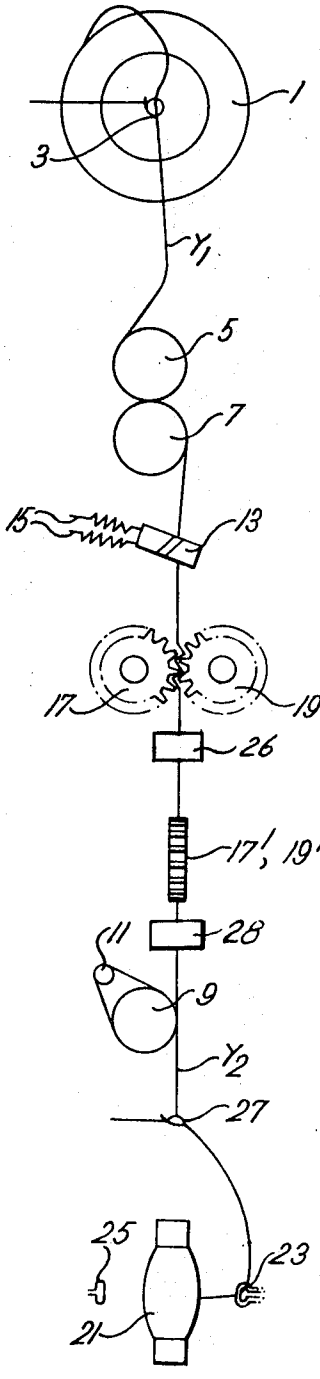
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METHOD OF CRIMPING CONTINUOUS FILAMENT

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METHOD OF CRIMPING CONTINUOUS FILAMENT

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ABSTRACT OF THE DISCLOSURE

Tandem hot gear-crimping, with the gears of the second assembly having differing crimping characteristics, e.g. teeth-per-inch, from those of the first assembly.

This is a continuation of Ser. No. 622,640, filed Mar. 13, 1967, now abandoned.

The present invention concerns improvements in or relating to the crimping of continuous filaments, and in particular concerns the mechanical form of crimping which utilizes denticulated members, such as gear wheels.

The above form of crimping has long been practised on a wide variety of yarns, whether of continuous filaments or of staple fibers; and it represents an essentially simple method by which a generally sinusoidal shape of crimp may be imparted.

It is nevertheless true that the nature of the crimp imparted by, for instance, a simple pair of gear wheels to a continuous filament yarn is not wholly satisfactory, mainly on account of the likelihood that the crimps in adjacent filaments of the yarn will be in register, and the resultant fabric thus have a rather too lean handle.

We have now discovered a method by which a desirable and entirely novel form of bulked yarn may be produced utilizing denticulated members.

According to the invention, continuous filaments are heated while travelling towards a first assembly of denticulated members, the filaments are passed through said first assembly to receive a crimp of a given characteristic, and then the filaments are passed through a second assembly of denticulated members to receive a crimp of a characteristic different from said given characteristic.

Depending on the type of bulked yarn desired to be produced, the assemblies of denticulated members, such as gear wheels, may differ in one or more respects, as for instance diameter, teeth per inch or extent of intermesh. Furthermore, they may be in the same or in different planes; advantageously, the plane of the second assembly being at right angles to that of the first.

Similarly, the assemblies, both of which are preferably positively driven either as to one or both members of the assembly, may be driven at the same or at differing peripheral speeds.

Cooling is preferably effected by a blast of air directed against the continuous filaments from a nozzle positioned between the two assemblies.

The continuous filaments may be heated by contact with a heated member; and, in the presently preferred process, this member will be a heated cylindrical snubbing pin forming part of a drawing means for continuous filaments of synthetic linear polymeric material. The sequence of apparatus in such preferred process will thus be: creel for supply package of undrawn filaments, feed roll (usually unheated), heated snubbing pin, first assembly of denticulated members, nozzle directed to supply cooling air to the filaments more particularly when the denticles of both

assemblies are closely-spaced, second assembly of denticulated members, draw roll (usually unheated), and finally wind-up means, as for instance a ring spindle. It may be desirable to effect some intermingling of the several filaments of a multifilamentary bundle by passing the bundle through an interlacing nozzle, to which air is supplied normally to the direction of travel of the bundle, which nozzle can conveniently be positioned between the draw rall and the winding means.

It is, however, within the scope of the invention to submit already drawn yarn to the action of the two assemblies of denticulated members; and also within its scope to utilize one or the other of such assemblies as the drawing agency for drawing undrawn continuous filaments. Furthermore, the preferred process described above may follow-on directly from an extrusion process for the filaments in question, i.e., the as-spun filaments will be passed directly into the drawing zone, usually by passage around the unheated feed roll driven at the appropriate drawing-off speed for the extrusion process, and without being first wound into a package of undrawn filaments.

The distance between the two assemblies of denticulated members needs sometimes to be selected so as to provide adequate time for any cooling of the hot filaments that may be required to take place between them, at the speed in question. The denticulated members are, themselves, preferably unheated and maintained at constant temperature; and it may be desirable, for the attainment of uniform processing conditions as soon as possible after start-up of the process, to direct cooling air on to one or both assemblies of denticulated members, as well as directly on to the filaments.

It is preferred that the two assemblies shall be driven through gearing from a single source of rotary drive. Continuous filaments have been referred to above, as the invention may be practised on single filaments or on bundles of filaments, whether twisted or untwisted and whether of small or large size. In general, however, the usefulness of the invention is presently seen to exist in the production of bulked yarns of textile sizes.

At appropriate combinations of denticulated members of the gear-wheel type, as to their teeth-per-inch, of circumference, and as to their speed, it is possible to produce the above referred-to novel bulked yarn in which some of the filaments of a multi-filamentary bundle have crimp mainly of one frequency and others have crimp mainly of a different frequency, while the majority have crimp with the one frequency superimposed on the other.

Such novel bulked yarn, which is itself the subject of a co-pending patent application of even date, hereto identified as Ser. No. 622,804, by Barrie Daniels and William Edward Whale, now U.S. Pat. No. 3,468,118 granted Sept. 23, 1969, has the advantage over other known bulked yarns that it is capable of meeting a very wide range of requirements, such as those dictated by handle and appearance. For instance, the dictates of stitch clarity and of fabric bulk in knitted fabric are antagonistic in regard to the number of crimps per inch in a bulked yarn; and thus a bulked yarn, most of whose filaments meet both requirements, is able to be utilized in a wider range of applications than bulked yarn the nature of whose crimp is suited to only one such requirement. In addition, the superimposing of one crimp over the other in the majority of the filaments means that the regularity of crimp normally associated with gear-crimped yarns is destroyed, and a desirably irregular crimp produced, with benefits both to bulk and handle.

In the accompanying drawing, being a diagram of a draw-twisting apparatus in which a continuous filament yarn is drawn and simultaneously crimped, undrawn yarn Y^1 is withdrawn over one end of a supply cylinder 1 of

such yarn, through axial thread-guide **3**, by means of driven feed rolls **5**, **7**, the yarn being laced through the nip of said rolls. The yarn is drawn by extension thereof between feed rolls **5**, **7** and draw roll **9**, with separator roll **11**, which draw roll is rotated at a given higher peripheral speed than feed rolls **5**, **7**. The point of drawing is localized by snubbing pin **13**, around which the yarn is wrapped twice; and heat is supplied to the yarn from said pin which is heated by internal electrical resistances supplied with electric current by wires **15**. Downstream of the snubbing-pin **13** the yarn is crimped by passage through a first assembly of denticulated members **17**, **19** and thence through a second assembly of denticulated members 17^1, 19^1 mounted at right angles to the first assembly. Preferably the crimped yarn is subjected to the action of a gaseous intermingling device **28** downstream from the second assembly of denticulated members **17'** and **19'**. From the draw roll **9**, the drawn yarn Y^2 is wound up on a ring-spindle wind-up comprising balloon-guide **27**, ring **23**, traveller **25** rotating therearound and package **21** mounted on the rotating spindle. As previously noted, cooling air may be supplied to the filaments via nozzle means intermediate the assemblies diagrammatically indicated at **26** in the drawing.

The invention will now be particularly described by the following examples, all relating to multifilament yarns of polyhexamethylene adipamide.

EXAMPLE I

In this example, and following the arrangement shown in the drawing, 50 filament yarn was supplied from a wound package in undrawn state (the denier when drawn being 400) to a feed roll driven at a peripheral speed of 512 feet/minute, thence with two wraps around a cylindrical snubbing-pin heated to 160° C. The yarn then passed through the meshing zone of the first of two 2-gear gear-wheel assemblies, was cooled by a blast of air in the span between that assembly and the second such one and then was passed with 4 wraps around a draw roll (and its separator roll) driven at a peripheral speed of 2000 feet/minute, and was finally wound up on a bobbin by a ring-spindle winding device, the spindle speed of which was 6000 r.p.m. The gear wheels in the two assemblies were of 3.0445 inch outside diameter and they differed as to their teeth-per-inch and their degree of intermesh. The gear-wheels in the first assembly had 38 teeth-per-inch and an intermesh of 0.021 in.; whereas those in the second assembly had 20 teeth-per-inch and an intermesh of 0.037 in. The gears were run at relative speeds so as either to produce yarn in which the crimp was mainly of one frequency or the other or alternatively was of a combination of the two, depending on the particular combination of speeds. Thus, at combinations of speeds within the range 1500–1600 r.p.m., the 38 crimps-per-inch crimp frequency predominated; while at combinations of 1300 r.p.m. and below for the first assembly and 1300 r.p.m. and above for the second, it was the 20 crimps-per-inch crimp frequency which predominated. In a narrow band of speed combinations, viz 1400 r.p.m. for the first assembly, 1600–1700 r.p.m. for the second, it was a combination of the two frequencies which was produced, some few of the filaments having one crimp frequency and some the other, while the majority had a combination of the frequencies, the one superimposed on the other. The best results in this latter respect were obtained when the plane of one assembly of gear-wheels was at right angles to that of the other.

EXAMPLE II

In this example, the undrawn yarn denier was 3630, with 68 filaments in the yarn. The yarn was drawn and crimped in a similar process to that described in Example I, but the feed roll speed was 500 feet/minute and the draw roll speed was 1500 feet/minute. The gear wheels of the first of the 2-gear gear-wheel assemblies had 20 teeth-per-inch of circumference, and those of the second assembly, 5 teeth-per-inch. The crimp and bulk obtained by various combinations of speeds of the two assemblies were as follows:

First gear wheel assembly speed (r.p.m.)	Second gear wheel assembly speed (r.p.m.)	Nature of crimp	Skein lengths L_{60}	Skein lengths L_{10}	Skein lengths $L_{60}-L_{10}$
900	1,100	5 c.p.i. only	17.3	12.5	4.8
1,000	1,100	5 c.p.i. predominating.	17.3	13.5	3.8
1,100	1,100	20 c.p.i. superimposed on 5 c.p.i.	17.0	14.8	2.2
1,200	1,100	20 c.p.i. predominating.	17.3	15.8	1.5
1,300	1,100	20 c.p.i. only	17.5	16.5	1.0
1,100	900	do	17.3	16.5	0.8
1,100	1,000	20 c.p.i. predominating.	17.0	15.6	1.4
1,100	1,200	5 c.p.i. predominating.	18.0	15.8	2.2
1,100	1,300	do	18.0	16.2	1.8

Note: L_{60} and L_{10} designate skein length in inches when the load is 60 grams and 10 grams, respectively.

The tension in the yarn in the span between the gear-wheel assemblies naturally rose as their relative speed changed from a minus to a plus value, the actual values in this example varying from 60 grams to 700 grams. Correspondingly, the tension in the yarn between the second gear-wheel assembly and the draw roll fell by similar values as the speed of the second gear-wheel assembly rose.

EXAMPLE III

In this example, the draw roll was not used, i.e., drawing was performed solely by the gear-wheel assemblies. The speed of the second gear-wheel assembly was set at 1350 r.p.m.; and with the speed of the first gear-wheel assembly varied between 800 r.p.m. and 1400 r.p.m., the crimp and bulk obtained by the various combinations of speeds were as follows:

First gear wheel assembly speed (r.p.m.)	Second gear wheel assembly speed (r.p.m.)	Nature of crimp	Skein lengths L_{60}	Skein lengths L_{10}	Skein lengths $L_{60}-L_{10}$
800	1,350	5 c.p.i. only	18.0	14.5	3.5
900	1,350	do	18.3	14.9	3.4
1,000	1,350	do	18.0	14.8	3.2
1,100	1,350	5 c.p.i. predominating.	18.2	15.4	2.8
1,200	1,350	do	18.0	15.7	2.3
1,300	1,350	20 c.p.i. superimposed on 5 c.p.i.	17.7	16.0	1.7
1,400	1,350	20 c.p.i. predominating.	17.5	16.2	1.3

Note: L_{60} and L_{10} designate skein length in inches when the load is 60 grams and 10 grams, respectively.

Balloon tension of the yarn being wound by the ring spindle wind-up was fairly constant at 60 grams–70 grams: while the tension in the yarn between the two gear-wheel assemblies fell from 820 grams to 370 grams, as the speed of the gear-wheels in the first assembly rose from 800 to 1400 r.p.m.

EXAMPLE IV

3630 denier/68 filament undrawn yarn was drawn on a standard machine to a ratio of 3:1. The drawn yarn was crimped according to the process described in Example I, save that the feed roll was by-passed. The gear-wheels, each of 3 inch diameter had 20 teeth-per-inch and 5 teeth-per-inch in the respective first and second assemblies.

Bulked yarn, having a "skein length" difference ($L_{60}-L_{10}$) of 1.7, was produced, with the 20 crimps-per-inch frequency superimposed on the 5 crimps-per-inch, when the draw roll was driven at 573 feet/minute, and the gear-wheels of the first assembly at 460 r.p.m. and those of the second at 530 r.p.m.

EXAMPLE V

Example IV was repeated, save that no draw roll was used.

Similar bulked yarn was produced with the gear-wheels of the two assemblies driven at 620 r.p.m. and 670 r.p.m., respectively.

Although in the examples the speeds of the respective gearwheels are set so as to be maintained uniform at the given differential, it is within the scope of the invention to vary them cyclically, or intermittently at random or regular intervals, so as to produce different effects in the yarn. Thus, in the former case, bulked yarn can be produced in which the proportion of filaments crimped to either one of the two frequencies or to a combination of frequencies varies continuously along the length of the yarn; and, in the latter case, bulked yarn having intermittent variability of crimp along its length can be produced.

The process of the invention is not limited in its applicability to filaments of nylon, but may be applied to filaments of any material in which the degree and permanence of the crimp is assisted by crimping while the filaments are hot, followed optionally by positive cooling thereof. Such filaments include those of polyester and polypropylene fibre.

We claim:

1. A process for producing a bulked, multi-filament yarn containing filaments which exhibit sinusoidal crimp of different crimp frequencies comprising passing an undrawn, synthetic filament yarn to be crimped from a feed roll to and around a heated draw pin and hence, between a first set of intermeshing rotating denticulated members, rotating said denticulated members at a higher peripheral speed than said feed roll, heating and drawing said yarn at said heated pin, passing said yarn while still heated by said pin between said denticulated members, to impart a crimp frequency thereto, passing said yarn to and between a second set of said intermeshing, rotating denticulated members, imparting a different crimp frequency thereto, withdrawing said yarn from second denticulated members under a drawing tension, said first denticulated members being rotated at a faster peripheral speed than said second denticulated members at such a rate to effect a predominance of the crimp set by the first denticulated members, and taking up a crimped yarn on a package.

2. The process of claim **1** wherein said rotating denticulated members are in different planes.

3. The continuous process as in claim **1** wherein a blast of cooling air is directed against the filaments between the first denticulated members and the second denticulated members.

4. A continuous process as in claim **1** including intermingling the filaments with a gaseous stream following passage of the filaments from said second denticulated members.

5. A process for producing a bulked, multi-filament yarn having filaments which exhibit sinusoidal crimp of different crimp frequencies comprising passing an undrawn, synthetic filament yarn to be crimped from a feed roll to and around a heated draw pin, and hence, between a first set of intermeshing, rotating, denticulated members, rotating said denticulated members at a higher peripheral speed than said feed roll, heating and drawing said yarn at said heated pin, passing said yarn while still heated by said pin between said denticulated members, to impart a crimp frequency thereto, passing said yarn to and between a second set of intermeshing, rotating, denticulated members, imparting a different crimp frequency thereto, withdrawing said yarn from said second set of denticulated members under a drawing tension, said second denticulated members being rotated at a faster peripheral speed than said first denticulated members at such a rate to effect a predominance of the crimp set by the second denticulated members, and taking up a crimped yarn on a package.

6. The process of claim **5** wherein the rotating denticulated members are in different planes.

7. A continuous process as in claim **5** wherein a blast of cooling air is directed against the filaments between said first denticulated members and said second denticulated members.

8. A continuous process as in claim **5** including intermingling the filaments with a gaseous stream, following passage of the filaments from said second denticulated members.

References Cited

UNITED STATES PATENTS

2,326,174	8/1943	Rutishauser.	
3,259,953	7/1966	Baer.	
3,293,843	12/1966	Bibby et al.	28—1.8 X
3,408,717	11/1968	Bryant et al.	28—72.15

FOREIGN PATENTS

718,589	9/1965	Canada.
291,120	5/1928	Great Britain.
759,070	10/1956	Great Britain.

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