

Dec. 26, 1961

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3,014,237

SPINNERET

Filed March 25, 1957

2 Sheets-Sheet 1

Fig. 1

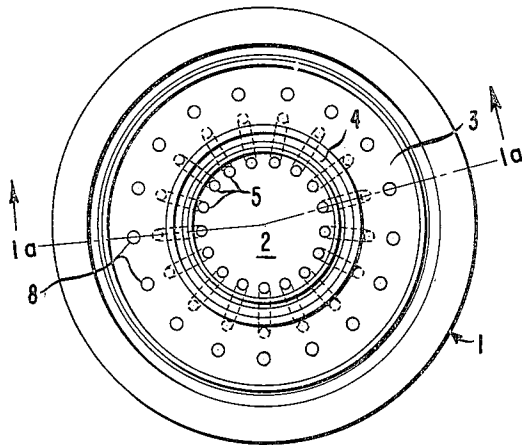


Fig. 1a

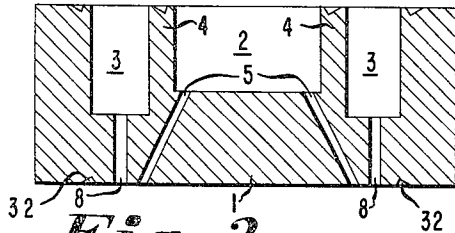


Fig. 2

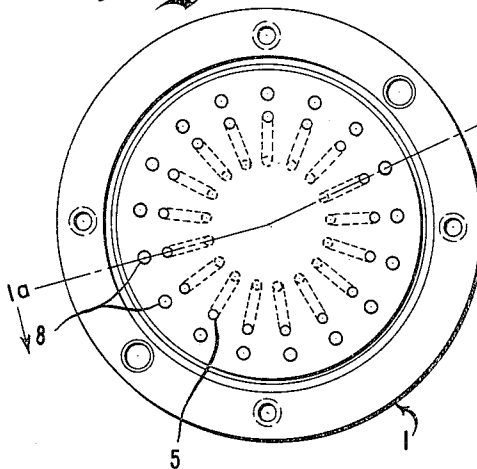


Fig. 3

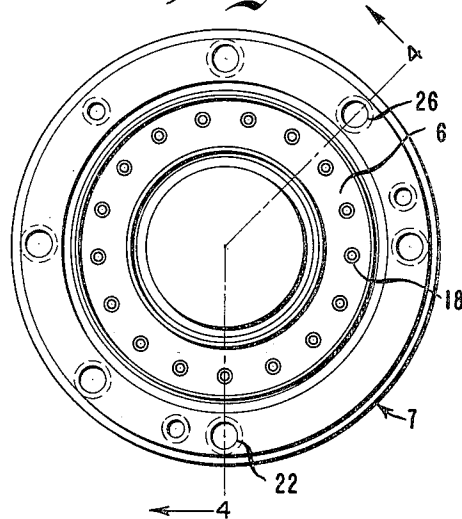


Fig. 4

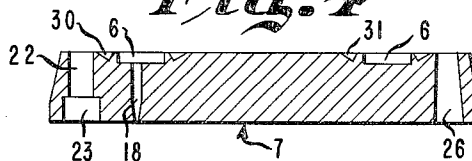
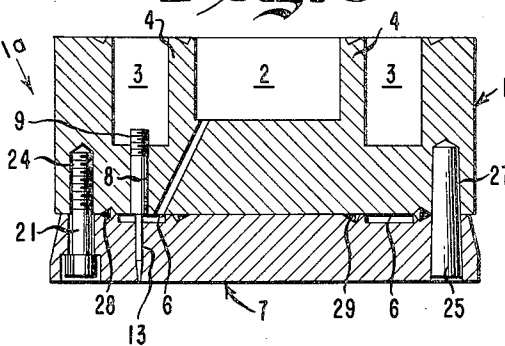


Fig. 5



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Fig. 6

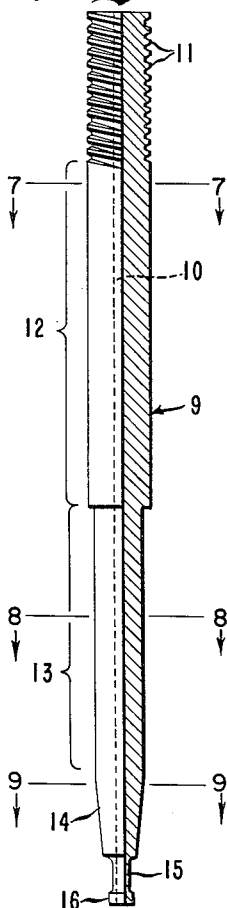


Fig. 7



Fig. 8

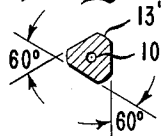


Fig. 9

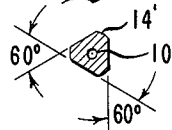


Fig. 10

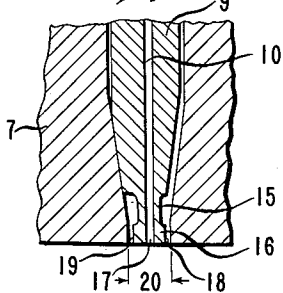


Fig. 11

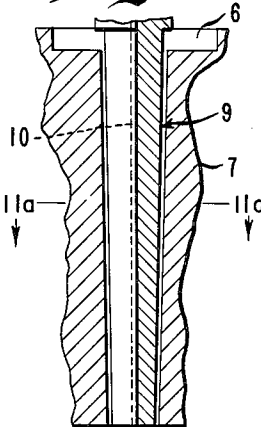


Fig. 11a

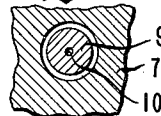


Fig. 12

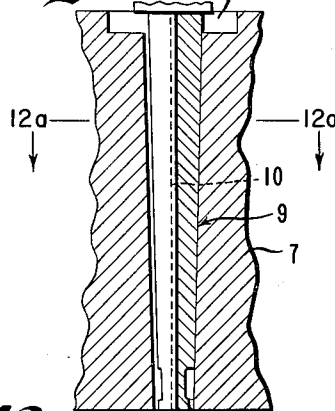
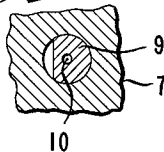


Fig. 12a



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Filed Mar. 25, 1957, Ser. No. 648,420

2 Claims. (Cl. 18-8)

This invention relates to a novel spinneret for the production of filaments.

There have been various types of spinnerets proposed for the spinning of hollow and also of composite filaments. Such spinnerets are adapted either to the production of hollow filaments or of composite filaments, but not of both, and have the further disadvantage of complexity, high cost, ineffectiveness in the production of uniform filaments of predetermined cross-section and lack of flexibility in the production of filaments over a wide range of denier. Also, many of these spinnerets are not adapted to produce filaments of which the components are, in cross-section, eccentrically disposed with respect to each other, a desideratum for the production of inherently crimpable or crimped filaments. There is a need for a design of spinneret which, in part or in whole, overcomes these and similar deficiencies.

It is an object of this invention to provide a new type of spinneret. It is a further object of this invention to provide novel spinnerets for the production of hollow and composite filaments, particularly those composed in whole or in part of synthetic linear polymers. An additional object is the provision of a new type of spinneret adaptable for the melt-spinning of filaments.

The objects of this invention have been attained by providing a spinneret in the spinning orifices of which is positioned a hollow pin connected to a source of fluid supply for extruding, simultaneously with a fiber-forming polymer, a gas, another polymer which may be fiber-forming, a molten metal or other liquid material. Such a spinneret is suitable for the production of hollow filaments and of composite filaments of various types.

Although the spinneret of this invention may be applied to the spinning of any forms of composite filaments, the following description and examples will, for purposes of illustration, be largely directed to the production of hollow filaments by the melt-spinning process.

In the drawings:

FIGURE 1 is a top plan view of the upper plate or filter pack of a spinneret used in the practice of this invention;

FIGURE 1(a) is an elevation view in cross-section of the upper plate or filter pack taken along the lines 1a-1a of FIGURE 1. The right-hand half of FIGURE 1(a) is an elevation in cross-section along the plane of the right-hand half of line 1a-1a of FIGURE 1 and the left-hand half of FIGURE 1(a) is an elevation in cross-section along the plane of the left-hand half of line 1a-1a of FIGURE 1. It will be noted that the two portions of line 1a-1a of FIGURE 1 form an angle at the center of the figure. The two halves of FIGURE 1(a) have been assembled in this fashion in order to show the shape and direction of the different holes and cavities even though they may not fall along the central plane of the spinneret;

FIGURE 2 is a bottom plan view of the apparatus of FIGURE 1 taken at a somewhat different angle than FIGURE 1, line 1a-1a of FIGURE 2 likewise showing the dual plane cut of FIGURE 1(a);

FIGURE 3 is a top plan view of the bottom plate of a spinneret used in the practice of this invention;

FIGURE 4 is an elevation view in cross-section of the bottom spinneret plate shown in FIGURE 3 with the right-hand half shown in the plane of the right-hand half of line 4-4 of FIGURE 3 (drawn to the center) and with

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the left-hand half of FIGURE 4 being cut on the plane of the vertical portion (from the center downwardly) of line 4-4 of FIGURE 3. As in the case of FIGURE 1(a), FIGURE 4 is assembled in the manner indicated to show the shape and direction of the holes and other elements of the bottom spinneret plate although, as is evident from FIGURE 3, these elements are not, in fact, aligned as shown in FIGURE 4;

FIGURE 5 is an elevation view, generally in cross-section, of the upper and lower plates of FIGURES 1, 1(a), 2, 3 and 4, in assembled position utilizing the showing of FIGURE 4 for the lower plate and the showing of co-acting parts of FIGURES 1, 1(a) and 2 for the upper plate or filter pack. FIGURE 5 shows the assembled spinneret with a full showing of the various elements, with the upper plate being shown, as assembled, in the position corresponding to that of the lower plate;

FIGURE 6 is an elevation (magnified and partly in section) of the extrusion pin shown in FIGURE 5;

FIGURE 7 is a cross-section taken on 7-7 of FIGURE 6;

FIGURE 8 is a cross-section taken on line 8-8 of FIGURE 6;

FIGURE 9 is a cross-section taken on 9-9 of FIGURE 6;

FIGURE 10 is a view in cross-section showing the details of the lower portion of the pin shown in FIGURE 6 while in operative position in the lower plate of FIGURES 3 and 4;

FIGURE 11 shows a modified form of extrusion pin; FIGURE 11(a) is a view in cross-section along line 11a-11a of FIGURE 11;

FIGURE 12 shows an additional form of modified extrusion pin; and

FIGURE 12(a) is a view in cross-section along line 12a-12a of FIGURE 12.

It can be seen from the drawings that top plate 1 of the spinneret adapted to receive the filter pack (not shown), has a central chamber 2 and an annular chamber 3 separated from each other by wall 4. In the bottom of chamber 2 are a plurality of holes 5 passing downwardly through plate 1 and diverging outwardly from each other. Holes 5 lead into shallow annular groove 6 formed in the top surface of lower plate 7 which, in assembling the spinneret, is fastened to plate 1 as described below. Holes 8 lead from the bottom of annular chamber 3 vertically downward through plate 1 and terminate at groove 6 of the lower plate 7. Pins 9, provided with longitudinal passages 10 therethrough are positioned in holes 8 with a press fit (and may be further fastened in place by a spline or other means for insuring a tight fit, if desired) with the upper ends of pins 9 extending above the bottom of annular chamber 3 as shown. The press fit of pins 9 may be supplemented by the action of circular serrations 11 provided at the top of pins 9 to grip the inside of holes 8.

Pins 9 are circular in cross-section in the portion 12 in contact with holes 8, as shown in FIGURE 7, having a diameter sufficient to give a press fit in holes 8, pins 9 in the major portion 13 passing through plate 7, having a cross-section which is partly arcuate (as shown at 13') but which has, as by cutting the pin to form chords in the cross-section of the pins, the general shape of a mutilated triangle as shown in FIGURE 8. Pin 9 then tapers at 14 near its lower part to a smaller, partially arcuate (as shown at 14') but generally mutilated triangular cross-section as shown in FIGURE 9, the next lower portion of pins 9 being necked down at 15 (to form an annular groove) and terminating in a short annular cylindrical section 16 somewhat larger in diameter than neck portion 15 as shown in FIGURES 6 and 10, with the ends of pins 9 being flush with the outer

face of plate 7 and with holes 10 terminating in orifices 17. Plate 7 is formed with holes 18 passing through plate 7, holes 18, which are tapered at their lower ends, having a circular cross-section throughout equal in diameter to the arcuate portions of sections 13 and 14 of pins 9 to insure a tight fit between the contacting surfaces.

It will be noted that annular orifice 19 is formed at the outer surface of plate 7 by the clearance between orifice 18 of the plate 7 and the outer and smaller cylindrical portion 16 of pin 9. The total area of the outer end of orifice 18 (inclusive of orifice 17 and the annular cylindrical portion 16 of pin 9) is collectively referred to as the extrusion orifice designated as 20 in the drawings.

Plates 1 and 7 are fastened with threaded bolts 21 passing through holes 22 in plate 7 with the bolt heads being received in counterbore 23 and abutting at their inner surface the shoulder of counterbore 23, bolts 21 being fastened into corresponding threaded holes 24 in plate 1. After the plates 1 and 7 are assembled and fastened in place by bolts 21, proper alignment is assured by insertion of tapered pins 25 of round cross-section having a drive-fit into tapered holes 26 of plate 7 and registering tapered holes 27 of plate 1, the ends of pins 25 being drawn into position above and clear of the outer surface of plate 7.

Gaskets 28 and 29 are inserted in plate 7 prior to assembling the spinneret and are pressed in place as shown respectively into circular grooves 30 and 31 (gasket 28 being additionally pressed into a corresponding circular groove 32 in plate 1) when plates 1 and 7 are fastened together so as to prevent leakage of the polymer fluid, metal or gas between the plates.

The apparatus is connected with suitable piping and filter packs (not shown) as required to supply a molten polymer and a gas to the spinneret.

In the melt-spinning processes preferred in the practice of this invention, a gas, preferably a gas which is inert towards the fiber-forming polymer, flows from annular chamber 3 through longitudinal passages 10 of pins 9 and out of the spinneret to form the center of the filament. Molten polymer flows from central chamber 2 through holes 5 into annular groove 6 (through which pins 9 pass) downwardly through the passages in plate 7 formed by the clearance between the pin (at its non-arcuate periphery) and hole 18 of plate 7 (shown clearly in FIGURE 10 which represents pin 9 in plate 7 turned from its position in FIGURE 6 in order to show the clearance between pin 9 and plate 7), then along the groove formed at neck 15 and outwardly as a sheath through annulus 19.

It is, of course, understood that the design of apparatus is capable of considerable variation. Thus pins 9, instead of being non-circular in cross-section within plate 7, may be circular in cross-section with sufficient clearance being provided between the pins 9 and holes 18 to permit passage of the polymer around the pins 9 as a sheath. Such a form of pin is shown in FIGURES 11 and 11(a). This modified pin has a taper of 1/4-inch per foot, is approximately 3/4 of an inch long in the taper beginning at the bottom of back plate 1 and extending to the spinning orifice. A further form of pin is illustrated in FIGURES 12 and 12(a) in which the pin is essentially circular in cross-section diminishing at its lower end as in FIGURES 6 and 10, except that the section of the pin from the bottom of back plate 1 to the groove 15 is cut on a chord so as to provide clearance between the pin and spinneret plate 7, thereby permitting fiber-forming polymer to pass from annular groove 6 to the spinneret orifice; this is adapted to give an eccentric feed of polymer so that the hollow filament will be uneven in cross-section for the production of inherently crimpable filaments.

In the examples, the relative viscosity (η_r) i.e., the viscosity of a solution of polymer relative to that of the

solvent is used as the measure of the molecular weight. The polyester solutions contained 2.15 g. of the polymer in 20 ml. of a 7/10 mixture by weight of trichlorophenol/phenol and the viscosity was measured at 25° C.

The following examples in which parts, proportions and percentages are by weight unless otherwise indicated, are intended to illustrate this invention and in no manner to limit it.

Example I

A spinneret similar to that shown in FIGURES 1 to 10 but having 5 spinning orifices, was made having orifices (20) of 0.063 inch in diameter in which the pin 9 had an opening 10 of 0.020 inch and had an outside diameter of 0.057 inch at the lower edge of the spinneret plate. Mol ten poly(ethylene terephthalate) with a relative viscosity of 32 containing 0.3% TiO_2 (as a delusterant) was spun at 280° C. into air at room temperature and the yarn was wound up at 950 y.p.m. (yards per minute). The pressure on the chamber 3 was controlled by means of a suitable bleed-off system and reducing valves (not shown) from a tank of nitrogen so as to have a gauge pressure of about 13.5 mm. of water. The hollow as-spun filaments has an inside diameter/outside diameter ratio of 0.70 which corresponds to about 50% by volume of void and were of uniform cross-section throughout their length. The yarn was drawn 200% (to 3 times undrawn length) on a drawing pin maintained at 83° C. The drawn yarn had a denier per filament of 3.3, a tenacity of 3.6 grams per denier, a dry elongation of 34% at the break and an initial modulus of elasticity of 65 grams per denier. Two worsted fabrics of similar construction were woven respectively from yarn made from staple fibers cut from these hollow poly(ethylene terephthalate) continuous filaments and yarn made from staple fibers cut from solid continuous poly(ethylene terephthalate) filaments of the same denier. The fabrics were mounted flat on a board and submitted to the abrading action of a cellulose sponge that revolved in contact with the fabric at a selected, uniform speed on an axis perpendicular to the fabric surface. After 15 minutes' sponging, the fabric containing hollow filaments showed only 6.4 pills per square inch as compared to 33 pills per square inch on the control fabric. By "pills" is meant the small balls of fibers that collect on the surface of a wool-like fabric. The superior resistance to pilling of a fabric made from the hollow filaments was quite surprising.

In a second spin, using the same equipment and polymers as before, but with the nitrogen pressure reduced to a gauge pressure of 6 mm. of water, continuous filaments having an inside diameter/outside diameter ratio of 0.5 (which corresponds to a hollow space of about 25% of the filament volume), were made and subsequently drawn 220% on a draw pin maintained at 83° C. as before, to obtain a strong, yet bulky, yarn.

By increasing the gas pressure above 13.5 mm. of water (gauge), satisfactory spinning was obtained and yarns made having an inside diameter/outside diameter ratio of 0.86 (about 75% hollow space).

Example II

A spinneret similar to that shown in FIGURES 1 to 10 but having 12 spinneret orifices, was constructed with the pin 7 having a hollow passage 10 of 0.006 inch in diameter and a lower outside diameter of 0.030 inch. The orifices 20 of the spinneret had a diameter of 0.034 inch. Poly(ethylene terephthalate) of relative viscosity 32 was melt-spun from this spinneret at 288° C. using a nitrogen-gas gauge pressure of 24 mm. of water and the hollow filaments were wound up at 1,000 yards per minute. The yarn was drawn 160% over a draw pin maintained at 90° C. The resulting filaments contained 50% by volume of hollow spaces, and had a denier per filament of 1.8. A yarn of solid filaments of the same polyester was spun and drawn under similar conditions for

comparison. Physical properties of the filaments are given below:

Item	Drawn Denier	Tenacity, gm./Denier	Dry Elongation, Percent	Initial Modulus
Hollow drawn, 160%-----	1.8	3.8	42	35
Solid drawn, 280%-----	3.4	3.6	59	23

It was quite surprising that a lower draw ratio could be used to obtain equivalent tenacity and initial modulus with the hollow filament as compared to a solid filament of the same polymer.

The continuous hollow filaments and control solid filaments described above in this example were cut into staple length and spun into a worsted-count yarn and fabrics woven therefrom. After weaving and finishing under similar conditions, the hollow filament fabric had a greater covering power (15% more cover per unit weight of fiber) than the control fabric. The pilling tendency of the fabric containing hollow filaments was about $\frac{1}{3}$ that of the fabric made from the solid filaments in this construction.

Sweaters knitted from the staple made from the hollow filaments made as described above in this example were softer, more luxurious and weighed 40% less than sweaters with the same covering power made from the staple fiber cut from the solid continuous filaments of the polyester.

The spin of this example was repeated, but the gas pressure reduced to about 10 mm. (gauge) of water so as to provide a final drawn yarn having 10% gas space by volume. A worsted-type fabric was woven from yarns spun from staple cut from these continuous filaments similar to that above. The fabric from the 10% gas-containing filaments had cover equivalent to that of a solid fiber fabric but weighed 15.5% less. However, the fabric did not exhibit the resistance to pilling possessed by fabrics made from the 50% gas hollow filaments.

A bundle of 50% gas-containing hollow filaments made as above in this example were immersed in a 2% dispersion of the dye Artisil Direct Blue (PR 62) in acetone. After air drying, the filaments were colored medium blue and showed no tendency toward crocking in rubbing off of the dye. When solid filaments of the same polymer were treated in the dye bath, they were stained only a light blue and the dried filaments crocked badly.

In a similar manner, the hollow filaments of this example, dyed with the vat dye Indigo Violet exhibited freedom from crocking.

Example III

A skein of drawn hollow poly(ethylene terephthalate) filaments as prepared in Example I was cut into short lengths with a sharp razor blade. The staple fiber thus prepared was covered with a 5% solution of cellulose acetate in acetone. After one minute, the solution was decanted, the fiber rinsed twice with acetone and the fiber air-dried. Examination of the dried fiber under microscope revealed that the hollow ends of all the fibers were completely sealed by a plug of cellulose acetate, although the individual filaments were not stuck together. The product had an actual density of about 0.7 gram/centimeters³ (cubic centimeters) with an apparent density in loosely compacted form of about 0.01 gram/centimeters³ and floated on water indefinitely without losing its buoyancy. The product is thus a good substitute for kapok fiber for use in lifebelts and like articles.

A similar product was obtained by cutting a tow of continuous hollow filaments with a flying knife staple cutter that had a dull blade. The pressure of the cutting effectively sealed the ends of the staple.

The thermoplasticity of melt-spun filaments can also be utilized in preparing the permanently-buoyant, low density staple of this example. In order to prevent adhesion between adjacent filaments, a finish containing an aqueous dispersion of a silicone should be applied to the tow of hollow filaments. After drying, the tow is cut by a revolving knife staple cutter that is heated to approximately the fiber melting point and purposely kept somewhat dull. Temperatures below the melting point down to room temperature have been effective also, presumably due to the heat generated on impact.

A novel product is made by subjecting staple cut from hollow filament (about 40% voids) of poly(ethylene terephthalate) to a pressure of about 10,000 p.s.i. in a bale crimping cylinder. Partial but random collapse of the hollow spaces occurs so that the fiber bulk is decreased but the fibers display a softer hand in fabric than the uncompressed ones. The use of a stuffer box crimper affords a more regular and controlled intermittent collapse of hollow filament structures at sufficiently high pressures.

Novel effects may be produced by pulsating the flow of gas forming the hollow core thereby varying the thickness and diameter of the filament wall so as to give filaments similar to the thick and thin solid filaments made by prior art processes. In this modification the pulsation will normally be so controlled as to maintain continuity of the gas core during spinning.

The following example illustrates the making of potentially crimpable and crimped hollow filaments in accordance with the present invention.

Example IV

A spinneret was made similar to Example I except that pin 9 shown with a reduced section 14 through the spinneret plate, is shaped with section 14 being reduced in diameter as compared with portion of pin 9 above the spinneret plate, and with the same reduced cross-section down to the neck portion 15. Section 14 of pin 9 is cut throughout its length on a chord plane as shown in FIGURES 12 and 12(a) of the drawings thereby providing passage for the molten polymer through the spinneret plate lengthwise of section 14 down to groove 15 in pin 9. Poly(ethylene terephthalate) having a relative viscosity of 36 was melt-spun at 280° C. into air at room temperature together with nitrogen (through passage 10 of pin 9) at the gas pressure of Example I with conditions adjusted to give 50% gas-containing filaments, and the yarn was wound up at 3,000 yards per minute. Without further processing the yarn was strong and bulky having much the same properties as the 50% gas space yarns of Example I. It differed from the yarn of Example I in that the filament wall thickness varied more or less uniformly with the maximum wall thickness being about twice the wall thickness of the filament section diametrically opposite. This varying wall thickness resulted from the design of pin 9 described above which effected the feed of more polymer to one side of the spinneret orifice 20 than to the other.

On exposure to boiling water, free of tension, the yarn became tightly coiled with each filament taking on a helical configuration, and (as determined by microscopic inspection) with the heavy-walled region of the filament being toward the inner side of the coils. This coiled or crimped yarn showed a high degree of stretchiness when made into knitted fabrics and significant bulkiness in woven fabrics of suitable construction.

The crimped fibers of this Example IV can be subjected to a pressure in the neighborhood of 10,000 pounds per square inch with a piston-cylinder type of press into which a mass of yarn is fed, and random partial collapse of the hollow spaces in the filaments will occur with interesting application to conversion into textile fabric having pleasing novel optical effects and fabric hand and feel. It is preferable, in this application of the invention, to have a gas-polymer ratio in the fila-

ments such that the hollow spaces will be 40% or less of the volume of the filament so as to resist too much collapse of the filaments under the applied pressure. With higher pressures, e.g., 40,000 pounds per square inch, collapse of the hollow filaments is almost total with the imparting of a cotton-like random ribbon-like form to the filament which is also useful to produce novel effects when processed into fabric.

While hot water has been mentioned in the above Example IV as a shrinking agent to develop crimp, other shrinking agents may be used to effect crimping.

The following example illustrates how the same equipment described above may be used in forming composite filaments comprising a fiber-forming polymer as a sheath together with a metal core.

Example V

A six-hole spinneret similar to that shown in FIGURES 1 to 10 of the drawings having extrusion orifices 20 with an outside diameter of 0.035 inch and end 15 of center tubes 9 having an outside diameter of 0.029 inch and an inside diameter for orifice 17 of 0.004 inch was made. Poly(ethylene terephthalate) of relative viscosity 32 was melt-spun as a sheath around a molten core of an alloy comprising 40% bismuth, and 60% tin having a melting range of 138–170° C. The spinneret head was maintained at 288° C. and the composite filaments were spun into air at room temperature (75° F.) at 500 yards per minute. The as-spun filaments had an outside diameter of approximately 0.006 inch with a uniform metal core of about 0.0043 inch in diameter. The core occupied about 50% of the filamentary volume. The ends of the metal core of a two foot length of the as-spun yarn were slivered to facilitate making connections and electrical measurements made. The yarn had a resistance of 100 ohms per foot and carried a current of 0.10 ampere for an indefinite period of time without causing any change in appearance of the polymeric sheath or making the composite filament hot. Under a current of 0.125 ampere the metallic core fused apart. This yarn, as spun, was drawn 100% in a 125° C. oil bath by hand to give a strong filament with a continuous metal core having an average diameter of about 0.003 inch completely surrounded by a uniform polyester sheath. The as-spun filaments could not be drawn at room temperature since the core broke at a low elongation and the sheath soon after. However, a filament prepared in a similar manner but with about 28% core could be drawn at room temperature 150%. The core fractured into segments. A filament with an oriented sheath and a similarly segmented core was also made by cold drawing a similar filament with a 33% core.

It will be understood that filaments having the fractured core of the above example present interesting and useful decorative effects in the composite filaments and fabrics made therefrom.

Materials used in accordance with the above example may be any metal that is molten at a temperature at which the polymer for the sheath is stable. Such metals include tin, lead, bismuth, lithium, selenium and their alloys with each other and such metals as an antimony and zinc as for example, bismuth solder, battery plate, white metal, aluminum solder and eutectic alloy, to name a few.

The hollow extrusion pins in the spinneret of this invention may be varied in exterior and interior size as desired. For filaments of regular cross-section, the hollow pins are, by virtue of the novel spinneret design, readily centered in the spinning orifices. However, they may be positioned off-center in the spinning orifices so as to give filament walls of varying thickness to produce filaments which may readily be crimped on exposure to boiling water, free of tension, as in Example IV.

Although this invention has been illustrated with filaments having a round cross-section, it will be obvious to those skilled in the art that the spinneret can be modified

within the realm of this invention to spin various cross-sections, whether or not the products made have hollow cores or solid cores. By modifying the shape of the orifice (20), cruciform, square, and triangular cross-section shaped filaments may be spun. Such filaments have the advantages of round hollow filaments but confer a different hand to fabrics made therefrom.

The shape of the hollow or solid core itself can be modified by changing the shape of passage 10 at the tip of pin 9. Round fibers having non-round voids such as oval, triangular, square or star-shaped may be made. The latter two modifications can be combined to give non-round filaments having non-round voids.

In making hollow filaments as above described, the gas pressure is preferably slightly above atmospheric pressure so as to prevent collapse of the filament at the spinning orifice. The gas pressure at the orifice may be suitably controlled so as to permit partial shrinkage of the spinning polymer on solidification beyond the spinneret orifice. In addition to preventing the inherent shrinkage of the polymer on solidification of the hollow filaments, the air pressure may be lessened slightly to permit partial collapse or retraction of the tubular filament. This can be done by proper control of the air pressure in chamber 3 or by suitable design of hole through pin 9. It is preferred that the air pressure in chamber 3 be not greatly in excess of atmospheric pressure, e.g., not more than about 30 mm. gage water pressure.

The hollow products described above in the practice of this invention are of great advantage in textile applications. They confer greater warmth and covering power than solid filaments at equivalent weights and confer a different and, for some applications, a more desirable hand to fabrics made therefrom. Those filaments containing more than 10% hollow space by volume are particularly valuable in that, when made into worsted-type fabric, they have a significantly lower tendency to pill than fabrics of solid filaments.

Hollow fibers offer a route to many new and useful products. All manner of substances, in a solution or as a melt, can be used to fill the hollow space or coat the inner wall of the filaments by treating the filaments in a vacuum chamber and then releasing the vacuum. A non-abrasive, but delustered filament, can be made by placing a pigment in the core, e.g., by filling with a solution of BaCl₂ and then treating the filament with sulfuric acid; this product is opaque to X-rays. Novel effects are obtained by placing luminescent or fluorescent materials in the hollow core. Silver or gold mirrors can be deposited on the walls of the hollow space. Substances such as a halomethylated phosphate as shown in U.S. 2,686,769, and like materials can be placed in the hollow core to render the filaments flame-proof. In all the above-mentioned applications, the added substances are protected by the outer layers of the polymer and, hence, are retained in the filament through rough usage.

The spinneret of this invention can also be used to produce composite filaments of which at least one component is fiber-forming, the other component preferably, though not necessarily, being fiber-forming. This may be done by extruding a core material in liquid form through the hollow pins.

The invention is preferably use in the melt-spinning of polymers such as polyesters and polyamides. However, the spinneret may also be used for the spinning of filaments composed in whole or in part of cellulosic fiber-forming materials, or synthetic addition polymers such as acrylonitrile polymers, either by wet or dry spinning processes.

Because of their commercial availability, ease of processing and excellent properties, the condensation polymers and copolymers, e.g., polyamides, polysulfonamides and polyesters and, particularly those that can be readily melt-spun are preferred in the practice of this invention. Suitable polymers can be found, for instance, among the

fiber-forming polyamides and polyesters which are described, e.g., in U.S. Patents 2,071,250; 2,071,253; 2,130,523; 2,130,948; 2,190,770; 2,465,319 and in other places. The preferred group of polyamides comprises such polymers as poly(hexamethylenedipamide), poly(hexamethylene sebacamide), poly(epsilon-caproamide) and the copolymers thereof. It will be understood from the above description, however, that polyesters, because of the resistance to pilling characteristic of polyester fabrics comprising hollow filaments, are preferred for hollow filament production. Among the polyesters that may be mentioned, besides poly(ethylene terephthalate), are the corresponding copolymers containing combined therein, in addition to the terephthalate radical, other acid radicals such as sebacic acid, adipic acid, isophthalic acid, as well as copolymers containing recurring units derived from glycols with more than two carbons in the chain. Other polyesters are those homopolymers derived from the above-mentioned acids and glycols.

The spinneret of this invention is of advantage in that it is of a very simple construction, is readily maintained, readily permits spinning of the various types of filaments referred to herein, permits the accurate positioning of the hollow or solid core in the filaments for the production of filaments uniform along their length, and may easily be cleaned.

The invention is particularly applicable to the making of filaments (and of yarns comprising said filaments, whether continuous filaments or staple fibers) having deniers of the magnitude used in textiles, e.g., a denier per filament in the range of 1 to 10 (inclusive) and a yarn denier of 30 to 8,000 (inclusive). The filaments may be made into knitted or woven textiles either unblended or blended with other synthetic or natural fibers. Blending may be effected during the manufacture of the yarn, e.g., by blending wool with staple fibers of filaments spun in accordance with the invention, or by combining yarns of the filaments made by this invention with yarns composed of other fibers.

Any variation from the above description of the invention which conforms to the spirit of the invention, is also intended to be included within the claims.

I claim:

1. An improved spinneret plate assembly for producing filaments of a first given organic composition, said filaments having an annular transverse cross section and provided with an interior portion containing a second given composition of matter, said spinneret plate assembly comprising a housing unit, the structure of said housing unit constructed and arranged to define a first chamber for the first given organic composition and a second chamber spaced therefrom for the second given composition, the structure of said housing unit further defining openings into each of said chambers for supply of said organic compositions into the respective chambers, the structure of said housing unit further defining a spinneret face, a plurality of passageways, one end of each passageway intersecting one of said chambers and the other end of each passageway intersecting the spinneret face to form a plurality of extrusion orifices, said passageways provided,

adjacent the spinneret face with radially inwardly extending portions forming restrictions in each of said passageways, each of said passageways containing a pin element, said pin element having a first portion closely fitted and frictionally secured in said passageway adjacent the intersection with said one of said chambers, and a second portion extending along said passageway into the vicinity of said extrusion orifices in the spinneret face, said second portion of said pin element provided with exterior shoulder means positioned in abutting engagement against the said radially inwardly extending restricted portion of said passageway, the frictional fit of the first portion of said pin elements and the engagement of the shoulder means of the second portion of said pin elements with the restricted portions of said passageways serving to positively align and secure said pin elements at two spaced points along their lengths in a desired position with respect to said extrusion orifices, the structure of each of said pin elements having cut away portions provided in the exterior of the pin element to form channels extending from a position intermediate the pin element ends to the end of the pin element adjacent the extrusion orifice, the structure of said housing unit further defining a plurality of conduits connecting the other of said chambers with each of the channels formed in each of said pin elements so that the composition in said other chamber may pass through the conduits in the housing unit and through the channels along the exterior of the pin elements to the extrusion orifices, each of said pin elements provided with a longitudinally extending interior passageway connecting the end of said pin element in said passageway adjacent said one of said chambers with the end of said pin element in the vicinity of said extrusion orifice so that the composition in said one chamber may pass through the interior passageway in said pin element to the extrusion orifice concurrently with the passage of the composition in said other chamber to said extrusion orifices.

2. The improved assembly of claim 1 in which the said shoulder means on said pin elements comprises circumferentially spaced segmental abutments contacting the restricted portion of said passageways in at least three circumferential points to provide a centering action for the pin elements with respect to the extrusion orifices.

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UNITED STATES PATENT OFFICE
CERTIFICATION OF CORRECTION

Patent No. 3,014,237

December 26, 1961

Alvin L. Breen

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 5, lines 73 and 74, for "curter" read -- cutter --; column 8, line 8, for "hololw" read -- hollow --; line 63, for "use" read -- used --; column 9, line 33, for "unblend d" read -- unblended --.

Signed and sealed this 24th day of April 1962.

(SEAL)

Attest:

ESTON G. JOHNSON
Attesting Officer

DAVID L. LADD
Commissioner of Patents