Dec. 14, 1965 J. A. JOLY 3,222,859

CRIMPING OF YARNS BASED ON THERMOPLASTIC POLYMERS

Filed April 19, 1961

FIG.1

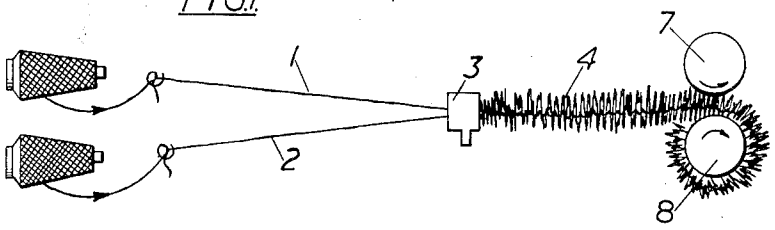


FIG.2

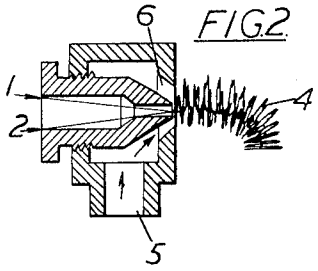


FIG.3

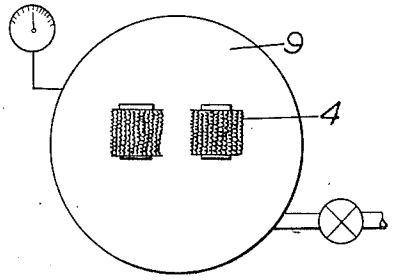
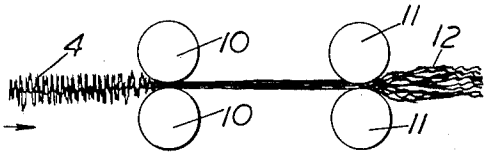


FIG.4



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CRIMPING OF YARNS BASED ON THERMOPLASTIC POLYMERS

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15 Claims. (Cl. 57—160)

This invention relates to improvements in the process of crimping yarns made of or based on thermoplastic polymers.

When the various artificial and synthetic fibres successively appeared on the market, means were sought for imparting thereto an appearance resembling as closely as possible that of wool, by applying a crimp which increased their apparent volume and at the same time gave them a more pleasant handle.

A number of processes have been applied on the industrial scale since synthetic fibres first came to the fore by virtue of their properties of breaking strength, resistance to friction and to biological attack, etc.

The oldest of these processes consists in subjecting continuous thermoplastic filament yarns to an overtwist, thermally setting them and then untwisting them, which sequence of operations may be carried out continuously by using the so-called "false twist" technique. Very high-bulk and highly elastic yarns are obtained, one disadvantage of which is that they possess a twist couple which produces a cockling in the articles produced from these yarns unless an assembly is used of two yarns which have been subjected to the overtwist in opposite directions.

In another process which also gives highly elastic yarns, heated thermoplastic filaments are caused to travel along an acute-angled path, at the apex of which they pass over a knife-edge.

The high elasticity of these two types of yarn, which is desirable in certain applications, proves to be disadvantageous when they are employed in certain articles of clothing, and especially sweaters, in which up to the present wool almost alone has given a satisfactory appearance.

Attempts have therefore been made to limit the elasticity of yarns which have undergone, either continuously or discontinuously, the operations of overtwisting, setting and untwisting by subsequently subjecting them to a thermal treatment under a controlled tension so as to adjust the final degree of elasticity.

A process is known which gives high-bulk yarns having a reduced elasticity and which consists in packing yarns under pressure in a chamber through which a setting agent such as steam is passed. Heretofore, this method has not given sufficiently uniform results, since the yarns treated often exhibit difference in dyeing affinity.

Another process for the preparation of high-bulk yarns consists in passing multi-filament yarns through a current of compressed air actuated with a turbulent movement. This treatment results in the formation of small loops on the individual filaments, rather than a true crimp. If two or more yarns are treated in parallel, it is possible to obtain varied effects by modifying the relative speeds of the yarns in addition to the other conditions of operation. These "textured" yarns include one which is normally called "mock-boucle" yarn, which comprises one or more peripheral yarns forming bunched elongated loops anchored in a substantially rectilinear support yarn.

Of the entire variety of fancy yarns obtained by this latter type of process, there is none which can be compared to wool in its appearance and in its handle.

According to the present invention, at least two yarns are simultaneously subjected to the action of a turbulent

or whirling current of compressed fluid so as to obtain a composite yarn of the mock-boucle type in which at least one of the yarns, hereinafter termed an "auxiliary temporary yarn," constitutes the core of the composite mock-boucle yarn and at least one of the other yarns, hereinafter termed a "peripheral yarn," is crimped or looped about the auxiliary temporary yarn, after which the composite yarn is subjected to a thermal setting and the peripheral yarn or yarns is dissociated from the core yarn and is recovered alone in the form of a crimped yarn. So as to constitute the core of the composite mock-boucle yarn, the auxiliary temporary yarn is fed into the whirling or turbulent gas stream at a lower speed, and preferably much lower speed, than the feed rate of the peripheral yarn or yarns and usually at a speed not much higher than the rate of winding the composite product. The peripheral yarn is made of a heat-settable material.

In a preferred embodiment, the mock-boucle yarn is prepared by the action of a current of a compressible plasticising fluid, for example a current of steam under pressure, in a manner known per se, thus enabling the setting to be dispensed with as a separate operation before the removal of the auxiliary temporary yarn.

The invention may be more readily understood by reference to the accompanying drawings, wherein:

FIG. 1 illustrates schematically the formation of a mock-boucle yarn from a core yarn (or auxiliary temporary yarn) and a peripheral yarn.

FIG. 2 is a vertical cross section through the nozzle used to form the mock-boucle yarn.

FIG. 3 is a diagrammatic representation of the thermal setting of the mock-boucle yarn, and

FIG. 4 illustrates schematically one form of removing the core yarn, namely breaking the core yarn.

Referring to the drawings, the numerals **1** and **2** represent a core yarn and a peripheral yarn which are fed separately and independently to the nozzle **3**, into which a compressed fluid is fed through an inlet **5**. The two yarns and the compressed fluid both emerge from a jet **6** where the turbulence of the fluid causes the formation of a mock-boucle yarn **4**, which is collected by rollers **7** and **8**. If necessary, the resultant mock-boucle yarn **4** is then passed through a heating chamber **9** where the yarn is thermally set. The set mock-boucle yarn is then subjected to a treatment which removes the core yarn, e.g. it is stretched between two pairs of rollers **10** and **11** to break the core yarn, thereby producing the crimped yarn **12**.

The crimped yarn obtained by the present process has various advantages over those hitherto known:

The crimp is random and has no periodicity. There is no danger of crimping "in phase" between two juxtaposed fibres or filaments (in contrast to what often happens when yarns are crimped by packing them in a compression chamber), because the crimp of each fibre is completely different from that of the neighbouring fibre;

The yarn has no residual twist couple and yields articles free from distortion (in contrast to yarns crimped by overtwisting, setting and untwisting).

The process is applicable to all thermoplastic yarns possessing sufficient strength to resist the action of the current of compressed fluid. Such yarns are more especially synthetic yarns based on polyamides, polyesters, polyolefines, polyacrylonitrile and polyvinyl derivatives.

The apparatus used for the production of the mock-boucle yarn is a compressed fluid feed jet of a type known per se. The auxiliary core yarn and the yarn to be crimped are simultaneously introduced from two independent supply rolls. The composite mock-boucle yarn is then wound after having left the jet. The core yarn is supplied at a speed slightly higher (by 5% to 15%) than the winding speed of the mock-boucle yarn. The

yarn to be crimped, which constitutes the peripheral or textured filament of the "mock-boucle" yarn is fed at a speed which may be substantially higher than the winding speed (10% to 5000%).

The choice of the operating conditions affects the fineness of the crimp, the ease with which the yarns can subsequently be separated and the productivity of the process as a whole (this is directly proportional to the speed of supply of the peripheral yarn, which is the yarn to be crimped). Good results have been obtained with feed speeds of 100–400 m./minute in the case of the yarn to be crimped, and winding speeds of 5–30 m./minute for the composite "mock-boucle" yarn. The pressure of the compressed fluid is generally from 4 to 7.5 kg./cm.^{2} in the case of air, but these figures are not to be regarded as limiting. If steam is employed, the productivity of the apparatus is increased, because beyond a certain value high pressures are easier to obtain with steam than with air. With these high pressures it is possible to operate with substantially higher speeds of travel of the yarn.

In choosing the core yarn, account must be taken of the fact that this yarn is not recovered at the end of the treatment and hence, for reasons of economy, the percentage by weight of this core yarn in the "mock-boucle" yarn will be reduced to a minimum. It may be as low as 0.5% to 1%.

If the "mock-boucle" yarn has been prepared by the action of compressed air, it is necessary to subject it to a setting treatment, which may be carried out by any appropriate technique. For example, steaming may be employed at a temperature depending upon the nature of the yarn. If air has been replaced by a plasticising fluid such as steam in this preparation of the "mock-boucle" yarn, subsequent setting is completely unnecessary, thus giving a number of practical advantages. In the first place, it reduces to two the number of separate operations carried out in the production of the crimped yarn. In addition, the elimination of the intermediate steam treatment of the "mock-boucle" yarn also eliminates the risk of yellowing, which is difficult to avoid in the course of a thermal treatment of some duration.

The removal of the core yarn on the dissociation of the core yarn and the peripheral yarn and the recovery of the latter in the form of a crimped yarn, may be carried out by any convenient method. There may be mentioned by way of example:

Dissolving out the auxiliary core yarn (more especially applicable where the core yarn consists of cellulose acetate or polyvinyl alcohol),

Melting of the core yarn when the latter has a relatively low melting point (for example, polyethylene), and

Mechanical methods involving the breaking of the core yarn by stretching, whereby short fibres are formed which can be separated, for example by electrostatic means, or which automatically disappear in the course of the subsequent textile treatments.

The crimped yarn obtained may be used as such for the production of textile articles free from distortion or two or more of these yarns may be assembled, for example by doubling, without any special precautions, to yield yarns having an astonishing resemblance to knitting wool.

If desired, the elasticity of the crimped yarn may be further reduced or may be increased by subjecting it to a thermal treatment with or without tension, according to requirements.

The following Table I summarizes the results obtained in a whole series of tests in which the fluid employed in the preparation of the "mock-boucle" yarn was compressed air. The nature of the yarn to be crimped and of the auxiliary core yarn, as also the operating conditions employed in the production of the "mock-boucle" yarn were varied in accordance with the indications appearing in the table, the abbreviations signifying the following:

P=pressure of the compressed fluid in kg./cm.^{2},
V_{D1}=feed speed of the core yarn in m./minute,
V_{D2}=feed speed of the yarn to be crimped in m./minute,
V_R=winding speed of the "mock-boucle" yarn in m./minute.

With regard to the nature of the yarns treated, the meaning of the abbreviations is as follows:

PA=polyhexamethylene adipamide.
Ac=cellulose acetate.
PP=polypropylene.

The figures appearing after these symbols indicate in each instance the denier of the yarn and the number of filaments.

Table I

Example No.	Material		Preparation of the mock-boucle yarn				Setting (steaming) ° C. and hours	Results	
	Core yarn	Peripheral yarn	P, air	V_R	V_{D1}	V_{D2}		Percent of core yarn before removal	Productions, g./hour per jet
I	PA. 15/3	PA. 70/34	7.5	11.5	12	400	145°—2 h	0.62	186
II	PA. 15/3	PA. 150/46	7.5	20	21	200	145°—2 h	1	200
III	PA. 15/3	PA. 300/92	7.5	20	21	200	145°—2 h	0.50	400
IV	PA. 15/3	PA. 300/20	7.5	10	10.5	100	145°—2 h	0.50	200
V	PA. 15/3	PA. 270/18	7.5	10	10.5	150	145°—2 h	0.40	270
VI	PA. 15/3	PA. 405/27	7.5	28	29	250	145°—2 h	0.40	672
VII	PA. 15/3	PA. 810/54	7.5	20	21	150	145°—2 h	0.25	810
VIII	PA. 15/3	PA. 840/56	7.5	5	5	20	145°—2 h	0.45	112
IX	Ac. 75/24	PA. 300/92	4	20	22	100	145°—2 h	5	200
X	Ac. 75/24	PA. 300/92	7.5	20	22	400	145°—2 h	1.25	800
XI	PA. 20/7	PA. 330/22	7.5	10	10.5	150	145°—2 h	0.40	330
XII	PA. 20/7	PA. 330/22	7.5	28	30	340	145°—2 h	0.50	742
XIII	PA. 30/10	PA. 810/54	7.5	20	21	150	145°—2 h	0.50	210
XIV	PA. 40/13	PA. 840/140	7.5	20	21	200	145°—2 h	0.50	1,120
XV	PA. 15/3	PP. 150/39	6.5	20	20.5	200	140°—2 h	1	200
XVI	PA. 15/3	PP. 150/39	7	30	31	300	140°—2 h	1	300
XVII	PA. 15/3	PP. 150/39	7.5	40	41	400	140°—2 h	1	400
XVIII	PA. 30/10	PP. 300/78	7.5	20	20	300	140°—2 h	0.66	600
XIX	PA. 30/10	PP. 600/156	7.5	20	20	150	140°—2 h	0.66	600
XX	Ac. 75/24	PP. 300/78	7.5	50	51	250	140°—2 h	5	500

The following Table II summarizes the results obtained in a second series of tests in which the "mock-boucle" yarn was prepared by using steam under pressure. Here again, the nature of the auxiliary core filament, the nature of the yarn to be crimped, and the operating conditions employed in the production of the "mock-boucle" yarn were varied (the abbreviations have the same meaning as in Table I). The twists are given in turns per metre.

The "mock-boucle" yarns were taken up in a rotating cylinder, and the winding speed was substantially equal to the speed of travel of the core yarn.

With regard to the nature of the treated yarns, the meaning of the abbreviations is as follows:

PA=polyhexamethylene adipamide.
PVA=polyvinyl alcohol.
PP=polypropylene.

Table II

Example No.	Materials		Preparation of the "mock-boucle" yarn			Results	
	Core yarn	Peripheral yarn	P, steam	V_{D1}	V_{D2}	Percent of core yarn before removal	Production, g./hour per jet
XXI	PA. 30/10, 20 Z	PA. 840/60, 20 Z, trilobal	5	20	200	0.36	1,120
XXII	PA. 30/10, 20 Z	PA. 840/60, 20 Z, trilobal	11	30	300	0.36	1,680
XXIII	PA. 30/10, 20 Z	PA. 840/60, 20 Z	5	30	250	0.43	1,410
XXIV	PA. 30/10, 20 Z	PA. 840/140, 20 Z	5	20	200	0.36	1,120
XXV	PA. 30/10, 20 Z	PA. 840/140, 20 Z, 2 ends	7	20	400	0.09	4,480
XXVI	PA. 30/10, 20 Z	PA. 300/92, 20 Z, 6 ends	7	25	225	0.18	2,705
XXVII	PVA. 35/20, unformalised, 150 S.	PA. 840/60, 20 Z, trilobal, 2 ends.	11	21	400	0.11	4,480
XXVIII	PA. 20/7, 20 Z	PP. 600/40, 5 Z	7	20	400	0.17	1,600
XXIX	PA. 30/10, 20 Z	PP. 540/146, 20 Z	7	20	400	0.28	1,440

The yarn of trilobal filaments used in Examples XXI, XXII and XXVII may be obtained using special spinning jets having Y-shaped holes or having three closely spaced holes, if desired, disposed round a fourth hole (see French Patent No. 1,096,943).

The following Table III summarizes comparative tests carried out on identical yarns, in which the nature and the pressure of the fluid passed through the jet were varied and the yarn to be treated was in each instance supplied at the maximum speed for obtaining satisfactory and comparable results.

The core yarn is in each instance a polyhexamethylene adipamide yarn 30/10, having 20 turns per metre Z-twist, and the peripheral yarn consisted of 2 ends of trilobal yarn based on polyhexamethylene adipamide 840/60–20 turns per metre Z-twist.

Table III

Example No.	Preparation of the "mock-boucle" yarn				Results	
	Nature of the fluid	P	V_{D1}	V_{D2}	Percent of core yarn before removal	Production, g./hour per jet
XXX	Air	7.5	20	200	0.18	2,240
XXXI	Steam	7	20	300	0.12	3,360
XXXII	do	11	20	400	0.09	4,480

Example XXX and XXXI show that the use of steam under a pressure of 7 kg./cm.^{2} instead of air under a pressure of 7.5 kg./cm.^{2} makes it possible to increase the feed speed of the peripheral yarn by 50%.

Example XXXII shows that steam under 11 kg./cm.^{2}, which is no more costly than air under 7–8 kg./cm.^{2}, makes it possible to double the feed speed of the peripheral yarn as compared with the latter.

It is also to be noted that the "mock-boucle" yarn obtained in Examples XXXI and XXXII by the action of steam, in contrast with that of Example XXX, which is treated with air, requires no intermediate setting before separation of the peripheral yarn from the core yarn.

I claim:

1. Process for the production of crimped yarns of thermoplastic polymers which comprises passing a first yarn and a second yarn through a compressed fluid feed jet, the said first yarn being of a thermoplastic polymer and being fed at a rate greater than said second yarn, the said first yarn and second yarn being subjected in the compressed fluid feed jet to the action of a turbulent fluid, thereby producing a composite mock-boucle yarn in which the said first yarn constitutes a peripheral yarn in which the individual filaments have a random, non-periodic crimp and the said second yarn constitutes a core yarn; and, after setting the crimp in the said peripheral yarn, removing the core yarn, leaving a crimped set yarn of the thermoplastic polymer.

2. Process according to claim **1**, wherein the fluid is air.

3. Process according to claim **2**, wherein the rate of feed of the core yarn to the turbulent fluid is substantially equal to the rate at which the composite mock-boucle yarn is wound up and the rate of feed of the peripheral yarn is substantially higher, whereby the core yarn in the product is substantially straight.

4. Process according to claim **3**, wherein the rate of feed of the peripheral yarn is between 4 and 33 times greater than the rate at which the composite mock-boucle yarn is wound up.

5. Process according to claim **2**, wherein the core yarn is made of a readily soluble material and is subsequently removed from the composite mock-boucle yarn by means of a solvent for such material in which the peripheral yarn is insoluble.

6. Process according to claim **2**, wherein the core yarn is made of a readily fusible material and the peripheral yarn of a material which melts, if at all, at a higher temperature and the core yarn is subsequently removed by fusion.

7. Process according to claim **2**, wherein the composite mock-boucle yarn is subjected to stretching to break the core yarn into short lengths preparatory to removal.

8. Process for the production of crimped yarns of thermoplastic polymers which comprises passing a first yarn and a second yarn through a compressed fluid feed jet, the said first yarn being of a thermoplastic polymer and being fed at a rate greater than said second yarn, the said first yarn and second yarn being subjected in the compressed fluid feed jet to the action of a turbulent fluid which plasticises the said first yarn, thereby producing a composite mock-boucle yarn in which the said first yarn constitutes a peripheral yarn in which the individual filaments have a set, random, non-periodic crimp and the second yarn constitutes a core yarn, and removing the core yarn, leaving a crimped set yarn of the thermoplastic polymer.

9. Process according to claim **8**, wherein the plasticising fluid is steam.

10. Process according to claim **9**, wherein the rate of feed of the core yarn to the turbulent fluid is substantially equal to the rate at which the composite mock-boucle yarn is wound up and the rate of feed of the peripheral yarn is substantially higher, whereby the core yarn in the product is substantially straight.

11. Process according to claim **10**, wherein the rate of feed of the peripheral yarn is between 4 and 33 times greater than the rate at which the composite mock-boucle yarn is wound up.

12. Process according to claim **11**, wherein the peripheral yarn and the core yarn each have a twist of at most 20 turns per metre.

13. Process according to claim **9**, wherein the core yarn is made of a readily soluble material and is subsequently removed from the composite mock-boucle yarn by means

of a solvent for such material in which the peripheral yarn is insoluble.

14. Process according to claim **9**, wherein the core yarn is made of a readily fusible material and the peripheral yarn of a material which melts, if at all, at a higher temperature and the core yarn is subsequently removed by fusion.

15. Process according to claim **9**, wherein the composite mock-boucle yarn is subjected to stretching to break the core yarn into short lengths preparatory to removal.

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