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Thom et al.

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[54] **THE MANUFACTURE OF BULKED YARN**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** ..... **264/210 F,** 264/168, 264/176 F, 264/234, 264/290

[51] **Int. Cl.** **D01d 3/10**

[58] **Field of Search** ..... 264/176 F, 168, 210 F, 264/290, 234, 103; 57/140

[56] **References Cited**

UNITED STATES PATENTS

3,636,149	12/1969	Tambini	264/168

FOREIGN PATENTS OR APPLICATIONS

1,034,401	6/1966	Great Britain	264/107
1,046,298	10/1966	Great Britain	264/107
37/7903	7/1962	Japan	264/107

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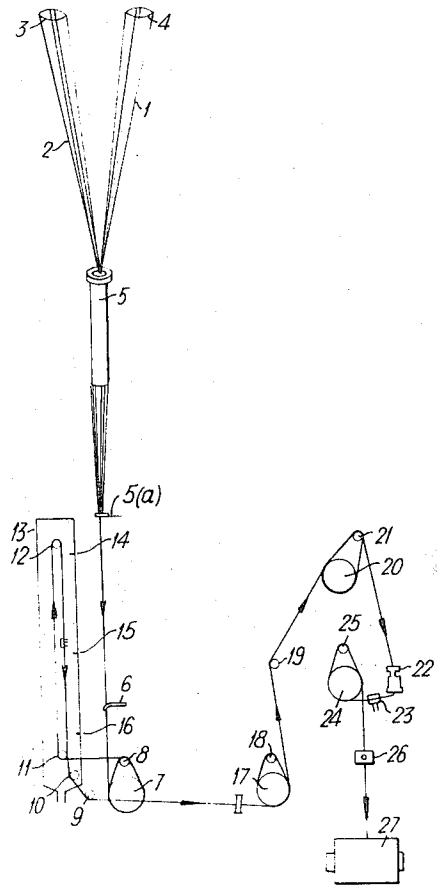
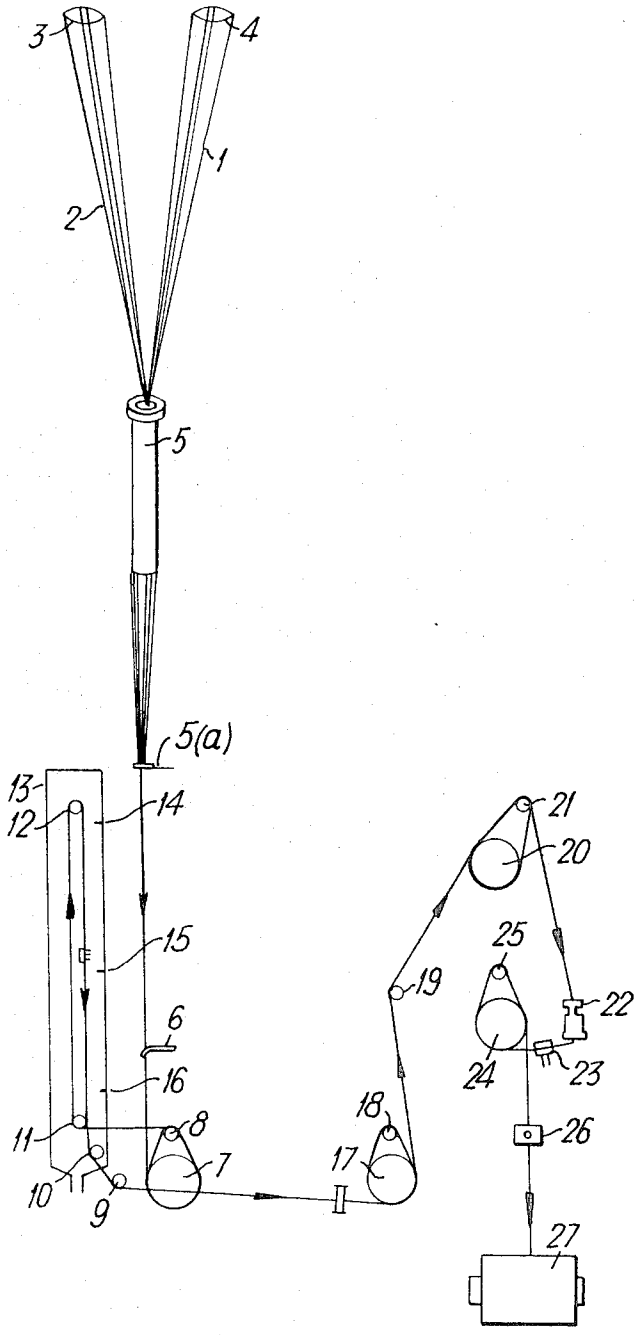
[57] **ABSTRACT**

A process for producing a bulked nylon 6.6 filament yarn by the steps of continuously spinning, drawing and crimping in which the filaments, after melt spinning are subjected to a two-stage steaming process, the second stage of which is for a period of at least 5 seconds maintaining the yarn temperature at at least 55° C and raising the moisture content of the yarn to at least 9 percent. Crimping is performed by a steam injection stuffer-box crimping treatment as described in British Pat. No. 1,034,418. Desirably the yarn is intermingled after crimping and wound up without the insertion of twist.

9 Claims, 1 Drawing Figure

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THE MANUFACTURE OF BULKED YARN

The present invention relates to a process for the manufacture of bulked yarns which comprises melt spinning, drawing and bulking the yarn in a single process, and is especially concerned with the manufacture of bulked polyamide yarns, such as polyhexamethylene adipamide, by this process.

Bulked synthetic filament yarns are commonly produced by melt spinning a plurality of filaments which are wound on to a container, stored for some finite period of time, frequently referred to as the "lagging" time, subsequently drawn to effect molecular orientation of the filaments, rewound on to a bobbin and finally crimped to impart bulk to the yarn by one of several well known processes.

In order to speed up the process and to make it more attractive economically, processes have been developed for spinning and drawing the yarn in a single step. Such a process is, for example, described in British Pat. No. 983,416. In this particular process the as-spun filaments, that is those filaments issuing from the extrusion orifices, are cooled by the transverse blast of air, have a finish applied, treated with steam and then drawn between feed rolls and draw rolls using a snubbing pin to locate the draw point, and finally wound up on to a container.

The so-called spin-draw process does, however, have drawbacks some of which are thought to be related to the absence of the above mentioned period of "lagging" which the filaments normally undergo between the spinning and drawing steps. Various methods for overcoming problems associated with this lack of "lagging" have been proposed. For example, in British Pat. No. 1,034,401 the cooled yarn is forwarded into a steaming chamber where it is treated with a steam atmosphere at a temperature from 30° to 200° C for a period of at least 1 second before being drawn. Preferably after the steaming step the filaments are subsequently passed through a heated space maintained at a temperature of about 60° to 70° C for a time of at least 1 second.

In British Pat. No. 1,046,298 the filaments, after cooling, have a spin finish applied and are then lagged in the undrawn state for a period of about 10 to 60 seconds by repeated passage, for example, over a pair of free-running rollers before being drawn.

It has further been alleged that filaments obtained by the spin-draw process have undesirable surface characteristics. In order to improve these characteristics it has been suggested, in British Pat. No 1,093,871, that after cooling the melt spun filaments are subjected to a steaming treatment at a temperature between the force-to-draw transition temperature and the force-to-draw transition temperature plus 60° C. Such treatment takes no longer than 0.004 to 0.2 seconds.

It has also been proposed, to speed up the process of spinning to obtaining a bulked yarn, to combine the steps of drawing and crimping the yarn. Such a process has been described in British Pat. No. 1,034,418. In this process a drawn yarn is entrained within a conduit by means of a gaseous forwarding fluid, which may be steam, and introduced into a chamber such that the yarn aranges itself in a randomly reversing helical configuration against an accumulated mass of yarn previously forwarded into the chamber, the mass of yarn being continuously discharged from the said chamber.

An obvious next step is to combine together the spin-draw and the draw-crimping processes into a single continuous process. However, when such a process is attempted using, for example, the draw-crimping process referred to above, crimped yarn having an unacceptable degree of bulk is obtained.

We have now found that in order to obtain a satisfactory bulked yarn by combining spin-draw-crimp processes it is necessary to subject the yarn after spinning and cooling to a two-stage steaming process prior to drawing and crimping.

Accordingly, therefore, the present invention provides a process for the manufacture of a crimped polyamide yarn in which the spinning, drawing and crimping processes are performed continuously wherein a polyamide is melt extruded into a plurality of undrawn filaments which are cooled and then subjected to the following series of process steps:

a. A first steaming treatment,
b. A second longer steaming treatment,
c. A drawing stage, and
d. A steam injection stuffer-box crimping treatment.

and finally wound up.

Following the crimping process the yarn is preferably subjected to an intermingling step prior to being would up twist free, for example on a side winder.

The process is preferably applied to the formation of a bulked yarn from polyhexamethylene adipamide.

The first steam treatment is the conventional steam conditioning process used in the manufacture of multifilament polyhexamethylene adipamide yarns by the melt spinning process. The second steam treatment maintains the yarn at a temperature of at least 55° C and raises the moisture content to at least 9 percent. To achieve these effects the yarn is normally required to be treated with steam for at least 5 seconds. For filaments of high decitex longer steam treatments will be required. The steam is preferably saturated but may be superheated, if required, to about 105° C. The use of wet steam should be avoided.

In the second steam treatment the tension in the yarn should be maintained at a level high enough to provide adequate control of the threadline, in the process described hereafter this is achieved by maintaining the tension at at least 0.05 grams/decitex at the start of the treatment, where decitex is the weight of one kilometre of yarn.

The yarn, having been subjected to the preceding steaming processes may then be drawn in the conventional manner, that is between draw and feed rolls, the draw point being located on a snubbing surface lying therebetween and then crimped by a steam jet process such as that described in British Pat. No. 1,034,418. The crimped yarn so produced has a commercially acceptable degree of bulk.

It is preferred that conventional spin finish be applied to the yarn after the first steam treatment and before the yarn is subjected to the longer second steam treatment.

It is believed that the second steaming process further conditions the yarn, since a significant growth in the yarn occurs during such treatment, believed to result from moisture penetrating to the centre of each filament in the yarn. In order to maintain the yarn under sufficient tension to prevent its slipping off rollers or tangling in guides it is preferred that it passes from the steam conditioner over a driven roll to determine the

speed of the yarn and then over a second such roll following the second steam treatment, the said second roll rotating at a higher peripheral speed than the first and also acting as a feed roll to the drawing stage.

The invention will now be more specifically described by reference to the accompanying drawings.

Two bundles of filaments **1** and **2**, each of 2000 dtex and having trilobal cross-sections, obtained by melt extrusion of a polyhexamethylene adipamide polymer through spinnerets **3** and **4**, are cooled and converged into two threadlines at the throat of steam conditioner **5**. The threadlines pass through the conditioner and are then converged into a single yarn at convergence guide **5**(*a*). This yarn then passes over finish applicator **6** to a pair of rolls **7** and **8** round which the yarn makes at least two passes, roll **7** being a driven roll and roll **8** its associated idler roll. These rolls determine the speed of the yarn into the steaming chamber **13** in which the yarn makes a plurality of passes over freely rotating rolls **11** and **12** whilst being subjected to the influence of steam injected through ports **14, 15** and **16** in the sides of the steaming chamber. On leaving the steaming chamber the yarn passes over guides **9** and **10** to a feed roll **17** and associated idler roll **18** round which it makes at least two passes and thence passes round a snubber pin **19** to the draw roll **20** and associated idler roll **21**. From the draw roll the yarn passes to a steam crimping chamber of the type described in British Pat. No. 1,034,418 round a take-out roll **24** and associated idler roll **25** first passing through an air jet **23** which acts to cool and tension the yarn. From the take-out roll the yarn passes to a windup package **27** via an intermingling jet **26**.

In a typical process using polyhexamethylene adipamide as the polymer two 34-filament bundles of yarn are converged to form two threadlines at the throat of the steam conditioner located 60 inches below the spinneret. The steam conditioner being 4 feet long and fed by an orifice 0.056 inches in diameter connected to an 8 p.s.i.g. steam supply. The two threadlines are converged into a single yarn about 12 inches above the finish applicator. A conventional oil in water finish is applied to the yarn at the rate of 18 ml/min and the yarn then passes four times round the draw roll **7** which rotates at a surface speed of about 985 ft/min. The yarn enters the steaming chamber **13** at a tension of 200 g and is taken 10 times around freely rotating rolls **11** and **12**, which are 4.7 feet apart, in a spaced arrangement. A further **12** wraps are then made on a second pair of rolls independent of the first pair but rotating on the same shaft (these rolls not being shown in the drawing). The residence time for the yarn in the steaming chamber is 20 seconds.

The steaming chamber is fed with saturated steam through five orifices (three only **14, 15** and **16** being shown) each of which is 0.18 inches in diameter and connected to a saturated steam supply at 50 p.s.i.g.; the steam jets issuing through the orifices are directed on to the yarn.

Emerging from the steaming chamber the yarn is taken to a feed roll **17** rotating at a 7½ percent higher speed than the draw roll **7** and thence via snubber pin **19** to the draw roll **20** rotating at a speed of 3,600 ft/min. The yarn being drawn at a draw ratio of 3.65.

From the draw roll the yarn enters the steam bulking apparatus **22** under a tension of not less than 30 g and preferably not less than 35 g where it is subjected to high pressure superheated steam (180 p.s.i.g. 280° C) and is removed by the take-out roll **24** after passing through an air jet **23** which tensions and cools it.

The yarn makes a plurality of wraps around the take-out roll and is then wound up on the package **27** after passage through an intermingler jet **26** to form the yarn into a cohesive entity. The wind-up speeds of package **27** is adjusted to give a final yarn tension of about **30** g.

Some physical properties of both the drawn and bulked yarns are given in the table below and compared with a drawn and bulked yarn which had been produced in a similar manner except that the second steaming process had been omitted and a control yarn produced by the conventional spinning and drawing processes and then bulked by the method referred to above.

	Example	Control	Ex. without 2nd steaming process
Extension of 3.7 draw ratio	50%	50%	30%
Draw ratio to give 50% extension	3.7	3.7	3.4
Skein length of bulked yarn	<16"	<16"	17½"

The yarn leaving the steam conditioner **5** has a moisture content of about 1 percent to which is added about 8–10 percent water by the finish applicator. Much of this moisture is lost on the draw roll **7** and the yarn, in consequence, enters the steaming chamber with a moisture content in the order of 5–8 percent. As a result of the steaming process the moisture content of the yarn is again increased to at least about 10 percent, the temperature in the yarn in the chamber being in the order of 55°–60° C. The moisture content after the drawing process is, as a result of drawing, reduced to about 5–8 percent.

Although the residence time referred to above was of the order of 20 seconds a satisfactory result may be obtained with shorter residence times, but below about 5 seconds the process does not run satisfactorily.

The process described above operates satisfactorily with filaments having circular or non-circular cross-sections. Furthermore, the starting polymer may contain conventional additives such as pigments, heat and light stabilisers, antistatic agents and dye assistants, etc.

We claim:

1. A process for the manufacture of a crimped polyamide yarn in which the spinning, drawing and crimping processes are performed continuously, wherein a polyamide is melt extruded into a plurality of undrawn filaments which are cooled and then subjected to the following series of process steps:

a. a first steaming treatment,
b. a second longer steaming treatment of at least 5 seconds,
c. a drawing stage, and
d. a steam injection stuffer-box crimping treatment, and finally wound up.

2. A process according to claim **1** wherein the yarn after the crimping treatment is intermingled and subsequently wound up without application of twist.

3. A process according to claim **1** wherein the polyamide is polyhexamethylene adipamide.

4. a process according to claim **3** wherein the first steam treatment comprises a steam conditioning process.

5. A process according to claim 4 wherein the second steaming treatment is continued for a time such that the yarn temperature is maintained at at least 55° C and the moisture content of the yarn is raised to at least 9 percent prior to leaving the steaming stage.

6. A process according to claim 5 wherein steam is saturated or superheated to about 105° C.

7. A process according to claim 5 wherein the yarn tension at the start of the second steam treatment is at least 0.05 g/dtex.

8. A process according to claim 3 wherein a spin finish is applied to the yarn between the first and second steam treatments.

9. A process for the manufacture of a crimped polyamide yarn in which the spinning, drawing and crimping operations are performed simultaneously, said process comprising: melt-extruding a polyamide into a plurality of undrawn filaments; cooling the filaments; steaming the filaments by exposing them to steam for a period of time up to about 0.2 seconds to raise the moisture content of the filaments to about 1 percent; applying a spin finish to the filaments; passing the filaments at a moisture content of about 5 percent –8 percent to a second steaming treatment of longer duration than the first steaming, said second steaming treatment being carried out for at least 5 seconds to raise the moisture content of the filaments to at least 9 percent and to maintain the filaments at at least 55° C.; drawing the filaments; crimping the filaments by the action of high pressure steam in a steam injection stuffer box; and winding up the filaments.

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