

June 22, 1971

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3,585,684

SPINNERET FOR MAKING COMPLEX HOLLOW FILAMENTS

Original Filed Dec. 23, 1966

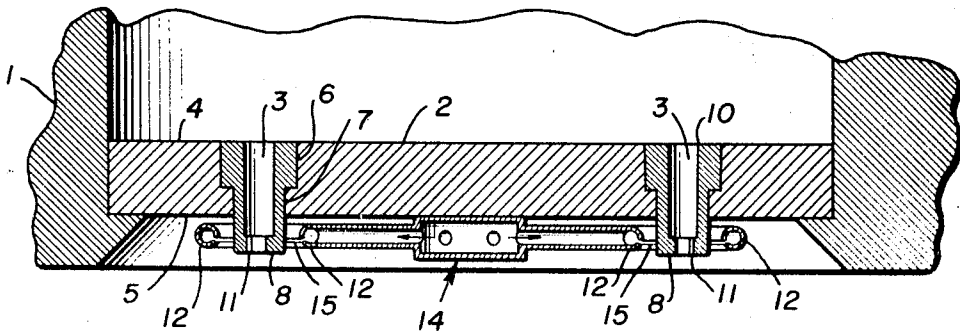


FIG. 1.

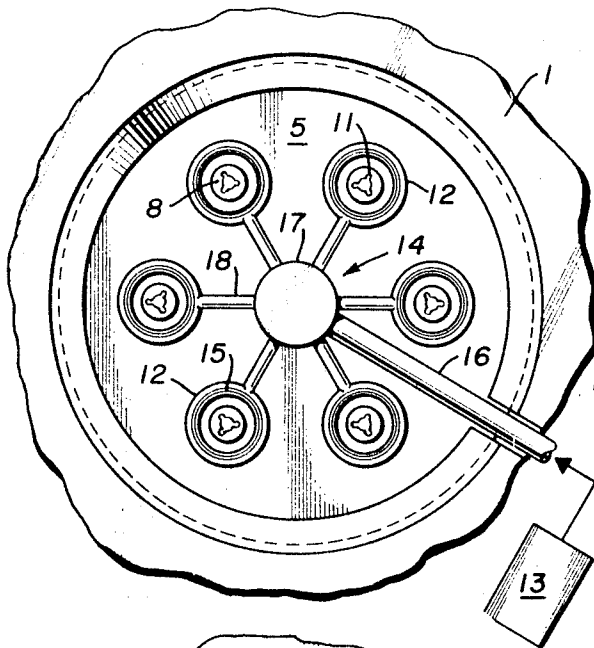


FIG. 2.

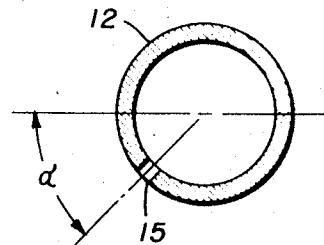


FIG. 3.

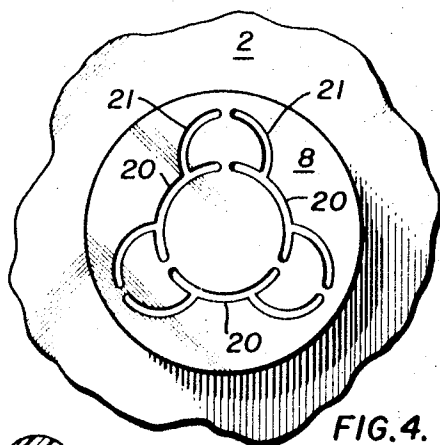


FIG. 4.

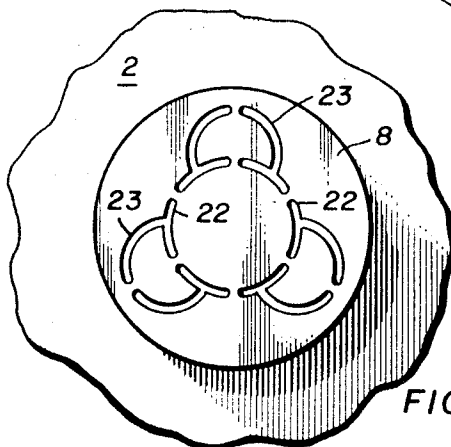


FIG. 5.

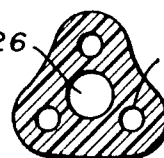


FIG. 6.

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SPINNERET FOR MAKING COMPLEX
HOLLOW FILAMENTS

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Original application Dec. 23, 1966, Ser. No. 604,287, now Patent No. 3,465,618. Divided and this application Feb. 3, 1969, Ser. No. 795,871

Int. Cl. D01d 3/00

U.S. Cl. 18—8

5 Claims 10

ABSTRACT OF THE DISCLOSURE

Melt spinning spinnerets are made by forming in a spinneret a hole of two different diameters. A hollow insert is press-fitted in the hole so that the insert extends slightly below the plane of the extrusion face of the spinneret. The insert has a counterbore communicating with a series of small passageways extending to the point of extrusion where the passageways form a pattern adapted to produce a textile filament by the coalescence of a cluster of small streams of polymer at a point below the spinneret face. The resulting filaments have a multitude of lobes and axially extending voids. During employment of the spinneret, rings surrounding the individual filaments can be used to supply a cooling fluid to solidify the filaments in a controlled manner shortly after the emergence of the streams of molten polymer from the spinneret.

The present application is a divisional application of application Ser. No. 604,287, filed Dec. 23, 1966 (now U.S. Pat. 3,465,618).

BACKGROUND OF THE INVENTION

It is well known to provide melt-spun filaments with one or more continuous axially extending holes in order for the filaments to have increased cover when used in the construction of fabrics and the like. A practical way of producing such filaments is to use an official grouping of a plurality of elongated segments in a spinneret permitting passage therethrough of molten fiber-forming polymer for each filament produced, such as disclosed in U.S. Pat. No. 3,174,364. The segments are disposed with respect to each other within each official group in such a manner that the ends of the plurality of molten streams of polymer extruded through the segments within the official group coalesce endwise shortly after issuing from the orifices. There are definite limitations as to the total amount of void that one can obtain in a filament produced by the coalesce of small polymer streams. For example, when one uses nylon-66 polymer of normal relative viscosity of, say 30–55 and conventional filament solidifying equipment, a void percentage of the total area occupied by the filament usually will not exceed 10–15%. Accordingly, it would be desirable to increase the amount of void that one can obtain at practical melt spinning speeds.

It has been suggested to provide lobes or branches in textile filaments to obtain increased cover. However, multilobal filaments possessing cross-sectional symmetry exhibit sparkles of light as can be seen from U.S. Pats. 2,939,201–2. Such sparkle is referred to as prismatic luster because the filaments actually reflect and refract light as a prism. In many end uses filaments having such sparkle are not desirable because fabrics made therefrom may be regarded by customers as being garish.

It has been disclosed in U.S. 2,965,925 to provide continuous axially extending holes in the lobular sections of man-made filaments. However, the prismatic phenomenon causing the garish sparkle in certain multilobar filaments

still occurs. To even a greater extent it would be desirable to increase the amount of void in man-made filaments while at the same time substantially to reduce or eliminate entirely the garish sparkle.

Therefore, it is an object of this invention to provide a spinneret and a spinneret assembly adapted for the practical production of man-made filaments providing increased cover by a reduction in the amount of polymer employed to constitute a filament through the presence of a multitude of holes and lobes and exhibiting reduced prismatic luster.

A further object is to provide such man-made filaments as just described.

Other objects may become apparent.

SUMMARY OF THE INVENTION

A melt-spinning spinneret is made by cutting in a spinneret blank at least one hole of two different diameters. The hole extends from the melt face to the extrusion face with the larger diameter-hole portion opening at the melt face and the smaller diameter hole portion opening at the extrusion face. For each hole an elongated insert member of two like outside diameters are shaped and force-fitted into the holes. The length of the insert is preferably greater than the thickness of the spinneret. A counterbore is cut in the larger end of the insert. A series of small passageways are cut between the counterbore and the smaller end of the insert. The small passageways are arranged to produce a complex hollow textile filament by the coalescence of a cluster of small streams of polymer normally issuing therefrom. The spinneret is placed in a conventional spinneret block of a melt-spinning apparatus. An annular member having exhaust ports for directing a stream of coolant onto the coalescing filaments is positioned around the extending ends of the inserts to provide controlled cooling of the streams of molten polymer forced through the spinneret orifices. The resulting filament is multilobal and has a central axially extending hole and a smaller axially extending hole in each of the lobes of the filament. The total cross-sectional area of the filament is 20–50% void; and the cross-sectional area of each of the voids in the lobes being about 10–75% of the cross-sectional area of the central void.

DESCRIPTION OF THE DRAWING

The invention can best be understood by reference to the following description taken in conjunction with the accompanying drawing in which:

FIG. 1 is a cross-sectional view of the spinneret assembly;

FIG. 2 is a bottom view of the spinneret plate and the distribution system of the coolant for solidifying the filaments;

FIG. 3 is an enlarged cross-sectional view of the annular ring in the coolant distribution system;

FIG. 4 is a bottom view of part of a spinneret plate showing one arrangement of an official group for producing a filament of multiple lobes and multiple holes;

FIG. 5 is a view of a second embodiment of a group of orifices;

FIG. 6 is a cross-sectional view of a melt-spun filament produced in accordance with the present invention.

With reference to FIG. 1 there is shown a spinneret assembly adapted for melt spinning multilobal filaments having a plurality of continuous axially extending holes. The assembly comprises a spinneret block 1 which is a part of conventional melt spinning apparatus. A spinneret plate 2 is carried in the block in sealed relationship. A plurality of holes 3 extend from the melt face 4 of the spinneret to the extrusion face 5 thereof. The holes

are provided with an upper hole portion 6 of larger diameter and a lower hole portion 7 of smaller diameter. In each of the holes 3 is an insert member 8. This elongated insert member has portions of different outside diameters corresponding to upper and lower hole portions.

A counterbore 10 extends from the larger end of the insert; and a plurality of small complex extrusion orifices 11 extend from the smaller end of the insert to establish communication with the corresponding counterbore. The smaller end of the insert extends slightly below the plane of the extrusion face of the spinneret face.

An annular ring 12 is positioned in encircling relation with each of the portions of the insert member that extend below the plane of the spinneret plate. A source of coolant 13 is provided; and the coolant in the form of air, steam, inert gas, water and the like is supplied through a manifold distributing system 14 to the individual rings. As can be seen in FIG. 3 the rings have an exhaust port 15 in the form of an inwardly opening annular slit from which the coolant exits and is directed onto the filaments to solidify the filaments as desired. Where a filament corresponding more closely to the shape assumed at coalescence is wanted, one may induce a quicker quenching of the melt spun filament by providing an increased rate of heat exchange.

The exit angle α of the coolant can be any suitable angle of 0° to 80°. The plane of the bottom of the insert member will normally be below the lowest point of the ring. In this manner the bottom of the insert member will be easily accessible for removal of any undesirable polymer deposits that may form on the edges of the orifices during spinning. However, if the exit angle requires the ring to be below the face of the capillaries in operation, the ring and distribution system should be designed so as to be recessed against the face of the spinneret during cleaning of the insert member.

In FIG. 2 it is seen that the distribution system 14 includes a conduit 16 connecting the source of coolant supply 13 to distributor 17 from which the coolant is apportioned to the rings 12 via smaller conduits 18.

FIG. 4 shows one preferred official grouping for making the multi-hole, multi-lobe filament of the present invention. In this arrangement three elongated extrusion orifices 20 are cut in insert 8 and arranged in a segmented pattern. Six elongated orifices 21 arranged in pairs corresponding in number to the number of lobes in the filaments branch outwardly from the annularly arranged orifices. The two branching orifices of each pair are bent to provide closely-spaced relation at the ends thereof. All the orifices of the group are spaced and arranged to provide coalescence of the polymer streams normally issuing therefrom into filaments having multiple lobes and axially extending multiple holes.

FIG. 5 shows another preferred official grouping for making the type of filaments described herein. In this case six elongated extrusion orifices 22 extend through the bottom of insert 8 and are circumferentially arranged in a segmented pattern. One orifice 23 branches outwardly from each of the annular arranged orifices 22. The branching orifices are arranged by pairs, each member of which has ends bent together to provide closely spaced relation. Again, all the orifices of the group are spaced and arranged to provide coalescence of the polymer streams into multi-hole, multi-lobe filaments.

FIG. 6 shows a cross-section of a typical filament 24 obtained by using either of the two disclosed clusters of official groupings. The filament, if completely solid, would present scintillations of reflected light normally characterizing lobular filaments of this type. However, the filaments herein have a multitude of axially extending voids and exhibit considerably reduced scintillations. In many cases the scintillations may not be manifest at all. In any event, the scintillations are of a much finer scale and of a reduced intensity. Each lobe of a filament has an axially extending hole 25 which is smaller compared to the one

central axially extending hole 26. The total cross-sectional area of the filament is 20–50% void; that is, the percentage of the total area defined by the periphery of the filament and made up of void area is 20–50. Below 20% the amount of void area is not sufficient to provide optimum covering power in the filament; and one does not obtain a reduction in scintillation and polymer usage to be practical. Above 50% collapsing of the filament may occur unless expensive care is exercised during filament formation to prevent this. The holes in the lobes are smaller than the central hole in the filaments. It is preferred that the cross-sectional area of each of the voids in the lobes be about 10–75% of the cross-sectional area of the central void in order to obtain optimum balance of greater cover and resistance to collapsing.

The spinneret can be used to produce filaments from any suitable substance that can be melt spun. Specific polymeric materials capable of being melt-spun include: nylon-66 (polyhexamethylenedipamide), nylon-6 (polycaprolactam), nylon-4, nylon-610, nylon-11, and their filament-forming copolymers thereof, e.g., nylon-6/66, 6/610/66, etc.; polyester derived from terephthalic acid or derivatives thereof and ethylene glycol; polyethylene and polypropylene; and other fiber-forming substances. By providing a proper molten polymer distribution system the spinnerets herein can be used to produce multi-component crimpable filaments having a side-by-side arrangement of dissimilar polymers.

The actual dimensions of the openings comprising an official group depend, of course, upon the characteristics of the polymer, the filament size or denier, the spinning speed, the temperature and nature of the coolant, and other factors in the particular melt-spinning processes. However, a spinneret for melt-spinning nylon-66 into filaments described above was made from a stainless steel spinneret blank of the following dimensions. The blank had a diameter of 2.030 inches and a thickness of 0.190 inch. Six official groupings were arranged in the spinneret and equally circumferentially spaced. The centers of each group were on a radial line 0.50 inch from the center of the spinneret blank. Six flat bottom round counterbores of 0.125 inch were drilled in the spinneret to a point of 0.020 inch from the face of the spinneret. From the bottom of the counterbore to the face of the spinneret a cluster of orifices as shown in FIG. 5 was machined using an electro-erosive technique. The circumferentially arranged slots were 0.003 inch thick and 0.027 inch long. Each was spaced 0.002 inch apart. The branching slots were 0.003 inch thick, 0.031 inch long, and were separated at their point of nearest approach of 0.003 inch. The spinneret was placed in a conventional melt-spinning equipment. The coolant supply system was installed as shown in FIG. 2. Nitrogen gas at 68° C. was supplied to the six spinning points via the system at a rate of 5 cubic feet per minute. Nylon-66 polymer of a relative viscosity of 42 was melted and forced through the spinneret holes. The yarn was given an orientation stretch and woven into fabric. It was noted that the yarn had a cross-section as that in FIG. 6. The yarn provided increased cover in the fabric, and it was noted that the yarn did not have the tiny sparkle normally associated with trilobal yarn.

It is apparent from the foregoing description that this invention represents a substantial advance in the art of spinneret manufacture and textile yarn made therefrom. The spinneret can be made with facility. Yarn made therefrom has a considerably large void area. This can be accomplished at high spinning speed. The prismatic luster of the present lobular yarn is of a much finer scale than that of a similar lobular yarn not having the internal void arrangement of the present invention.

It is apparent that many different embodiments of this invention can be made without departing from the spirit and scope thereof; and, therefore, it is not intended to be limited except as indicated in the appended claims.

We claim:

1. A spinneret assembly for melt spinning complex hollow filaments comprising:

- (a) a spinneret block;
 - (b) a spinneret carried in said block and having a melt face and an extrusion face with a plurality of holes of at least two different diameters, the hole portion of larger diameter opening to the melt face and the hole portion of the smaller diameter opening to the extrusion face;
 - (c) a hollow elongated insert member of corresponding different outside diameters press-fitted in each of said holes, a counterbore extending from the larger end thereof and a plurality of small complex extrusion orifices extending from the smaller end thereof and establishing communication with the counterbore, the smaller end extending slightly below the plane of the extrusion face and presenting a cluster of extrusion orifices through which polymer normally flows and coalesces into a complex hollow textile filament;
 - (d) an annular member having exhaust ports for directing a stream of coolant onto the coalescing filaments and being positioned in encircling relation with each of the portions of said insert member extending below the plane of the spinneret extrusion face; and
 - (e) means for supplying coolant to the exhaust ports of the annular rings.
2. A spinneret assembly for melt spinning complex hollow filaments comprising:
- (a) a spinneret block;
 - (b) a spinneret plate carried in said block and having a melt face and an extrusion face with a plurality of holes of at least two different diameters, the hole portion of the larger diameter extending to the melt face and the hole portion of the smaller diameter extending to the extrusion face;
 - (c) a hollow elongated insert member of corresponding different outside diameters press-fitted in each of said holes, a counterbore extending from the larger end thereof and a plurality of small complex extrusion orifices extending from the smaller end thereof and establishing communication with the counterbore, the smaller end extending slightly below the plane of the extrusion face and presenting the cluster of extrusion orifices;
 - (d) a plurality of the extrusion orifices in each cluster being elongated and annularly arranged in segmented pattern;
 - (e) a plurality of pairs of elongated orifices corresponding in number to the number of lobes in the filaments

and branching outwardly in spaced relation from the annularly arranged orifices and bent together to provide a close spaced relation at the ends thereof;

- (f) the orifices being spaced and arranged to provide coalescence of polymer streams normally issuing therefrom into filaments having multiple lobes and axially extending multiple holes;
 - (g) an annular ring having exhaust ports for directing a stream of coolant onto the coalescing filaments and being positioned in encircling relationship with each of the portions of said insert member extending below the plane of the spinneret extrusion face; and
 - (h) means for supplying coolant to the exhaust ports of the annular rings.
3. A spinneret plate for use in melt spinning textile multilobal filaments having a plurality of holes extending axially along the length of the filaments comprising:
- (a) a solid plate having a melt face and an extrusion face;
 - (b) at least one cluster of polymer extrusion orifices;
 - (c) a plurality of the extrusion orifices in each cluster being elongated and annularly arranged in segmented pattern;
 - (d) a plurality of pairs of elongated orifices corresponding in number to the number of lobes in the filaments and branching outwardly in spaced relation from the annularly arranged orifices and bent together to provide a close spaced relation at the ends thereof; and
 - (e) the orifices being spaced and arranged to provide coalescence of polymer streams normally issuing therefrom into filaments having multiple lobes and axially extending multiple holes.
4. The spinneret plate of claim 3 wherein in each cluster three elongated orifices are annularly arranged in a segmented pattern.
5. The spinneret plate of claim 4 wherein in each cluster six elongated orifices are annularly arranged in a segmented pattern and one orifice branching from each of said annularly arranged orifices.

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