April 14, 1970 D. C. PREVORSEK ET AL 3,506,535

METHOD OF FIBRILLATION AND PRODUCT

Filed Nov. 6, 1967 4 Sheets-Sheet 1

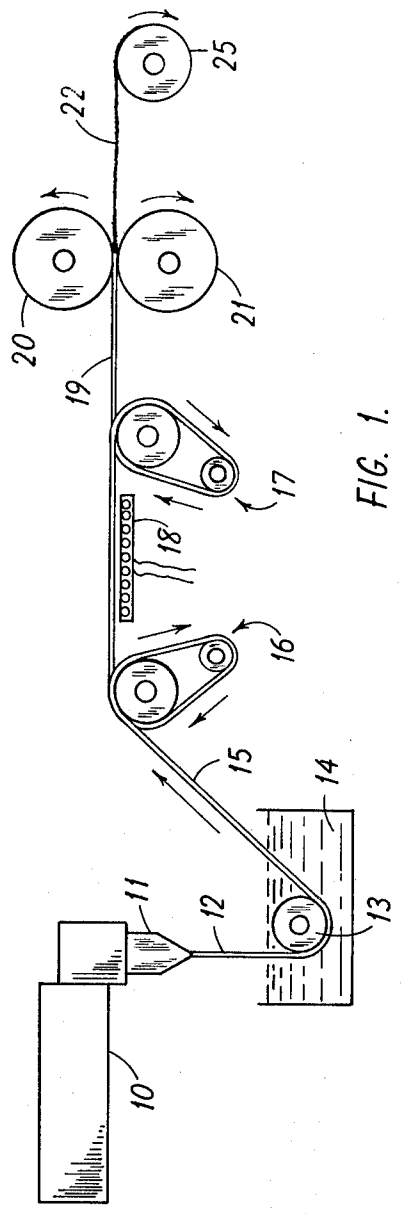


FIG. 1.

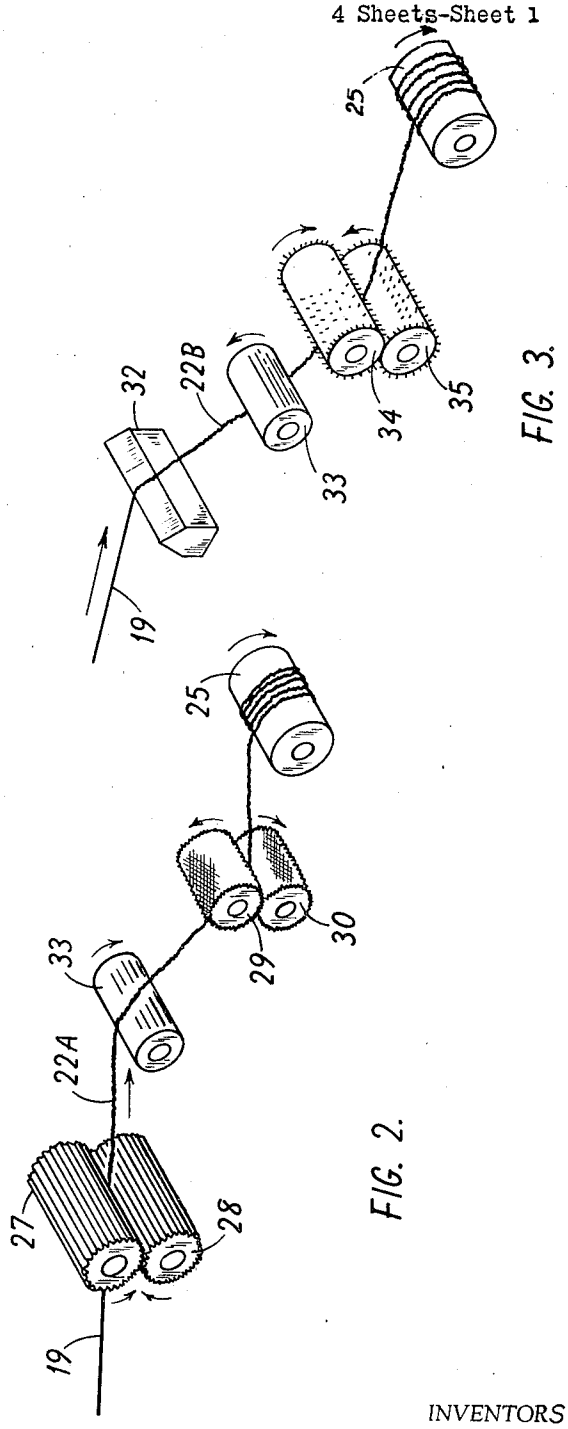


FIG. 3.

FIG. 2.

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METHOD OF FIBRILLATION AND PRODUCT

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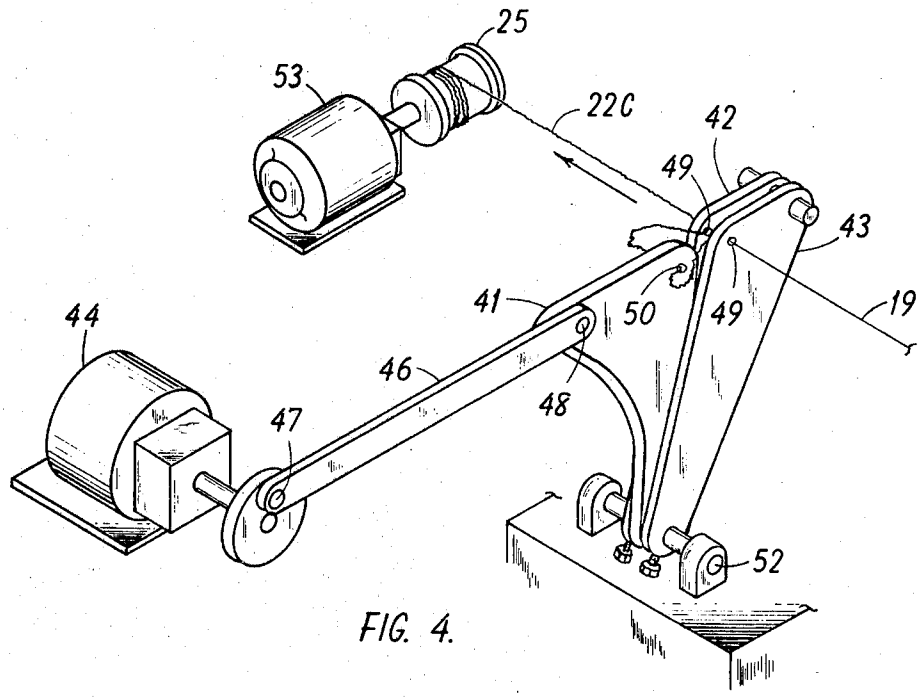


FIG. 4.

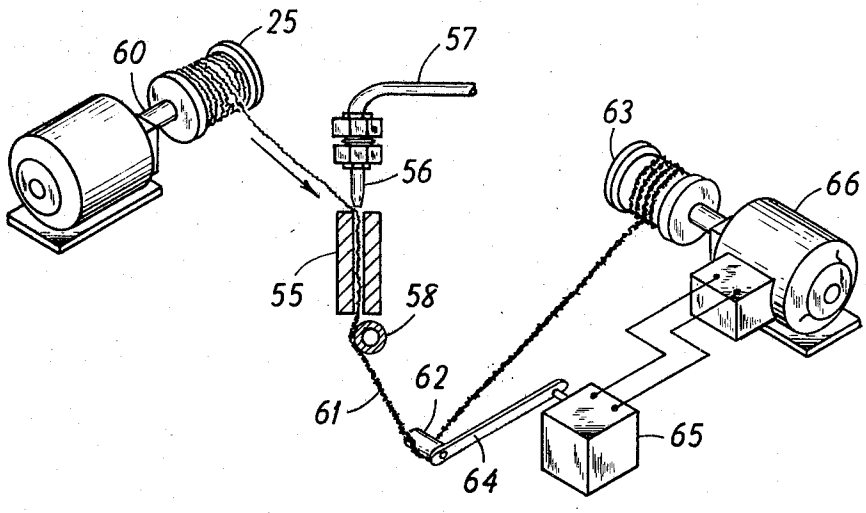
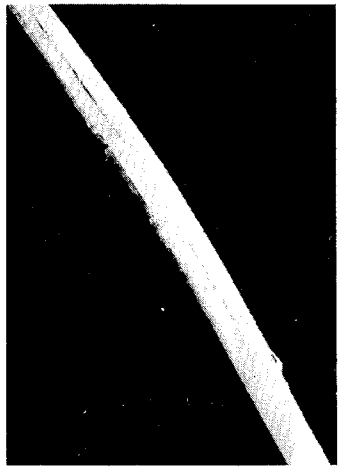


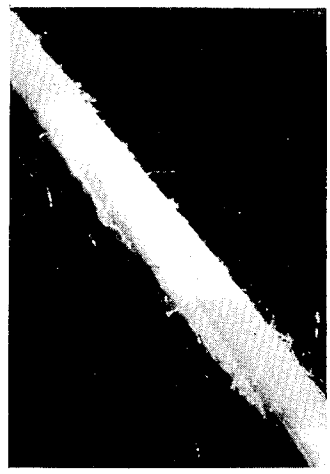
FIG. 5.

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20x

FIG. 6A.



20x

FIG. 6B.

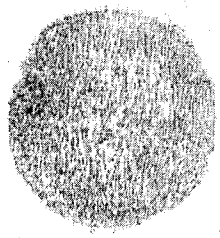


20x

FIG. 6C.

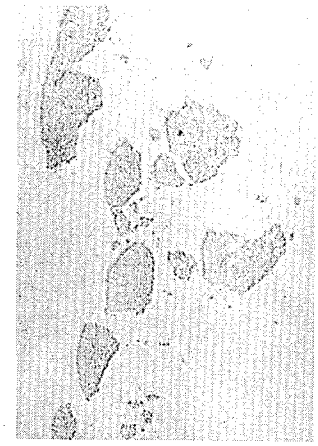
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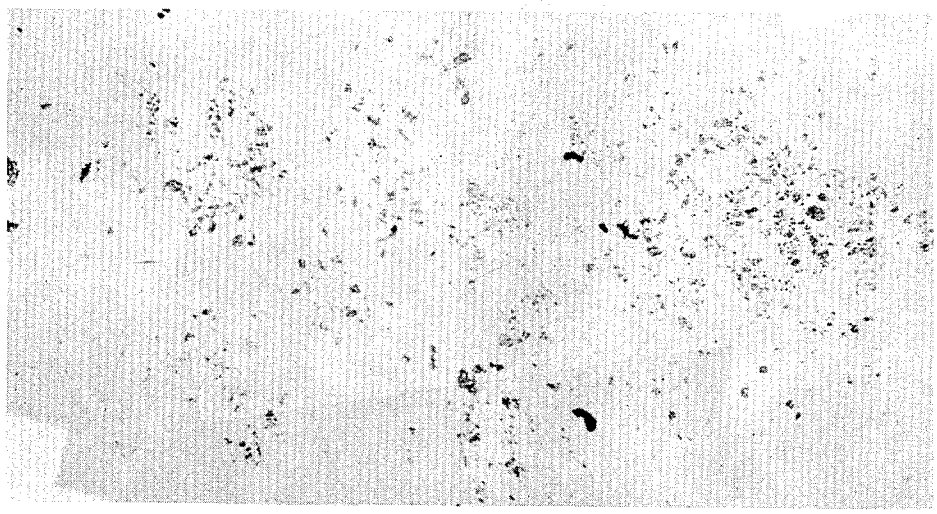
140x

FIG. 7A.



140x

FIG. 7B.



140x

FIG. 7C.

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Patented Apr. 14, 1970

3,506,535

METHOD OF FIBRILLATION AND PRODUCT

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Filed Nov. 6, 1967, Ser. No. 680,678
Int. Cl. D02g 3/06
U.S. Cl. 161—177 9 Claims

ABSTRACT OF THE DISCLOSURE

The invention comprises a method of producing a yarn having a plurality of fibers from a relatively heavy unitary strand, strip or monofilament, referred to as a monofil. The monofil is mechanically pretreated to introduce fissures therein, i.e. to substantially increase the surface to volume ratio. Thereafter, the fibrillation of the pretreated monofil is completed to separate the fibrils and produce a relatively high bulk yarn by subjecting it to a flagellating action of a gas stream or jet. The product yarn may be corded, spun and woven substantially similarly to yarns spun from natural staple fibers.

This invention relates to a process for preparing yarn-like structures from synthetic polymers. More specifically it relates to the preparation of textile yarns directly from molecularly oriented monofilaments, or tapes or slit films of wide thickness range.

Yarns made from continuous filaments, as such, are not suitable for textile applications where good tactile properties, covering power, i.e. high bulk, per unit weight of fabric, comfort, or aesthetic qualities are important factors. The main reason for the inadequacy is that since the filaments have a smooth surface, a uniform diameter and a circular or near-circular cross-section, they have a tendency to pack closely in the yarn. Consequently, the fabrics made from such yarns have too high a density which affects their insulating capacity and covering power. Furthermore, fabrics made from such dense yarn have a relatively high contact area when placed in contact with the skin which affects their tactile properties and comfort which is often reflected by a clammy feeling on the wearer.

Thus, a large percentage of the total production of continuous filaments of synthetic fiber-forming polymers intended for textile applications has to be cut and spun into staple yarns.

The production of yarns from staple fibers is a time consuming and costly process which involves a series of complex operations. Cut fibers have to be combined into assemblies suitable for drawing operation where the fibers are aligned into bundles and the bundle is reduced to a smaller diameter while twisted. Twisting is necessary to prevent excessive slippage of adjacent fibers past one another. It is obvious that such structures have a very low translational efficiency, that is, the strength of the fiber assembly is much lower than that of the individual component.

The cost of staple yarn production increases rapidly as the denier of the spun yarn decreases. The higher cost is primarily due to the necessity for obtaining great uniformity of fibers in the smaller yarn bundle. The need of greater amounts of twist to secure adequate yarn strength, and the fact that machine output is lower on per pound basis. In addition to the high cost, the conventional staple yarn technology has additional shortcomings. For example, while it is very difficult to achieve a high degree of uniformity in the yarn texture and denier and to secure good translational efficiency, it is probably even more difficult to achieve intentionally random or

regular non-uniformity in texture and/or denier. Those skilled in the art will recognize that such functional non-uniformity is required when fabrics with special aesthetic requirements such as material appearance are the consideration.

The development of a bulky yarn from a monofil, rather than from staple fiber, it will thus be apparent, offers considerable economical advantages since its production bypasses several complicated and costly operations requiring enormous specialty equipment. Additionally to the manufacturer of synthetic fibers, an effective method for producing bulk yarn from a monofil provides for him a market now reserved largely to textile mills.

Although it has been known for some time that yarn-like structures can be obtained by fibrillating highly oriented films, the products obtained were either too weak or too coarse to be useful without further treatment for production of high quality textiles, or they lacked the desired bulkiness required for good covering power and comfort. Typical steps required to upgrade such products are twisting and/or crimping. Both processes are expensive and are not needed to produce yarns of this invention.

In other words, for the most part when mechanical fibrillation has been applied to monofils heretofore it has been necessary to overly weaken the structure before satisfactory fibrillation or bulkiness was imparted to the structure. On the other hand, in general where mechanical fibrillation was stopped before the yarn lost the necessary strength needed to satisfactorily work the product, the fibrils split from the monofil remained oriented very closely to the yarn axis, i.e., were placed too densely and therefore do not avoid the essential objection of lack of high bulk found in fabrics manufactured from the relatively dense monofilament.

The invention involves a method which in essence utilizes a sequence of two steps each of which is critical in the conversion of a relatively thick monofil into a bulky fibrillated yarn. The first step involves a mechanical pretreatment to introduce fissures into the monofil so that the unitary cross section divides or fissures along the length of the fiber into many thin fibrils. This mechanical working is terminated prior to loss of satisfactory strength. At this juncture the "fibrils" of the fissured monofil, as has been noted, remain oriented too closely to the yarn axis to provide a product of suitable bulk, i.e., the fibrillation is inadequate.

In the second step, the fissured monofil is flagellated, i.e., subjected to a violent whipping action in a gas jet or stream. This treatment with a gas jet separates or disengages the fibrils and imparts fluffiness and bulk to the yarn without further weakening the structure. While the utilization of a gas jet alone to effect fibrillation has been proposed as noted in the U.S. Patent 3,177,557, attempts to utilize that process have demonstrated that it is useful only with thin slit film and cannot be utilized on relatively thicker strips or with conventional monofilaments. Also, according to the teachings of that patent wherein a very thin film is passed through a zone of high turbulence provided by a high velocity jet or steam of air or gas, the yarns produced by that process have several shortcomings. For example, the shape of fibrils in the final yarn are trapezoidal with the thin dimension being that of the film fed into the fibrillating device. Additionally, as has been noted, that process is restricted solely to very thin films which generally require critical and expensive technology to produce. Consequently, with thick films or with other shapes such as heavy monofils or tapes, it would be necessary, if at all possible, to use an air jet of extremely high velocity to achieve even significant fibrillations; a requirement which is impractical and

would complicate the processing apparatus and otherwise render the process completely uneconomical. It is noted also that it is frequently necessary to use solvent casting techniques to achieve the desired fineness of films which greatly affects the rate of production and increases the total cost of production. Furthermore, the disclosed technology offers very little flexibility where the achievement of special effects in texture, denier and/or preferential dyeing is concerned.

The product resulting from gas jet fibrillation of thin film, as noted in U.S. Patent 3,177,557, retains the thickness of the film used as one of the dimensions of the fibrils, i.e., one of the dimensions of the fibrils of the fiibrillated product is the same as the thickness of the starting film. In the product resulting from the process of the present invention, on the other hand, the fissuring step and subsequent after treatment with gas jet results in a fibrillated product in which the cross-sectional dimensions of the fibrils in every case are substantially reduced from any of the cross-sectional dimensions of the starting strand. This marked reduction is depicted in FIG. 7C.

It is an object of this invention to provide an improved process for preparing bulky yarns which is not limited to very thin oriented films, but is also applicable to thick films where the fibrillation by an air-jet alone is extremely inadequate.

A further object of this invention is to produce a bulky yarn from a variety of oriented shapes including monofilaments, tapes, relatively thick slit films, etc., i.e. of any cross-section, in addition to the circular one which is the most difficult to fibrillate.

Another object of this invention is to provide a process for preparing bulky yarns of relatively large cross-section having, in addition to the desired aesthetic qualities, tactile properties, warmth and good covering power per unit weight, also substantial strength without twist.

It is still a further object of the invention to provide a process for the production of strong textile yarns without the necessity of forming staple fibers as an intermediate step and without the necessity of spinning and twisting of staple filaments into yarns.

Another object of the invention is to provide a process for production of textile yarns of good uniformity in denier and texture.

A further object of the invention is to provide a process for production of textile yarns where preferential dyeing effects can be achieved without the use of mechanical blending of various components in the staple fiber form and spinning and twisting such components into a combined staple yarn.

Yet another object of this invention is to provide a continuous process for production of strong bulky yarns having randomly or uniformly spaced irregularities and/or nonuniformities required for special aesthetic effects such as "natural" appearance.

Other objects and advantages will be apparent from the disclosure which follows:

In accordance with the present invention, bulky yarns are prepared by a method which includes mechanically working an essentially integral cross-section, e.g., monofilaments or tapes or slit films which start out as a single strand, to cause them to split or divide longitudinally into many thin fibrils. These divided fibrils while essentially split by the mechanical treatment are only to a minor extent separated one from the other. Following flagellation by a gas jet, these pre-worked fibers are then more fully separated and are then only randomly connected, thus giving the yarn a unity which aids handling and without twisting preserves the yarn strength. The structure of the resulting yarn, that is, the average fineness of split fibrils, average length, the concentration of interlacing points and the number of free ends of these fibers can be greatly affected by the design of the apparatus, the rate of feeding and passing of the monofilament, slit film or tape through the device and the frequency and stroke of the reciprocating mechanical action. The mechanical action employed to divide the single strand includes any of various operations which are suitable to split or divide the strand, e.g., reciprocatory, bending, brushing, rolling, rubbing, crushing, twisting, grating, impacting, striking, etc., action on the strand.

Although the yarn-like structures, after the initial pretreatment step wherein fissures are introduced into the unitary structure at the stage represented by FIGURE 6B, may have considerable additional covering power, i.e., increased bulk per unit weight, as compared to untreated monofilament, and provide an appearance and strength suitable for some applications such as carpets, reinforcements, etc., they do not generally have the desired tactile properties, bulkiness and compliance required in applications where the comfort of the wearer and insulating capacity are important factors. The main factor is that in the yarn structures obtained by this preliminary step in the process, the majority of fibrils are oriented closely to the yarn axis, and the individual fibrils are still packed very closely. The separation of the fibrils or opening of the structure, flagellation of free ends and their disorientation from the yarn axis, which is the second essential treatment, is then achieved by passing the mechanically fibrillated yarn through a zone of high velocity air jet. Exposure of successive portions of the split yarns to the turbulent gas increases the length of individual fibrils, increases the yarn bulkiness by further splitting of fibrils, flagellation of free ends and general disorganization and disorientation of the three dimensional network achieved by the first step.

The resulting yarns have, in addition to sufficient zero-twist strength for further processing into textile structures, greatly enhanced tactile properties and insulating power which also extends their end use application where the comfort of the wearer is an important concern.

This invention will be better understood by referring to the drawings, of which

FIGURES 1, 2 and 3 depict schematically several means which may be employed to mechanically impart fissures into a monofil in the pretreatment step.

FIGURE 4 is still another alternate means which is desirably utilized to initiate fibrillation fissures into the monofil by rapid bending action.

FIGURE 5 depicts diagrammatically a suitable device for subjecting the pretreated yarn to flagellation with a high velocity jet of gas, thereby disorienting the fibrillated ends from the main axis of the yarn.

FIGURES 6A, 6B and 6C photographically depict a monofilament prior to treatment and the effect thereon in accordance with the invention, after mechanical working and flagellation by gas jet, respectively.

FIGURES 7A, 7B, and 7C are photomicrographic cross-sections of the same monofilament at the same stages of the process, i.e., prior to mechanical treatment, after mechanical treatment and after exposure to the gas jet, respectively.

Referring to the drawings, any of a number of suitable mechanical means may be used to increase the surface area of the monofil, i.e., to introduce fissures into the structure. In FIGURE 1, a rolling operation wherein the monofil is crushed between rollers **20** and **21** is employed. As seen in the schematic arrangement of FIGURE 1, a molten blend of at least two substantially incompatible polymers, contained in extruder **10**, is passed through a die **11**. The extruded filament **12** passes under a roller **13** positioned in a cooling bath **14**. The monofil **15** passes over an orienting assemblage of two sets **16** and **17** of Godet rollers and heater **18** where the fiber is drawn. From there the oriented monofil **19** is introduced through a pair of rollers **20** and **21** of close tolerance which crush the monofil and thereby essentially increase its surface area by introducing fissures into the structure, i.e. by mechanically parting the incompatible components of the strand longitudinally. The monofil thus pretreated

is stored on a wind-up roller **25**, or it may be passed prior to storing to the flagellation operation described in connection with FIG. 5.

In lieu of the crushing treatment, or in addition thereto, the oriented monofil **19** may be treated to increase the surface area by passage through one or more sets of grooved or knurled rollers. As illustrated in FIG. 2, the first set of rollers **27** and **28**, comprise meshing fluted or geared rollers which mechanically flex the strand as it passes between the rollers. The preworked strand **22A** is then fed over a guide **33** to a second set of rollers **29** and **30** which may serve to enhance the parting of the fibers, e.g. wire brush rollers. Rollers **29** and **30** may be arranged to rotate so as to draw the monofil **22A** in the same direction of travel as the wind-up roll **25** while at the same time optionally aiding in conditioning the mechanically preworked strand **22** to a more advanced fibrillated stage.

In the embodiment depicted in FIG. 3, the oriented monofil **19** is drawn preferably at an angle across a sharp cutting edge **32**. After this mechanical treatment, the strand **22B** may optionally be drawn through a set **34** and **35** of brush rollers (similar, but oppositely rotating, to rollers **29** and **30**) after passage under a guide roller **33** and before storage on wind-up roll **25**.

Still another fibrillating device is depicted in FIG. 4 wherein the monofil is threaded through at least two plates closely associated, one of which reciprocates relative to the other. The flexing device of FIG. 4 is described in greater detail in the copending application of G. E. R. Lamb et al., Ser. No. 680,679, filed on even date herewith, now U.S. Patent 3,457,609 granted July 29, 1969. As shown, the fibrillating device may comprise plates **41**, **42** and **43** of which **42** and **43** are fixed, while **41** is moved in a back-and-forth fashion on pivot **52** by the motor **44**, acting through the cam **45** and connecting member **46** through connecting pivot points **47** and **48**. The plates **41**, **42** and **43** may be formed of any suitable composition, e.g. metal, wood, plastic, etc. The monofilament, tape or split film **19** passes through one hole in each of the plates **41**, **42** and **43**, and as it is pulled through is bent, rubbed, twisted and beaten, in the space between the plates, where it is forced to reside briefly. The forward passage of the filament may be effected by taking up the processed fiber **22C** on a suitable wind-up roll **25** driven by motor **53**.

An apparatus for imparting flagellation to the pretreated fissured monofil is shown in FIG. 5, which comprises a short tube **55** of suitable dimensions, e.g. having an inside diameter of about 1–3 mm., preferably about 1.5 mm., into which air or other suitable gas is blown from one end through a smaller tube or nozzle **56** provided by source **57**. At the other end of the tube **55** and slightly displaced from a central position where the gas stream would impinge directly, is positioned an obstruction **58**, whose function is essentially to increase the gas stream turbulence and improve the flagellation action of the device. As shown, a cylindrical element **58** is used upon which the gas passing through tube **55** is deflected.

The pretreated yarn is fed through the flagellating device by a suitable feed mechanism, e.g. motor driven spindle **60** on which the wind up roll **25** is mounted and which feeds the yarn at a predetermined rate through the flagellator tube **55**. The flagellated yarn **61** is passed around a low friction guide **62** mounted on a tension actuated lever **64** of a tension sensitive control device **65** which regulates the speed of the take up unit **63**, i.e., as the lever **64** is lowered when tension on strand **61** is relaxed, the speed of motor **66** and of take up roll **63** is increased thereby effecting an increase in the rate at which the yarn is wound up. Tension on fiber **61** and hence on roller **62** and lever **64** is thus increased, which in turn decreases the speed of motor **66** for take up roller **63**. It will be apparent that various alternated arrangements may be used. The processed yarn may be collected on spools **63** and stored or alternately the arrangement may be appropriately modified so as to utilize the yarn directly after flagellation.

We have found that in order for the air jet to produce optimum effect, that is to say to lead to the direct increase in bulkiness, fibril length, covering power, etc., it is necessary that the first step, the mechanical treatment of the monofils, produce sufficient fissures into the structure. To obtain suitable pretreated, i.e., fissured structures, for use in practicing the present invention, the yarn is subject to a preliminary disintegration treatment wherein internal fissures or fractures of the integral structure of the strand is effected. The thus treated strand may not be actually split into fibrils, rather the structure is "shattered" and weakened to some extent but still appears intact as a unit. Those skilled in the art will realize that the "degree of pretreatment or weakening" at which an air jet may become effective on the fiber so conditioned depends on numerous factors such as yarn and composition, method of making the yarn, particular construction of the air jet assembly, air velocity, particular material in consideration and its dimensions, the relation between the dimensions of the air jet and those of the material included for fibrillation, time of the exposure to the air jet, etc. The problem of the definition of a "degree of preweakening" is further complicated by the fact that there are numerous ways of describing a complex structure, such as a partially fibrillated system. One wall would be to describe the structure in terms of the number and average size of fibrils per unit cross-sectional area, average length of fibrils between the interlacing points, number of free ends per unit length or per unit area. While such a descriptive analysis of the fibrillated product is often very useful for the purposes of characterization, it is not a reliable indicator for determining whether a particular fissured structure is suitable for an additional treatment in an air jet.

We have found by microscopical examination, however, that the "degree of mechanical preworking to make fissures in the yarn which is required for a particular air jet to become effective can be adequately described by two parameters; the increase in surface-to-volume ratio achieved by the mechanical pretreatment and a minimum surface to volume ratio before it enters the turbulent zone of the gas jet to effect the fibrillation.

In general with monofils having a denier from 100 to 1500 made of incompatible blends of fiber-forming polymers, we have found that the exposure of the preweakened material to the action of the air jet of the design shown in FIGURE 5 at an air pressure greater than about 30 p.s.i. leads to noticeable improvement in its bulkiness, covering power, tactile properties and other observed textile characteristics provided that (a) the mechanical treatment prior to flagellation with a gas jet resulted in at least a substantial increase and generally at least a two-fold, and preferably at least a three-fold increase in the surface-to-volume ratio of the monofil and (b) the pre-weakened structure had a surface-to-volume ratio greater than 300 $cm.^{-1}$ and preferably greater than 400 $cm.^{-1}$. The efficiency of the air jet, of course, increases with increasing surface-to-volume ratio at a given total cross-sectional area.

The following examples illustrate specific embodiments of this invention:

EXAMPLE 1

A dry blend of 70% by weight of pellets of nylon 6 having a molecular weight of 29,000 (Allied Chemical Plaskon 8203) and 30% by weight of pellets of polyethylene terephthalate with a reduced viscosity in metacresol of 0.3 (measured at ½% concentration) was extruded at a temperature of 280° C. into a monofilament with a .020" diameter. The monofilament was drawn by passing consecutively over two rollers, the second turning faster than the first, the monofilament in going from one roller to the second passing through an oil bath held

at a constant temperature. The extruded monofilament was drawn 4× at 140° C. It was then passed through the device shown in FIGURE 4 at a speed of 10 feet per minute and subsequently passed at 20 feet per minute through the device shown in FIGURE 5 with the air being supplied at 30 p.s.i. A bulky yarn resulted consisting of many interlacing fibrils whose cross-sections had a multitude of different shapes. The fibrils had an average denier of 3.5. The yarn had a zero twist strength of 2.57 grams per denier.

EXAMPLE 2

A dry blend of 62% by weight of pellets of polypropylene having an average molecular weight of 296,000 and 38% by weight of pellets of polyethylene terephthalate having a reduced viscosity of 0.6 in metacresol was extruded at 280° C. into a monofilament having a diameter of 0.020". The monofilament was drawn as in Example 1, but in two stages: the first 3× at 100° C., the second 2× at 150° C. After drawing the monofilament was passed through the device shown in FIGURE 4 at a speed of 10 feet per minute and subsequently through the device shown in FIGURE 5 at a speed of 20 feet per minute. The pressure of the air supply was 30 p.s.i. The resulting yarn was similar in appearance to that produced in Example 1. The fibrils had an average denier of 4.5. The yarn had a zero-twist strength of 2.72 grams per denier.

EXAMPLE 3

A dry blend of 60% by weight of pellets of nylon 6 with a molecular weight of 18,000 (Allied's Plaskon 8201), 20% by weight of a low molecular weight polyethylene terephthalate having a reduced viscosity in metacresol of 0.3 and 20% dry weight of polypropylene of average molecular weight 296,000 was extruded at 280° C. into a monofilament 0.020" in diameter. The monofilament was drawn 3× at 100° and then 1.5× at 150° C. The drawn monofilament was converted into yarn following the procedure outlined in Examples 1 and 2. The yarn produced was similar in appearance to those produced in Examples 1 and 2 but was softer to the touch, and presented a number of protruding short fibril ends. The fibrils had an average denier of 3.0. The yarn had a zero-twist strength of 1.3 grams per denier. Similar results are derived by fibers mechanically preworked in the devices depicted in FIGURES 1, 2 and 3.

EXAMPLE 4

A dry blend of 60 parts of nylon 6 (having a formic acid viscosity of 70), 20 parts of poly(ethylene terephthalate) having a reduced viscosity of 0.3, and 20 parts of polypropylene having a melt index of 15 were placed in a ball mill and mixed for 30 minutes. All polymers were in the form of pellets and thoroughly dried. The mixture of polymers was then extruded using a Reifenhauser type extruder operating at the following conditions: barrel temperatures (zone 1) 500° F.; barrel temperature (zone 2) 510° F.; die temperature, 510° F.; screw pressure 1000 p.s.i.; die pressure, 750 p.s.i.; using a circular die having a diameter of 0.040 in. The extruded fiber which was quenched in a water bath placed 3 inches below the die had a diameter of 0.028".

This monofil was then flattened to various thicknesses using a heated roller mill kept at 170° C. and drawn 2× using a block heater at 160° C. and a feeding speed of 3 ft./min. The resulting oriented tapes had the following thicknesses: 0.005 in., 0.010 in., and 0.015 in.

In one set of experiments the tapes were passed only through an air jet operating at 100 p.s.i.; fibrillation of any significance was observed only with the thinnest tape. The 10 mil and 15 mil tapes were not affected by this treatment.

In the second set of experiments the 10 and 15 mil tapes were first exposed to a reciprocating bending action in an apparatus of the kind described in connection with FIGURE 4, which weakened the structure. When these mechanically pretreated tapes were subsequently subjected to the air jet operating at the same conditions, a bulky structure was obtained with a large number of fibrils.

EXAMPLE 5

A dry blend of 50 parts of nylon 6 having a number average molecular weight of 18,000, 25 parts of poly(ethylene terephthalate) having a reduced viscosity in metacresol of 0.3 deciliter/g., and 25 parts of polypropylene having a melt index of 15 were placed in a ball mill and mixed for 30 minutes. All polymers were in the form of pellets and thoroughly dried. The mixture of polymers was then extruded using a Reifenhauser type extruder operating at the following conditions: barrel temperature in zone 1 of 500° F.; barrel temperature in zone 2 of 510° F.; screw pressure, 1000 p.s.i.; die pressure, 750 p.s.i.; using a circular die having a diameter of 0.040 in. The extruded fiber which was quenched in a water bath placed 3 inches below the die had a diameter of 0.014 in. This monofil was then stretched to 4 times its original length using a block heater at 160° C. and a feeding speed of 10 feet/min., preweakened using a flexing device described above in connection with FIGURE 4 and in detail in the copending application above mentioned of G. Lamb et al., and subsequently passed through the air jet of the design shown in FIGURE 5 operating at an air pressure of 40 p.s.i. The degree of fibrillation in the final product as well as the appearance of the monofil at various stages of the process is depicted in the sequence photographic reproductions of FIGURES 6A, 6B and 6C. In FIGURE 6A the untreated drawn monofil is shown; 6B shows the same monofil after the mechanical pretreatment; and in FIGURE 6C the product in accordance with the invention, wherein the strand or fiber after being mechanically pretreated is thereafter passed through the air jet, is depicted.

FIGURES 7A, 7B and 7C similarly illustrate the effect in cross section. FIGURE 7A shows the drawn monofil having a denier of 350 and a surface-to-volume ratio of 175 $cm.^{-1}$. After mechanical pretreatment, the surface-to-volume ratio is increased to approximately 500 $cm.^{-1}$ determined according to the procedure outlined above. While the surface-to-volume of the structure depicted in FIGURE 7B is seen as substantially increased, nevertheless at this stage the fibrillation has not advanced to a degree sufficient for most typical textile applications. FIGURE 7C shows the cross section after flagellation with an air jet. The number of filaments for the same cross-section shown in FIGURES 7A and 7B is 836 with an average denier per filament of 0.42.

The importance of the mechanical pretreatment was demonstrated by passing a specimen of the drawn fiber through the same jet directly without the mechanical pretreatment step; in the latter the monofil did not show any signs of splitting even when the air pressure was increased to 100 p.s.i., i.e., the appearance of the monofil does not differ from that shown in FIGURE 6A.

It will be apparent to those skilled in the art that various modifications can be made in our invention without departing from the spirit of the invention or from its scope.

We claim:

1. In a method of fibrillating a unitary strand which comprises a mixture of at least two substantially incompatible polymers, the steps comprising (1) pretreating said strand to introduce fissures into the matrix of the strand and increase its surface-to-volume ratio by a treatment selected from the group consisting of crushing said strand, passing said strand through reciprocating plates, drawing said strand over a knife edge, and brushing said strand, and (2) subjecting the strand thus pretreatea to a flagellating operation under a high velocity gas jet of sufficient turbulence to substantially separate said fissured matrix

longitudinally into a structure having a plurality of separated thread-like fibrils which have intermittent interconnecting points and which have a cross-sectional dimension substantially smaller than the cross-sectional dimensions of said strand.

2. The method of claim 1 wherein the unitary strand is pretreated by substantially crushing between rollers.

3. The method of claim 1 wherein the unitary strand is pretreated by threading through at least two closely contiguous plates in which one plate reciprocates relative to the other.

4. The method of claim 1 wherein the unitary strand is pretreated by drawing over a knife edge at an angle.

5. The method of claim 1 wherein the unitary strand is pretreated by brush rollers.

6. The method of claim 1 wherein the pretreated strand is passed through a tube concurrently with the gas jet directed through said tube.

7. The method of claim 6 wherein the gas jet, after passing through said tube, is impinged on an obstruction to increase turbulence and promote the flagellating effect.

8. The method of claim 1, wherein the increased surface-to-volume ratio is greater than 400 $cm.^{-1}$.

9. The product produced by the method of claim 1.

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