surface of the block be made of a resistant to wear material and will conduct heat to the yarn efficiently at the temperature employed. As illustrated, the block has a yarn passageway 23 having an entrance 31 and an exit 32. Walls 33 and 34 are spaced apart, present flat surfaces, and are curved together so that the passageway turns one way

and then the other a plurality of times. As shown, the block is provided with two electrically energizable heater elements 35, electrical power being supplied thereto through conductive lines 36 connected with a suitable source of electricity. The elements can be removable cartridges or inserts as shown or they may be permanently embedded in the block. For convenience of lacing-up, passageway 23 is open on one of the long sides so that it assumes the form of a slot.

As can be seen, one side of yarn 10 contacts a first curved surface 37 so that the yarn is heated and assumes the path of the surface. The yarn is removed tangentially from the first curved surface and passed in a substantially straight line without contacting the heated surface. While in the unbent form, the yarn is radiantly heated since it is still within the heated passageway. Next, the yarn contacts a second heated surface 38 curved inversely with respect to the first curved surface. Thus, the side of the yarn opposite to that which engaged the first curved surface engages the second curved surface, the yarn being heated and assuming the path of the second curved surface. Therefore, one side of the yarn and then the opposite side of the yarn are sequentially heated in the heat-stretch zone B by alternate surface engagements with the curved surfaces.

The method and apparatus of the present invention is applicable to a wide variety of continuous filament yarns. The yarns can be formed by known techniques from synthetic fiber-forming thermoplastic resins. Examples of such resins are polyethylene; polypropylene; polyurethanes; copolymers of vinyl acetate and vinyl chloride; the copolymers of vinylidene chloride and a minor proportion of mono-olefinic compounds copolymerized therewith, such as, for example, vinyl chloride; homopolymers of acrylonitrile, copolymers of acrylonitrile and a minor proportion of at least one mono-olefinic compound copolymerized therewith and polymer blends containing combined acrylonitrile in a major proportion; copolymers of vinyl chloride and acrylonitrile; linear polyesters of aromatic dicarboxylic acids and dihydric compounds, such as polyethylene terephthalate and copolymers derived from terephthalic acid and bis-1,4 (hydroxymethyl) cyclohexane; modifications of such polyesters; linear polycarbonamides such as, for example, polyhexamethylene adipamide; polyhexamethylene sebacamide, polymeric monoaminomonocarboxylic acids, such as polymeric 6-amino caproic acid; and other fiber-forming polymers. The invention is applicable particularly for treatment of polycarbonamide yarns generically referred to as nylon yarns.

The present process and apparatus is suitable for treatment of yarns whose filaments have circular or non-circular cross sections. Twisted yarn, as well as untwisted yarn, can be processed. The denier of the yarn, as well as the denier of the individual filaments, can be of any suitable range. However, yarns of heavy total denier can be processed by the present invention to a significant advantage over other known procedures. The temperature at which the yarn heater block is operated depends upon many factors including the type of yarn, the yarn speed, etc.

It is seen that there are many advantages associated with the present invention. Heavy denier yarn can be evenly heated throughout the threadline, as well as throughout the individual filaments, although the yarn moves through the heater block at a rapid rate. Yarn can be heat-stretched in a manner to provide high tenacity yarn of high quality suitable for reinforcing rubber articles. Other advantages can be noted.

Any departure from the description herein that conforms to the spirit of the invention is intended to be included within the scope of the following claims.

What is claimed is:

1. In a process for treating synthetic filaments capable of being molecularly oriented comprising the steps of

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longitudinally feeding said filaments to a heat-stretch zone at one rate of speed, withdrawing said filaments from said heat-stretch zone at a predetermined increased rate of speed to attenuate said filaments therebetween, contacting one side of said filaments within said heat-stretch zone against a first heated curved surface so that the filaments are heated at said one side thereof and assume a path of the first curved surface, removing the filaments tangentially from the first curved surface and passing the filaments in a substantially straight line into tangential engagement with a second heated surface curved inversely with respect to said first curved surface, contacting the side of the filaments opposite to said one side thereof against the second curved surface so that the filaments are heated and assume a path of the second curved surface, removing the filaments tangentially from the second curved surface and passing the filaments to the withdrawal point thereof, whereby said one and said opposite side of the filaments are sequentially heated in said heat-stretch zone.

2. The process of claim 1 wherein the synthetic filaments are nylon filaments.

3. The process of claim 2 wherein the nylon is nylon 66.

4. The process of claim 2 wherein the nylon is nylon 6.

5. Apparatus for heating and stretching synthetic filaments capable of being molecularly oriented comprising,

(a) means for forwarding the synthetic filaments from a source of supply thereof to a heat-stretch zone at one rate of speed,

(b) means for withdrawing said synthetic filaments from said heat-stretch zone at a predetermined increased rate than said one rate whereby the molecular orientation of said synthetic filaments along their axes is increased,

(c) a filament heater block disposed in the filament path between said means for forwarding and means for withdrawing said filaments,

(d) said heater block being adapted to be heated and provided with a continuous inversely curved slot defined between spaced upper and lower walls and extending outwardly of said block along one side thereof to provide an opening permitting in-

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sertion and lacing of said filaments therein so that the filaments travel sequentially into contact with said upper and said lower walls defining said curved slot to positively effect uniform heating of the filaments directly at one and the opposite sides thereof while the filaments are simultaneously being stretched.

6. Apparatus for heating and stretching synthetic filaments capable of being molecularly oriented comprising,

(a) means for forwarding the synthetic filaments from a source of supply thereof to a heat-stretch zone at one rate of speed,

(b) means for withdrawing said synthetic filaments from said heat-stretch zone at a predetermined increased rate than said one rate whereby the molecular orientation of said synthetic filaments along their axes is increased,

(c) a filament heater block disposed in the filament path between said means for forwarding and means for withdrawing said filaments,

(d) heater means connected to a source of electrical energy and embedded within said heater block for heating the latter,

(e) said heater block having a continuous curved slot with one bend and an inverse bend defined between a flat upper and a flat lower spaced block wall and extending outwardly of said block along one side thereof to provide an opening permitting insertion and lacing of said filaments therein so that the filaments travel from said flat lower wall of said one bend and then substantially longitudinally into contact with said flat upper wall of said inverse bend before moving to said withdrawing means to positively effect uniform heating of the filaments directly at one and the opposite sides thereof while the filaments are simultaneously being stretched.

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