June 25, 1963 J. C. DEELEY ETAL 3,094,834

APPARATUS FOR SIMULTANEOUSLY STRETCHING AND FALSETWISTING YARN

Filed June 27, 1960

FIG. 1.

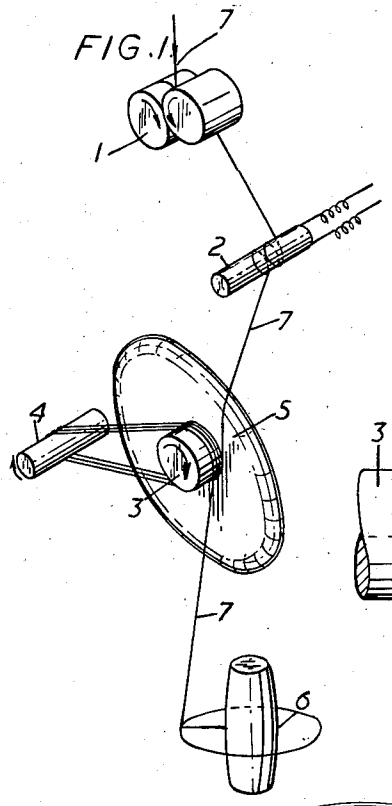


FIG. 2.

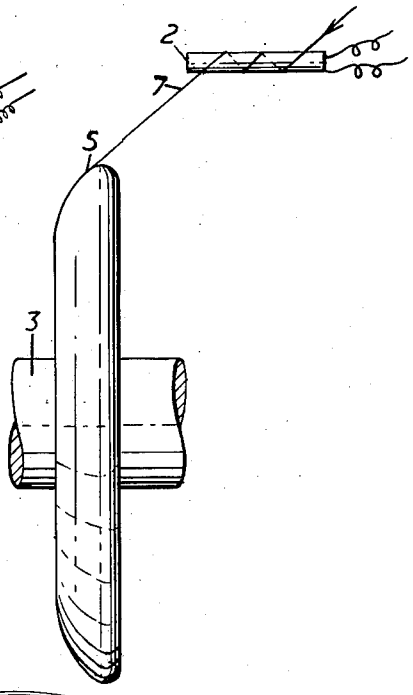
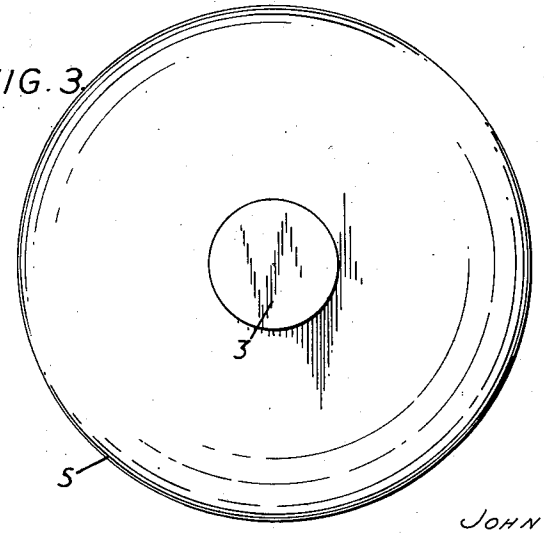


FIG. 3.



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United States Patent Office

3,094,834

Patented June 25, 1963

3,094,834

APPARATUS FOR SIMULTANEOUSLY STRETCHING AND FALSETWISTING YARN

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Filed June 27, 1960, Ser. No. 39,037
Claims priority, application Great Britain July 3, 1959
3 Claims. (Cl. 57—55.5)

This invention relates to crimped yarn and more particularly to yarn crimped by means of setting a twist therein and to processes for the manufacture thereof.

The present yarn consists of continuous filaments and is composed of a synthetic linear polymer, for example, a polyamide or a polyester. The filaments may consist wholly of polyhexamethylene adipamide, but other synthetic linear polymers may form the material of the filaments, for instance, polyureas, e.g. polyhexamethylene urea, polyurethanes, e.g. polybutylene glycol hexamethylene dicarbamate, polyesters, e.g. polyethylene terephthalate, stereo-specific polyolefines, e.g. polypropylene, or the following polyamides namely, polyhexamethylene sebacamide, poly-kappa-aminoundecanoic acid, poly-epsilon-caprolactam. The yarn of the present invention may include filaments of other textile material besides synthetic linear polymers provided that the latter constitute at least the major proportion of said yarn.

Yarn consisting of synthetic linear polymer filaments, for example, a polyamide yarn made of polyhexamethylene adipamide, possesses many properties eagerly sought for textile purposes and, in particular, a high degree of strength expressed as the tenacity at the point of rupture. Such yarn is accordingly manufactured commercially on a large scale, the high tenacity being attained by submitting the filaments to a process of drawing while they are in the solid state, a process frequently referred to as cold-drawing. Thus the filaments, in their undrawn condition after being solution-spun or melt-spun from the required polymer, are elongated in the solid state, commonly by passage between two pairs of rolls, the second pair revolving faster than the first. Between the rolls the filaments may, if desired, pass round a snubbing pin so as to locate the point at which drawing takes place.

For many uses the yarn is required in a crimped condition, and one known method of crimping comprises setting the yarn by heat while in a false-twisted condition. It has furthermore been proposed to make crimped yarn by taking synthetic polymer yarn in its undrawn condition, i.e. as spun, and false-twisting and drawing it simultaneously while hot. In this way the yarn is elongated while temporarily twisted and at a raised temperature, and when the tension is released, the filaments become crimped or curled. The yarn then possesses a pleasant fullness. Thus, the filaments after being drawn while hot and in a false-twisted state, have become potentially crimpable, which is defined as meaning that they will assume a crimped configuration on being relaxed. The process of relaxation or crimping may be promoted by the application of heat.

Whereas sundry forms of false-twisting apparatus are known, a novel method of inserting the false-twist during the drawing process has now been found, which is at once simple and effective. The present method and apparatus comprises employing a draw roll provided with a flange and causing the yarn, as it approaches the draw roll, to rub against the flange, which rapidly rotates the yarn, and is most effective in imparting a false-twist thereto, so that the yarn is drawn while in an intensely false-twisted condition, and subsequently relaxing the yarn.

Accordingly this invention relates to a process and apparatus for the production of crimped yarn, comprising

drawing undrawn or incompletely drawn synthetic linear polymer multifilament yarn between a feed roll and a draw roll provided with a flange, the yarn being heated and guided on to the flange of the draw roll in a direction making an acute angle with the axis thereof whereby the yarn makes frictional contact with said flange, which has a contour constituting a surface of rotation generated and defined by a curved geodesic line connecting the points at which the yarn makes and breaks contact therewith, and which rapidly rotates the yarn about the axis thereof, imparting false twist to the hot yarn and making it potentially crimpable as hereinbefore defined, and subsequently relaxing the yarn in order to crimp it.

The invention includes the potentially crimpable yarn made as described above, and its conversion into crimped yarn before or after fabrication into fabric or textile articles by weaving or knitting. The invention also comprises crimped yarn made by the above process and textile articles knitted or woven therefrom.

Thus, the operation of weaving or knitting may be conveniently carried out on the potentially crimpable yarn and the crimp developed by relaxing the resulting fabric or textile articles made therefrom by boiling in water. The employment of the yarn in the potenatially crimpable but uncrimped state in this way has the advantage that the action of the textile machinery is not impeded by the presence of the crimps. Nevertheless, it is desirable that the fabric structure be of a loose or open character, otherwise the development of the crimps in the fabric will be prevented or hindered.

The undrawn or incompletely drawn yarn employed as starting material should preferably possess no or only a low twist, so that the aforesaid term "yarn" is to be understood to include twistless yarn.

Preferably in the present process the yarn is passed round a snubbing pin positioned between the feed roll and the draw roll. In this case the false-twisted portion of the yarn extends from the draw roll and flange to the snubbing pin.

Any suitable external source of heat may be employed for heating the yarn. For example, the snubbing pin (if used) may be heated, or the yarn may be caused to run over a hot plate. Some other means for heating the yarn are hot nitrogen, steam, infra-red radiant heat, hot molten metal or a high frequency electrical field. It is evident that the temperature reached must not be so high as to melt the polymer, and the melting points of the polymers already mentioned above are therefore now quoted as a guide:

	°C.
Polyhexamethylene adipamide	248
Polyhexamethylene urea	270
Polybutylene glycol hexamethylene dicarbamate	178
Polyethylene terephthalate	255
Stereospecific polypropylene	165
Polyhexamethylene sebacamide	209
Poly-kappa-aminoundecanoic acid	187
Poly-epsilon-caprolactam	214

If desired, the heat treatment of the yarn may take place while a swelling agent for the polymer is present. To obtain a given degree of setting of the deformations, a lower temperature is normally needed when a swelling agent is employed. Examples of swelling agents for use with polyhexamethylene adipamide are water, steam, aniline, and alcohols such as methyl alcohol, ethyl alcohol, isopropyl alcohol, glycol, glycerol.

While under normal conditions of working, the draw roll is sufficiently cool for the success of the present process, the draw roll and/or the yarn in the neighbourhood of the surface thereof may be deliberately cooled, if desired, for example, by a jet of cold air directed thereon, or by circulating cooling fluid within the draw roll. The

importance of the temperature of the yarn at that portion thereof where the false twist is no longer present (i.e. on the draw roll) lies in the fact that the deformations already set in the yarn could be annihilated under the influence of sufficient heat and tension.

The feed roll or the snubbing pin (if used) may conveniently be offset with reference to the draw roll so that the yarn approaches the flange making an acute angle with the axis thereof. The necessary acute angle may also be obtained by suitably directing the yarn by guides. Provided that this angle be not so small as to incur the risk of breaking the yarn, it has been observed that in general, the smaller the angle, the better the quality of the resulting crimp. The greater the diameter of the flange, the higher the maximum peripheral speed where it makes contact with the yarn, and consequently the greater the possible degree of false-twist.

The flange may be fabricated of any convenient material capable of withstanding abrasion, as far as possible, while yet apt to gain a grip on the yarn so as to diminish slippage. The following materials for instance, may be quoted: glass, ceramics, vulcanite, polyamides, polyurethanes, for instance, polybutylene glycol hexamethylene dicarbamate, alumina, Carborundum, stainless steel, but the optimum degree of smoothness (or roughness) of the surface depends on the substance chosen. Resilient materials are particularly effective for this purpose. Thus, natural and artificial rubbers and other elastomers are very useful, e.g. polybutadiene, butadiene-methyl-methacrylate copolymer, polychloroprene, butadiene-acrylonitrile copolymer, butadiene-styrene copolymer; polysulphide rubbers, e.g. polyethylene tetrasulphide; polymers derived from isobutylene, e.g. polyisobutylene, isobutylene-isoprene copolymers; polyacrylic esters, e.g. ethyl acrylate-2-chloroethyl vinyl ether copolymer; silicones e.g. polydimethyl-silicone. Suitable polyester-urethanes, polyester-amide-urethanes and polyether-urethanes may likewise be employed. Polychloroprene has been found especially effective. The Shore hardness of the elastomer may vary between 55 and 86 but the range 75 to 85 is preferred.

The contour of the flange constitutes a surface of rotation generated and defined by a curved geodesic line connecting the points at which the yarn makes and breaks contact therewith, and accordingly the flange may be either convex, or flat (i.e. conical) or somewhat hollow, since the yarn does not traverse the flange radially but follows an oblique course. It is preferred that the flange be convex.

The flange may be constructed so as to form with the draw roll one piece of material or may be separate, and is conveniently detachable therefrom. When an elastomer is used, this can take the form of a sleeve fitting over a steel flange. The sleeve, for example, a rubber sleeve, may then, when worn, easily be replaced by a new one.

It will be apparent therefore that the present process may readily be carried out on a conventional drawing machine after relatively minor modification thereof comprising fitting a suitable flange. Moreover the presence of the flange does not interfere with the normal method of threading the yarn on to the machine when commencing drawing. Although the speed of drawing may have to be reduced somewhat in order to obtain the best crimped yarn, crimp of acceptable quality may be got at the relatively high speeds of drawing employed commercially.

The process of crimping on relaxation as already indicated may be advanced or hastened by the application of heat, for instance, by submitting the potentially crimpable yarn, after releasing the tension, to the action of hot air and steam. This may be done before or after the potentially crimpable yarn has been twisted and/or converted into a fabric. It is important to note, however, that when this process of crimping is accelerated by the application of heat, the temperature must not be raised too rapidly, especially if the yarn is in the form of a fabric, otherwise the yarn may become set before there has been an opportunity for the crimp to develop. This is because the effect of heat is to set the yarn, as is well-known.

If desired, the tension need not be wholly released when heat is applied to develop the crimp, since it may be preferred to allow the yarn to retract only to a limit extent. This may be conveniently effected by overfeeding the yarn by a prescribed amount as it proceeds from the draw roll to some forwarding nip rolls, provision being made for the yarn to traverse a hot zone situated between the draw roll and the forwarding rolls. Instead of the aforesaid hot zone, the forwarding rolls themselves may be heated.

The heat treatment applied to develop the crimp may thus serve also to set it adequately, or else, a subsequent heat-setting can be applied if desired. In the latter case the crimped yarn produced, or fabric or textile articles, woven or knitted therefrom, are submitted to a setting treatment by means of heat and optionally water or steam or another swelling agent. The effect of swelling agents in reducing the temperature needed for a given degree of setting, has already been noticed. The degree of setting necessary or desirable depends, inter alia, on the finishing or after-treatment, e.g. dyeing, which the filaments are likely or intended to receive.

The crimped yarn of this invention is very suitable for knitting into underwear, or hose, and also for weaving into fabric having an attractive warm full handle. The present process moreover has the advantage that the drawing and crimping of the yarn are accomplished simultaneously in one continuous operation with economy in production costs.

Further objects, advantages and novel features of this invention will become apparent in the specification and claims, taken in connection with the accompanying drawings:

FIGURE 1 is a diagrammatic perspective view of an apparatus according to this invention;

FIGURE 2 is a side elevation view of the draw roll and flange in FIGURE 1; and,

FIGURE 3 is a front elevation view of the draw roll and flange shown in FIGURES 1 and 2.

Reference is now made to the accompanying drawings, wherein there is shown a feed roll **1** and an electrically heated snubbing pin **2** spaced apart therefrom. Mounted below the pin **2** is a draw roll **3** being in a plane generally perpendicular to the snubbing pin **2**, as best shown in FIGURE 2.

There is provided a separating roll **4** axially separated from the axis of the draw roll **3**, the draw roll **3** including a flange **5**. Mounted below the flange **5** of the draw roll **3** is a conventional bobbin for winding the yarn **7**.

The yarn **7**, as best shown in FIGURE 1, is passed once round the feed roll **1**, twice round the snubbing pin **2** and thence to the draw roll **3** with flange **5**. The heated snubbing pin is set off from the draw roll, as can be seen in FIGURE 2, so that the yarn rubs on the flange **5** and has imparted to it a **Z** false twist. The yarn then passes thrice round the draw roll **3** and separator roll **4**, and is wound up on bobbin **6**.

Example 1

The materials used in the above apparatus are as follows:

Feed and draw rolls	Chromium plated steel.
Snubbing pin material	Alumina.
Temperature of snubbing pin	100° C.
Flange on draw roll	Polybutadiene rubber.
Flange hardness	Shore hardness 80.

The yarn used is multifilament polyhexamethylene adipamide yarn containing 34 filaments and possessing a denier of 210 in the undrawn state. The mechanical draw ratio is 3 and the peripheral speed of the draw roll 400 feet per minute. The wind up bobbin revolves 4000 times per minute.

Sundry dimensions appertaining to the draw roll and flange are:

	Inches
Diameter of draw roll	3⅞
Diameter of flange	8
Yarn distance between draw roll and snubbing pin	3
Offset distance between draw roll and snubbing pin	2

The acute angle between the yarn and the axis of the flanged draw roll is thus approximately 48°.

On heating the resulting yarn is water under a low tension an intense crimp developes. For instance, 60 yards of the yarn are wound into a hank on a reel having a circumference of 54 inches. A weight of 3¼ grams is hung on the hank which is 27 inches long as it hangs. On immersing the hank in a water bath at 60° C., its length contracts to 8 inches.

Example 2

Example 1 is repeated but two yarns are used and the apparatus is duplicated, the two draw rolls and flanges being arranged back to back on the same shaft. In this way one yarn acquires a **Z** false twist and the other yarn an **S** false twist. The resulting yarns are doubled together and submitted to a relaxation treatment by passage through a bath of boiling water. A pleasantly crimped yarn is obtained in this way.

Example 3

In this example the conditions of Example 1 are altered as stated below, those conditions which are unmentioned remaining the same.

Snubbing pin material	Chromium plated brass.
Temperature of snubbing pin	165° C.
Flange material	Polychloroprene.
Flange hardness	Shore hardness 86.
Flange diameter	3¾ inches.
Mechanical draw ratio	2½.
Peripheral speed of draw roll	800 ft. per minute.
Yarn distance between draw roll and snubbing pin	5½ inches.
Offset distance between draw roll and snubbing pin	2¾ inches.
Acute angle between yarn and axis of flanged roll	60°.

When relaxed the resulting yarn becomes well crimped. Thus if 120 yards of the yarn be wound into a hank on a reel having a circumference of 54 inches and a 3¼ gram weight hung on the hank, the length thereof, as it hangs, is 27 inches. When plunged into a bath of water at 60° C., the hank contracts from 27 inches to 7.4 inches owing to the development of the crimp.

It is found that the speed of drawing can be increased to 1260 feet per minute with little deterioration in the resulting crimp.

Example 4

Example 3 is repeated except that the speed of the draw roll is reduced to 600 feet per minute and the flange diameter increased to 5¼". A similar crimped yarn results.

Example 5

Polycaprolactam yarn comprising 6 filaments and having a total denier of 342 is drawn by means of the apparatus described in the preamble at a draw ratio of 4.3 and drawing speed of 400 feet per minute over a chromium plated brass snubbing pin maintained at 165° C. The draw roll carries a polychloroprene flange of 3¾ inches diameter and possessing a Shore hardness of 88. The yarn as it is drawn rubs against the rotating flange approaching it at an angle of 45° with the axis thereof and thereby acquires false twist. After relaxation a good crimped yarn is obtained.

Example 6

Stereospecific polypropylene yarn having 6 filaments and a total denier of 78 is drawn in exactly the same way as described in Example 4 except that the draw ratio is reduced to 2 and the temperature of the snubbing pin to 115° C. A yarn with a tight helical crimp is produced on relaxation.

From the foregoing description of the various embodiments of this invention, it is evident that the objects of this invention, together with many practical advantages are successfully achieved. While preferred embodiments of my invention have been described, numerous further modifications may be made without departing from the scope of this invention.

Therefore, it is to be understood that all matters herein set forth or shown in the accompanying drawings are to be interpreted in an illustrative, and not in a limiting sense.

What we claim is:

1. A yarn drawing apparatus comprising means for supporting a yarn package; a feed roll spaced apart from said package; a draw roll including a hub and a convex peripheral flange, said flange surface being defined by a surface of rotation generated by a curved geodesic line connecting the points at which the yarn makes and breaks contact therewith; a snubbing pin spaced apart from said feed rolls and positioned in offset relationship with respect to the plane of said draw roll flange and operative to guide yarn therefrom in contact with said drawn roll flange surface in a direction defining an angle relative to the axis of said draw roll flange which is a maximum of approximately 60°; means for heating the yarn prior to passing the same past said flange surface, the ratio of said hub to said peripheral flange being sufficient to produce a false twist of at least 40 turns per inch.

2. Apparatus defined in claim 1 wherein said yarn heating means is operative to heat said snubbing pin.

3. Apparatus defined in claim 1 wherein said flange is composed of an elastomer having a Shore hardness between 55 and 86.

References Cited in the file of this patent

UNITED STATES PATENTS

2,410,419	Bellezza	Nov. 5, 1946
2,590,374	Brown	Mar. 25, 1952
2,936,567	Russell et al.	May 17, 1960
2,943,433	Van Dijk	July 5, 1960