July 22, 1969 L. E. LEFEVRE 3,457,338

PROCESS FOR CRIMPING POLYPROPYLENE FILAMENTS

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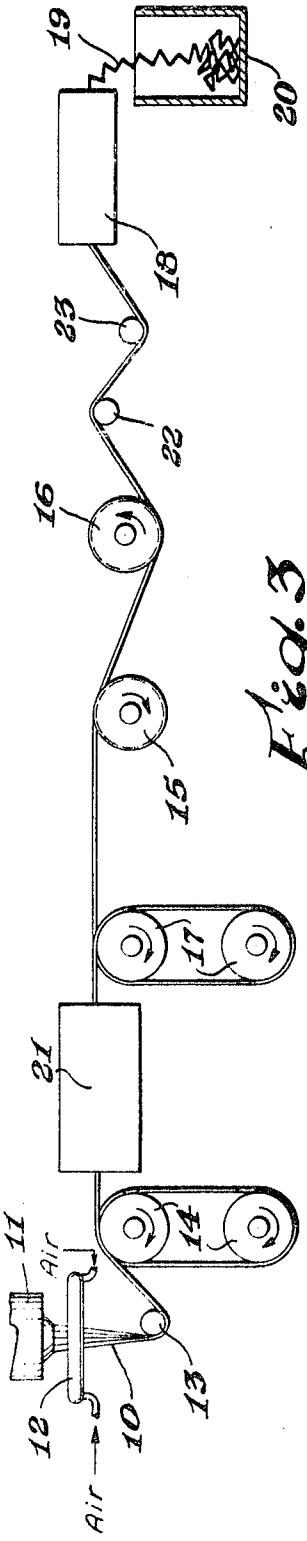


Fig. 3

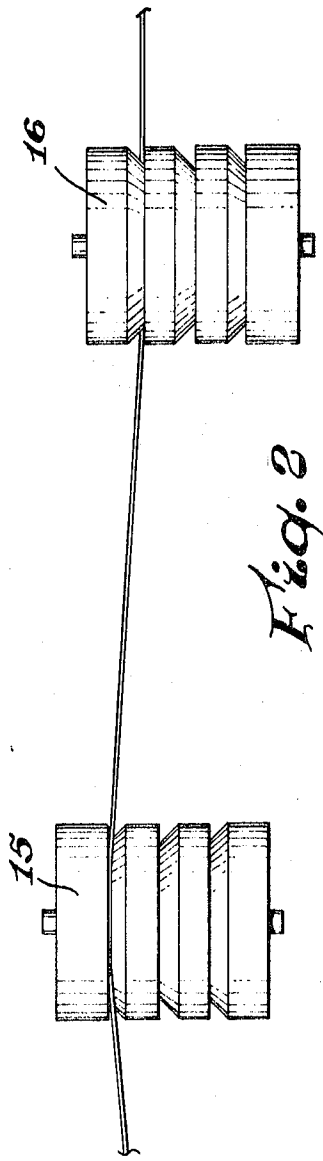


Fig. 2

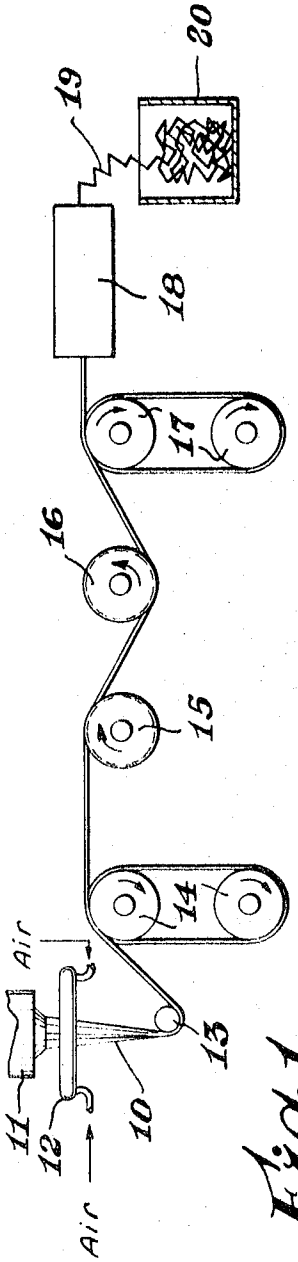


Fig. 1

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PROCESS FOR CRIMPING POLYPROPYLENE FILAMENTS

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ABSTRACT OF THE DISCLOSURE

Crimped polypropylene filaments of improved bulkiness are prepared by peripherally cooling the melt spun filaments with a transverse current of air to impart a helical crimp to the filaments and then unbanding the crimp by passing the filaments through a pair of heated angular grooved rolls whereby the filaments are first twisted in one direction and then twisted in the reverse direction.

The present invention relates to a process and apparatus than can be utilized efficiently for imparting a helical crimp to polyolefin filaments of improved bulkiness or fluffiness.

It is known to impart to synthetic thermoplastic filaments some of the qualities of natural filaments such as wool. One way of accomplishing this is to peripherally cool melt spun filaments with a current of an inert fluid cooling medium such as air or nitrogen to impart a helical crimp to the extruded filaments. The peripheral cooling of melt extruded thermoplastic filaments, especially those of Saran, to produce crimped or crinkled filaments is well known to the art, for example, U.S. 2,542,973.

However, when such a cooling procedure is applied to melt extruded polyolefins, the helical crimped filaments thereby produced have the disadvantage in that the helical crimps of the individual filaments are tightly banded together, and, as a result, the filaments do not have the requisite high bulkiness or fluffiness which is desired in textile applications where bulked products having high covering power are required.

It is an object of the present invention to improve this state of affairs and to impart more bulkiness to the fabrics or other articles manufactured therefrom, and to provide an apparatus therefor.

According to the process of the present invention, a polyolefin material such as polypropylene is extruded at a melting temperature usually above about 130° C. through a suitable multihole die or spinnerette to form a multiple filament strand. The forcibly extruded filaments are surface chilled immediately after extrusion by subjecting them to a transverse flow of an inert fluid cooling medium such as air or nitrogen against the outer periphery of the filaments, at a temperature less than the melting temperature, generally in the range of 5° to 25° C., and in a manner such as to impinge on all of the hot filaments at the same predetermined distance from the extruding die while not forcing them into coherence with one another. The chilled filaments are then oriented and stretched from 1 to 4 times their original length. Before or after the filaments are stretched, the filaments are passed through a first heated grooved guide element maintained at a temperature ranging from about 100° to about 225° C., the groove of the guide element having a sloping side and the filaments being passed through the guide element in a direction substantially tangential to the slope of the groove and oblique to the horizontal axis of the element so that the multifilament strand is turned about its longitudinal axis. The filaments are removed from the first guide element and are passed through a second guide element disposed substantially parallel to the first guide element, heated to a temperature of about 100° to about 200° C., the second guide element also having a groove with a sloping side, the sloping side of the groove of the first guide element being parallel to the sloping side of the second guide element but inclined in the opposite direction. The multifilament strand is passed through the second grooved guide element in a direction substantially tangential to the slope of the groove of the guide element and oblique to its horizontal axis so that the multifilament strand is turned about its longitudinal axis in a direction opposite to that occurring during the course of its passage through the first guide element.

By way of illustration, the invention will be described in greater detail with reference to the accompanying drawing wherein:

FIGURE 1 is a diagrammatic illustration, partly in cross section, of a procedural sequence to be followed in carrying out the process of the present invention and an apparatus useful therein;

FIGURE 2 is an enlarged plan view showing the first and second guide elements which may be used in the process of the present invention showing the passage of the multifilament strand from the first grooved guide element to the second grooved guide element;

FIGURE 3 is a diagrammatic illustration, partly in cross-section, of a modified procedural sequence to be followed in carrying out the process of the present invention and an apparatus useful therein.

There is illustrated in FIGURE 1 a multiple filament strand 10 of a polyolefinic material being extruded through a suitable multihole die or spinnerette (not shown in detail) in a suitable extrusion apparatus 11. As mentioned, it is preferable to employ an essentially isotactic polypropylene or like fiber-forming material. The extrusion temperature should be sufficiently high to melt the material uniformly for spinning. Ordinarily, temperatures in excess of about 130° C. are employed for melt spinning polyolefins such as polypropylene.

The multifilament strand **10** passes downwardly while still hot through annular ring **12** located at a predetermined distance from the spinnerette having a slit circumscribing the ring and facing generally toward the filament cluster through which is directed a blast of the cooling medium transversely against the outer peripheral side of the filaments. The annular ring which may be employed is more fully described in U.S. 2,832,642. The cooling medium may be any suitable fluid such as air or other gas, liquid or vapor which is inert to the filaments and is at temperature below the melting temperature of the material being spun. Preferably, air at about 18 to 25° C. is employed as the cooling medium to chill the surface of the freshly extruded filaments. The optimum distance for separating the annular ring from the spinnerette depends on the size of filamentary material being spun and the extrusion rate being employed. When relatively coarser filaments are being spun at higher rates, a greater distance may be employed. Ordinarily, a distance between about 0.5 and 2 inches is suitable.

It is understood that other equivalent types of stream-directing apparatus may be suitably employed in place of the annular ring used in this illustration.

The multifilament strand is then passed about idler roll **13**, and thence around godet rolls **14**, from which the multifilament strand is passed to the first of a pair of heated angular shaped grooved guide elements **15** and **16** which may take the form of heated grooved rolls. In the embodiment of the invention illustrated in FIGURE 1, the heated guide elements are shown as grooved rolls **15** and **16**. Following the grooved roll **15**, the filaments next pass under grooved roll **16**, so located

as to deflect the path of travel of the filaments **10** as they leave roll **15**.

The guide elements **15** and **16**, as depicted in FIGURE 2, are heated grooved rolls, with the grooves in each roll being at an angle to the axis of rotation of the roll, the slope of the angle of the grooves in the guide roll **15** inclining in a direction substantially parallel and opposite to the slope of the angle of the grooves in the guide roll **16**. The angle of the grooves may vary from about 45° to about 60° and are about ¼ to 5/16 inch in depth. The grooves in each roll are offset from each other relative to the path of travel of the multifilament strand as illustrated in FIGURE 2 so that as the strand is fed over the first roll **15** and under the second roll **16** it contacts a short portion of the base of the groove imparting a rolling action to the filaments in opposite directions, which serves to impart an S and Z twist to the multifilament strand.

Following grooved roll **16**, the filaments pass around a second pair of godet rolls **17**, operated at a peripheral speed greater than that of godet rolls **14** so as to effect orientation and stretching of the filaments to the extent desired which may vary from 1 to 4 times the length of the extruded filaments. The stretched, oriented filaments are then passed to an aspirator **18** and the crimped multifilament strand **19** is collected in a container or hopper as indicated at **20**.

Alternatively, heated rolls which are not offset from each other or other suitable yarn heating means such as an oven may be substituted for rolls **15**, **16** and heated angular grooved rolls similar to rolls **15**, **16** and offset from each other may be situated so that the multifilament strand may undergo the unbanding treatment during heat relaxation of the filaments, if such a step is desired or required. FIGURE 3, illustrates such a procedure.

In FIGURE 3, multifilament strand **10** is extruded through suitable extrusion apparatus **11** and passed downwardly while still hot through annular ring **12** and cooled by a blast of air directed traversely against the outer peripheral side of the filaments. The multifilament strand **10** is then passed about idler roll **13** and thence around godet rolls **14** from which the strand is passed through an oven **21** heated to a temperature of about 400° to 600° F. From the oven the strand **10** is passed to a second pair of godet rolls **17** which are driven at a greater peripheral speed than rolls **14** so as to stretch the filaments about 1 to 4 times the length of the extruded filaments. From rolls **17** the multifilament strand is passed over a pair of annular grooved rolls **15**, **16** identical in construction to the grooved rolls depicted in FIGURE 2 and offset in a similar manner heated to a temperature of about 100° to 300° F. From roll **16** the multifilament strand is passed about snubber rolls **22**, **23** and passed through aspirator **18** and the crimped multifilament strand **19** collected in a container or hopper as indicated at **20**.

The degree of offset between the first and second guide elements may be varied within certain limits. As a general guide, it will be found that an offset of from about ⅛ to about 1 inch may be employed to produce the relatively unbanded bulked filaments of the present invention.

The method of the present invention is illustrated more particularly by way of the following examples, but as will be more apparent, is not limited to the details thereof.

Example 1

A prevailingly isotactic polypropylene (cold xylene solubility in the order of 8 percent) having a melt index of 7.5 decigrams/minute was melt extruded at 160° C. to form a filament through a 30 hole spinnerette having holes of 0.018 inch diameter. The molten filaments were passed through an annular ring located 0.75 inch below the spinnerette face where they were chilled with air at 18° C. The annular ring had a slit having an opening of 0.015 inch circumscribing the ring which discharged air transversely against the outer periphery of the filament tow. The cooled filaments were passed around illustrated intermediate idler roll **13**, and godet rolls **14** operated at a peripheral speed of 95 feet per minute. The filaments were then passed over a pair of angular grooved, heated, free-turning rolls (illustrated rolls **15**, **16**) the first roll located 14 inches from godet rolls **14** while the second grooved roll was located 5.5 inches from the first with the grooves offset 0.5 inch sideways from the grooves in the first. Each of the rolls was heated to approximately 150° C. The width of the grooves in roll **16** through which the filaments first passed was ¼ inch at the surface and was formed by a 60° angle cut into the roll with one side perpendicular to the surface of the roll to a depth of 7/16 inch. The grooves of roll **16** had the same dimensions except the roll was mounted so that the slopes of the grooves of the rolls inclined in opposite directions. The filaments after leaving the grooved rolls were passed over a second pair of godet rolls **17**, operated at 325 peripheral feet per minute so as to effectuate a stretch of 3.4:1 and then collected.

The crimped multifilament strand produced by the above procedure had a relatively unbanded appearance, the diameter of the strand ranging from ¼ to 5/16 inch.

By way of contrast, a crimped multifilament strand produced according to the above-described procedure, with the exception that the cooled filaments were not passed through a pair of heated angled grooved rolls offset from each other, was comprised primarily of tightly banded helical crimps, the crimped strand having a diameter of ⅛ to 3/16 inch.

Example 2

Isotactic polypropylene was melt extruded following the procedure of Example 1. The cooled filaments were passed around an idler roll and then around a pair of godet rolls operated with a peripheral speed of 105 feet per minute. From the godet rolls the filaments were passed through the center of a 12 inch heating oven maintained at 500° F. and then around a second pair of godet rolls operated with a peripheral speed of 370 feet per minute so as to orient and stretch the filaments 3.5 times their original length. From the second set of godet rolls the multifilament strand was passed over a pair of angular grooved, heated, free-turning rolls similar to the angular grooved rolls employed in Example 1, the first angular grooved roll located 10.5 inches from the second pair of godet rolls, while the second angular grooved roll was located 10.5 inches from the first with the grooves offset 1 3/16 inches sideways from the grooves in the first. The grooved rolls were heated to a temperature of about 225° F. The filaments, after leaving the grooved rolls were passed over a pair of snubber rolls, operated at a peripheral speed of 354 f.p.m. giving a stretch ratio of 0.96:1, then through an aspirator and collected.

The crimped multifilament strand produced by the above-described procedure had a relatively unbanded appearance, the diameter of the strand ranging from ¼ to ⅜ inch.

By way of contrast, a crimped multifilament strand produced according to the above-described procedure, with the exception that the cooled filaments were not passed through a pair of heated, angled grooved rolls offset from each other, was comprised primarily of tightly banded crimps, the crimped strand having a diameter of ⅛ to ¼ inch.

What is claimed is:

1. A process for the production of crimped polypropylene fibers having improved bulk which comprises:

(a) extruding the polymer at a temperature above the melting temperature of the polymer;

(b) cooling the extruded filaments by subjecting them to a transverse blast of an inert fluid cooling medium

against the outer periphery of the filaments at a temperature in the range 5 to 25° C.;

(c) twisting the filaments about their longitudinal axis in one direction in a first heating zone at a temperature from about 100° to about 225° C.;

(d) twisting the filaments about their longitudinal axis in a direction opposite to that in said first zone in a second heating zone at a temperature from about 100° to about 225° C.; and

(e) stretching the filaments from about 1 to about 4 times their extruded length during the process.

2. The process of claim 1 wherein the filaments are passed through the first and second heating zones during the stretching of the filaments.

3. The process of claim 1 wherein the filaments are passed through the first and second heating zones after the stretching of the filaments.

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