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Schwarz

(54) FIBROUS WEBS OF BI-COMPONENT MELT-BLOWN FIBERS OF THERMOPLASTIC POLYMERS FROM A BI-COMPONENT SPINNERETTE ASSEMBLY OF MULTIPLE ROWS OF SPINNING ORIFICES

(76) Inventor: **Eckhard C.A. Schwarz**, Neenah, WI (US)

Correspondence Address:
Eckhard C.A. Schwarz
P.O. Box 512
NEENAH, WI 54957-0512 (US)

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(57) **ABSTRACT**

Fibrous webs of bi-component fibers are made by extruding a polymer through one set of nozzles arranged in multiple rows, and another polymer through a second set of nozzles each of which surround a nozzle of the first set. In the design of having a nozzle inside a nozzle, contact between polymer pairs can be avoided inside a spinnerette, and bic-omponent fibers of unique properties can be produced. Polymer pairs can be grouped together which could not be co-extruded in traditional designs where laminar flow of layered molten masses of different polymers is rerquired.

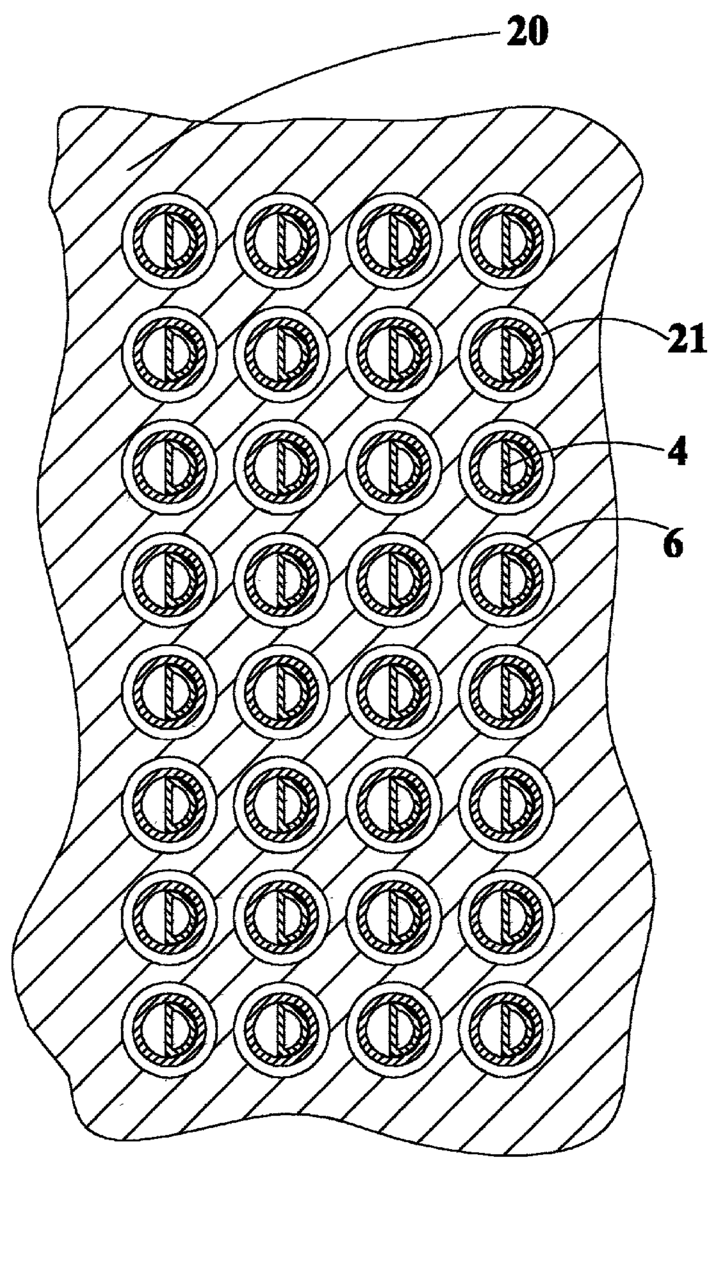
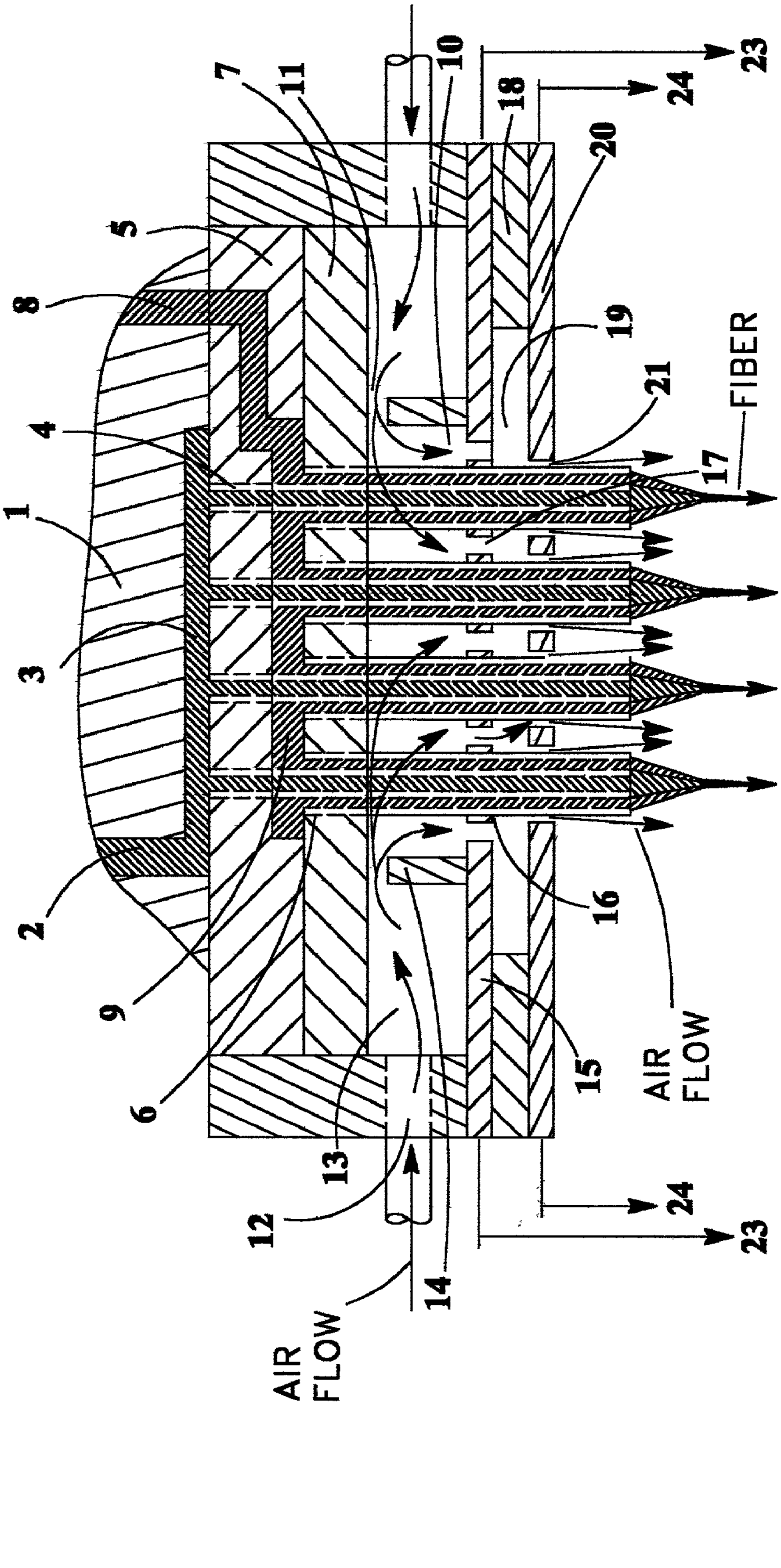
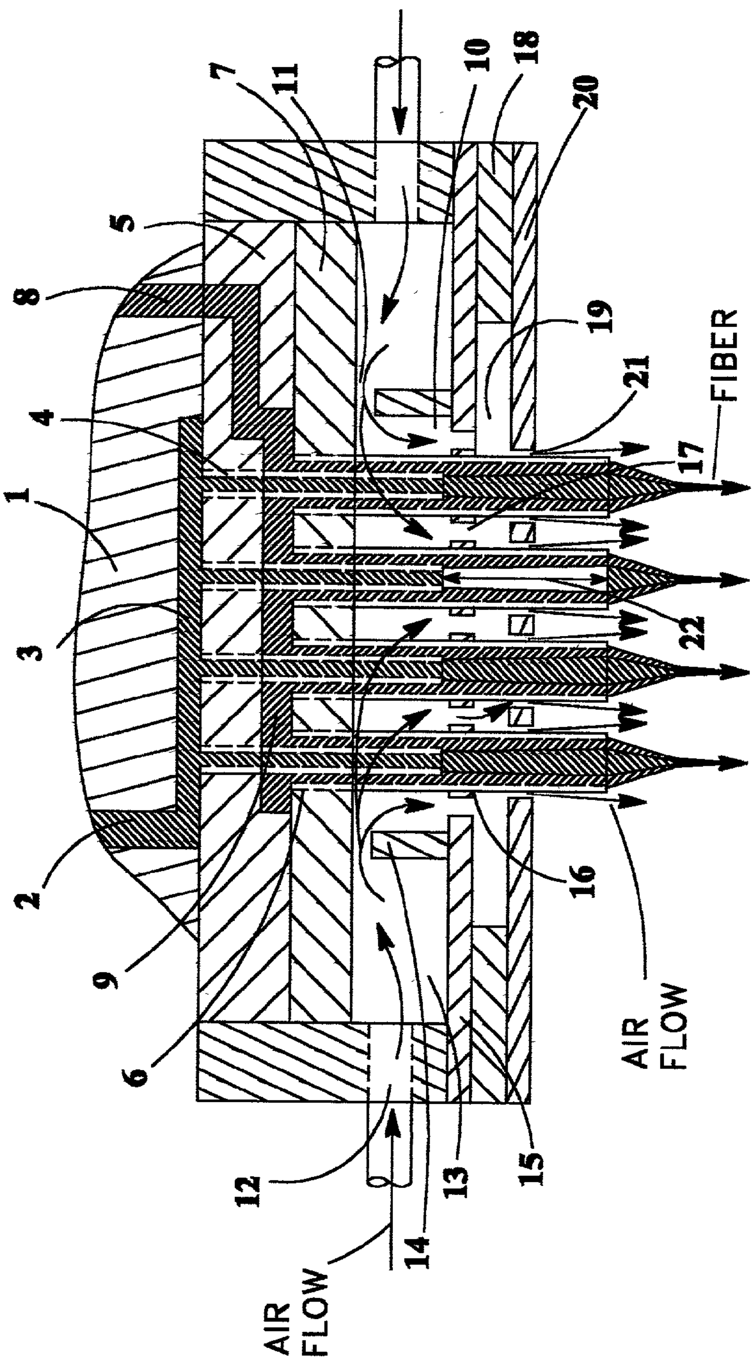


FIG. 1A




AIR FLOW
AIR FLOW
FIBER
1
2
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4
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6
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FIG. IB

FIG.2A

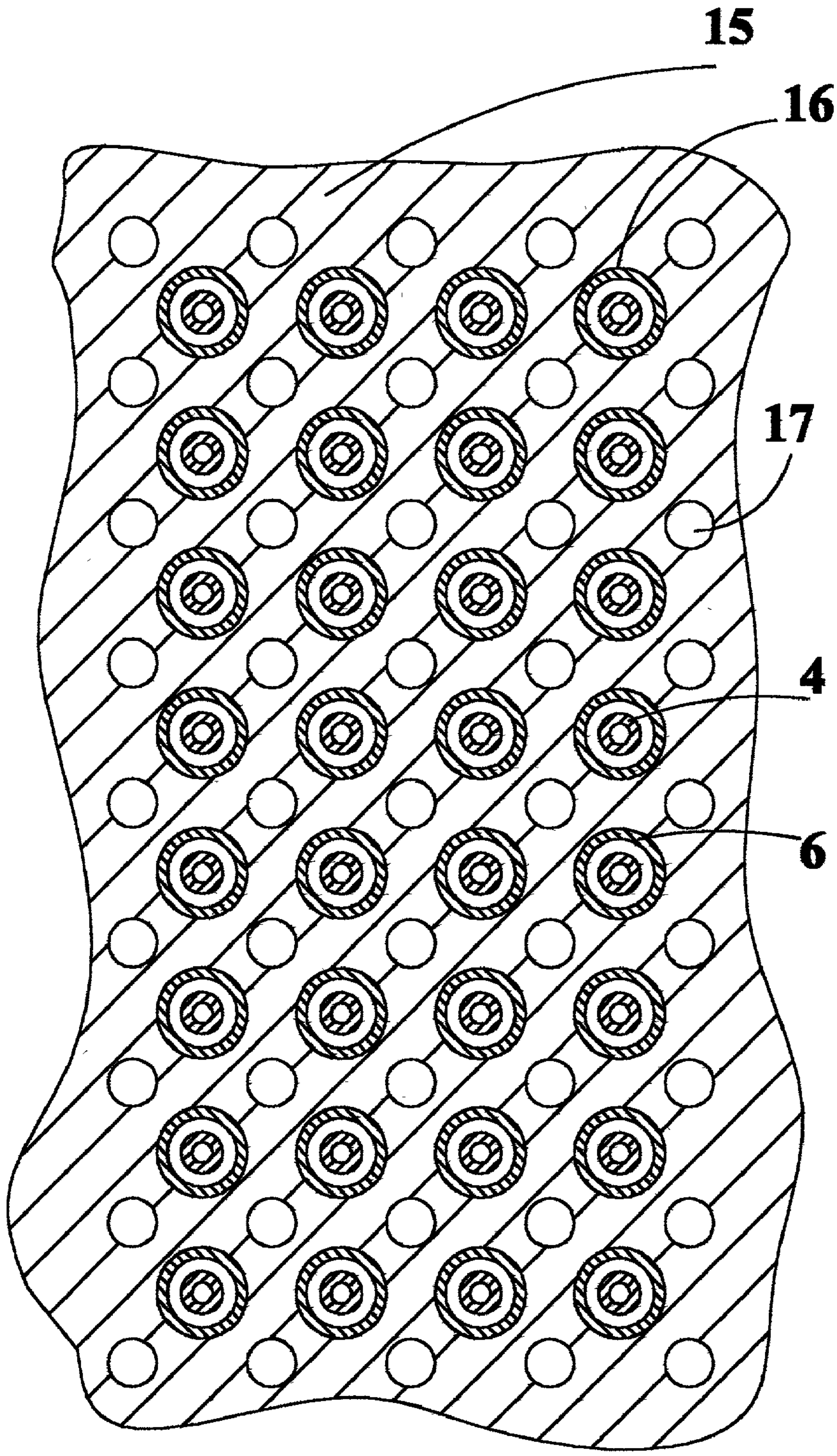


FIG. 2B

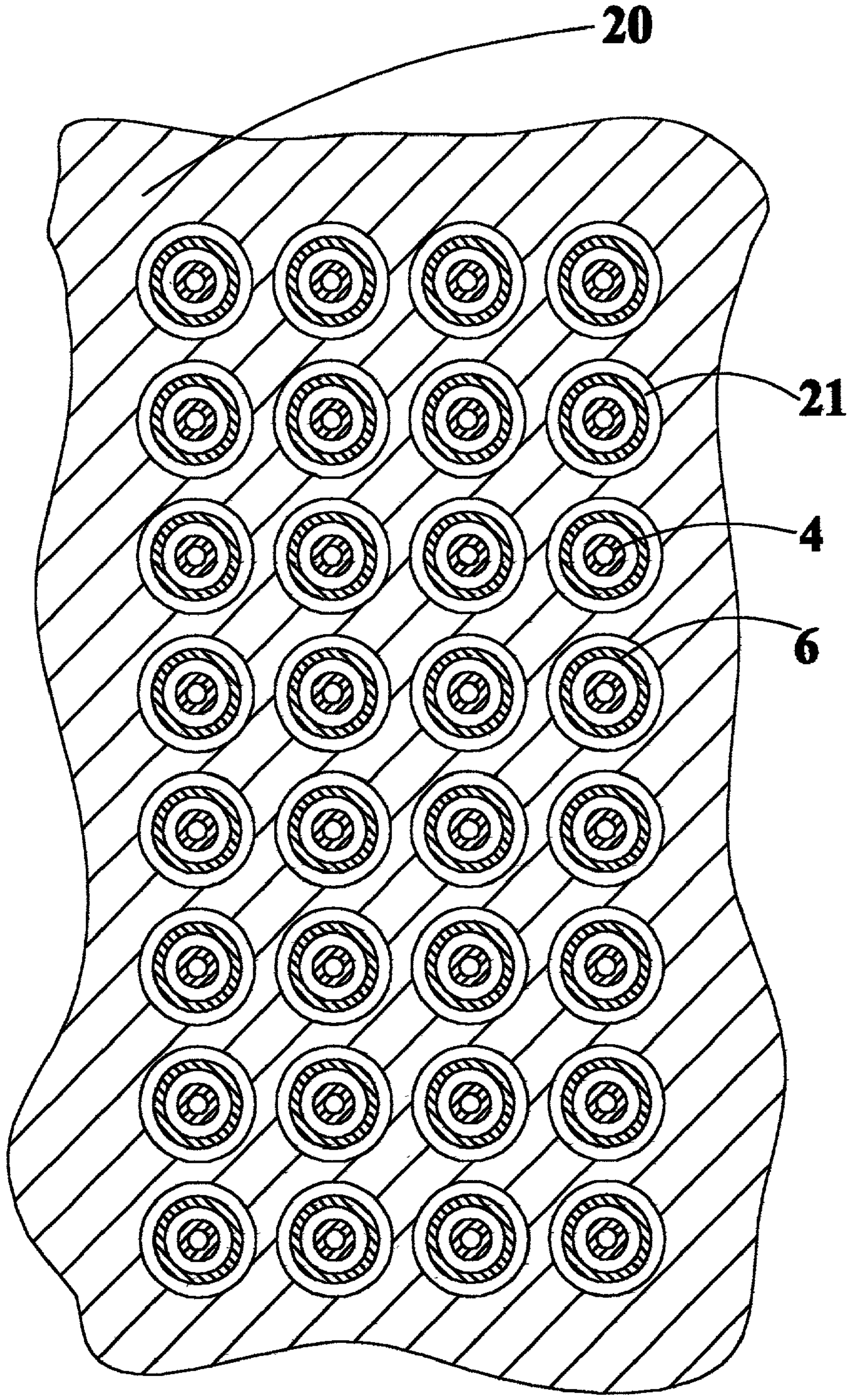
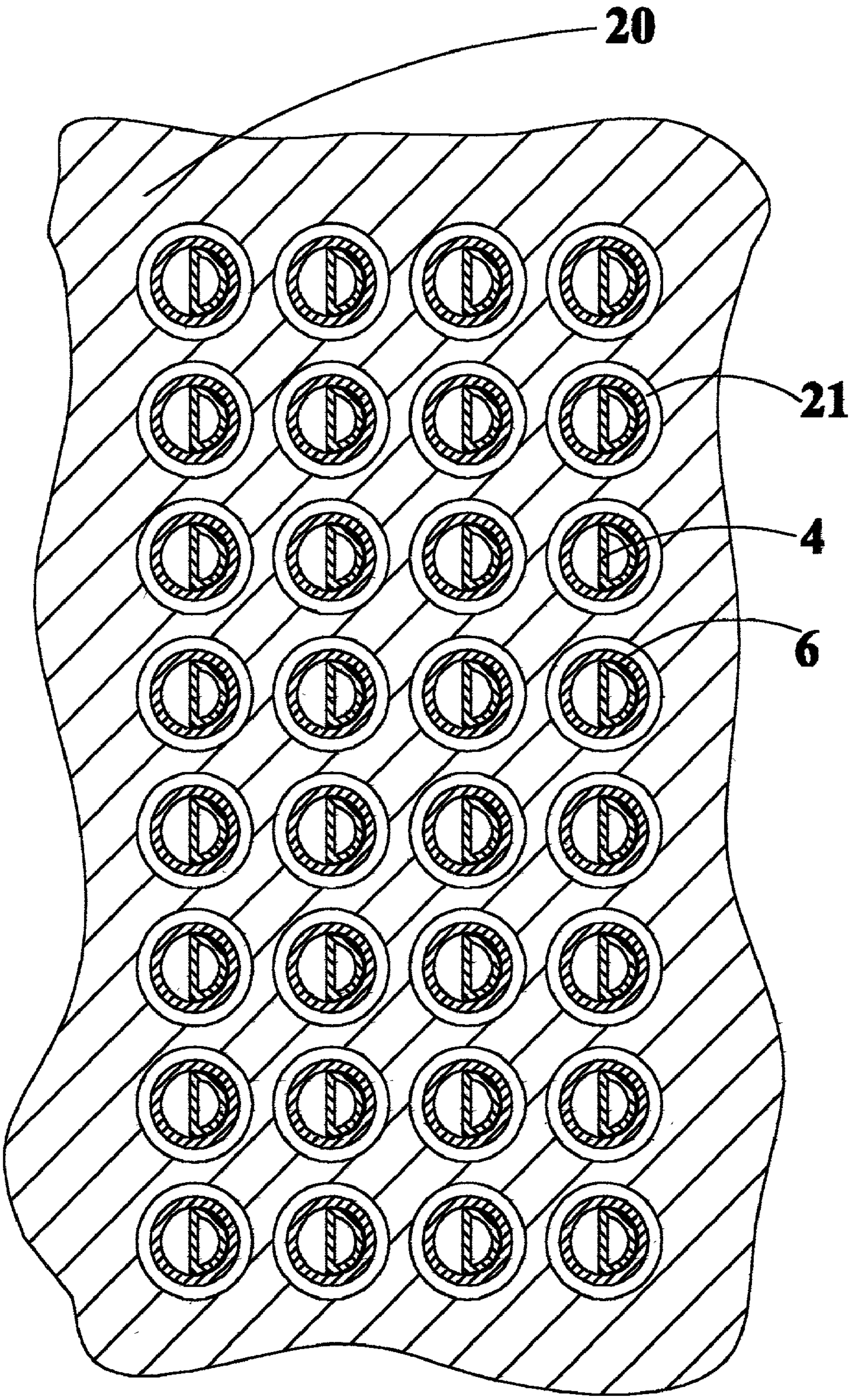


FIG. 3



FIBROUS WEBS OF BI-COMPONENT MELT-BLOWN FIBERS OF THERMOPLASTIC POLYMERS FROM A BI-COMPONENT SPINNERETTE ASSEMBLY OF MULTIPLE ROWS OF SPINNING ORIFICES

BACKGROUND OF THE INVENTION.

[0001] This invention relates to an adaptation of bi-component fiber spinning to a melt-blowing process as described in U.S. Pat. No. 5,476,616, which is herewith incorporated as reference. More particularly, it relates to the improvement whereby the number of rows of spinning orifices can be extended beyond the number possible before and still maintain fiberforming spinning quality, using polymer pairs of greatly differing melt viscosities and other properties.

OBJECTS OF THE INVENTION.

[0002] It is an object of the present invention to provide a bi-component spinning system whereby a spinning nozzle fed by one type of polymer from one chamber is located inside another slightly larger spinning nozzle fed by a second chamber, said nozzle pairs being arranged in multiple rows of spinning orifices, and directing streams of gas to each row of spinning orifices.

[0003] Another object of the invention is to provide a uniform stream of attenuating gas around each spinning nozzle by centering the nozzle pairs in round holes of gas cover plates to achieve an even gas flow around the circumference of each nozzle pair.

SUMMARY OF THE INVENTION

[0004] These and other objects of the invention are achieved by directing a gas flow to the base of the spinning nozzle pair by means of baffle plates, and extending the length of the spinning nozzle pairs. The spinning nozzle pairs are guided through a family of gas cover plates providing for the centering of the round spinning nozzle pairs through round gas supply holes and supplying a uniform stream of gas to each nozzle pair and row of nozzle pairs.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] A better understanding of the present invention as well as other objects and advantages thereof will become apparent upon consideration of the detailed disclosure thereof, especially when taken with the accompanying drawings, wherein like numerals designate like parts throughout; and wherein

[0006] **FIG. 1A** is a partially schematic side view of a spinnerette assembly of the present invention, showing the path of gas and the two polymer flows;

[0007] **FIG. 1B** is the same spinnerette where the inner nozzles **4** have been shortened by the distance **22**.

[0008] **FIG. 2A** is a partial bottom view of the concentric spinning nozzles and gas cover plates, taken along the lines **23-23**.

[0009] **FIG. 2B** is a partial bottom view of the concentric spinning nozzles and gas cover plates, taken along the lines **24-24**.

[0010] **FIG. 3** is a partial bottom view of a spinnerette assembly, wherein the inner nozzle is off-center and shaped in a half-circle to form side-by-side bi-component fibers.

DETAILED DESCRIPTION OF THE INVENTION

[0011] In previous bi-component spinning assemblies, side-by-side or sheath-core structures are being formed by having two polymers flow through capillaries in a laminar flow pattern without mixing before exiting the capillary and then solidifying. This limits the polymer pairs to such groups that are capable of laminar flow, i.e. have similar melt-viscosities and other properties at similar extrusion temperatures. Bi-component designs have been disclosed in U.S. Pat. Nos. 2,931,091 and 3,039,174. Most of these designs were used in traditional textile yarn spinning and are not easily adaptable to the melt-blowing process.

[0012] In U.S. Pat. No 6,057,256 to Krueger et al. a bi-component met-blowing process is shown where the polymers are contacted with each other inside the die-body as previously described, and, by laminar flow exit the spinning orifice and are drawn down by high velocity air. This design, however, is limited to a single row of spinning orifices and consequently relatively low capacity.

[0013] In the present invention, a bi-component melt-blowing system is shown where bi-component fibers are being spun out of multiple rows of spinning orifices, and whereby the contact time of two or more polymers inside the die-body can be controlled from zero to any finite time chosen, by having one capillary in which a first polymer flows, being fed from one polymer manifold, is surrounded by a second, larger than the first capillary, through which a second polymer fed from a second polymer manifold flows; at the exit point, each tubular nozzle is surrounded by a concentric flow of high velocity air as described in previously cited U.S. Pat. No. 5,476,616.

[0014] Referring now to **FIG. 1**, the spinnerette assembly is mounted on the die body **1** which supplies polymer melt **2** to first supply cavity **3** feeding the spinning nozzles **4** which are mounted in the spinnerette body plate **5** wherein nozzles **4** are mounted. A second set of nozzles **6**, larger than nozzles **4**, having an identical mounting pattern as nozzles **4**, is mounted on the die body plate **7** and is being fed with a second polymer **8** from the die body **1** and through plate **5** to cavity **9** which feeds nozzles **6**. Nozzles **4** are inserted into nozzles **6**, and have the same or shorter length than nozzles **4**. The nozzles **4** and **6** lead through the gas cavity **10**, which is fed with gas, air or other suitable fluids from gas inlet slot **11**. The primary gas supply enters the spinnerette assembly through pipe **12** into the supply cavity **13**. The baffle plate **14** diverts the gas stream and forces the gas through the slot **11** toward the base of nozzles **6**. The nozzles **4** and **6** protrude through gas cover plate **15** through tight fitting holes **16** arranged in the same pattern as the nozzle mounts in spinnerette body plates **5** and **7**. The gas cover plate family further consists of spacer plate **18** which forms a second gas cavity **19** between plate **15** and **20**. The complete path of the gas is now from inlet pipe **12** into the gas supply cavity **13** through inlet slot **11** into gas cavity **19**. The gas then flows through gas holes **17** of plate **15** into the gas cavity **19** and then around the nozzles **6** through holes **21**, in which nozzles **6** are centered. The high velocity gas out of holes **21** accelerate and attenuate the exiting polymer melt to form fine fibers. **FIGS. 2A and B** show the bottom view of plates **15** and **20**, respectively. **FIG. 3** shows a bottom view of plate **20**, wherein the inner nozzles **4** are shaped in a half circle to produce a side-by-side bi-component fiber.

[**0015**] The following examples are included for the purpose of illustrating the invention and it is understood that the scope of the invention is not to be limited thereby.

EXAMPLE 1

[**0016**] A 5" long spinnerette was used of the type shown in **FIG. 1**. The spinnerette had 12 rows of nozzles, spaced 0.060" apart, within each rows, the nozzles were also spaced 0.060" apart, resulting in a total number of nozzles of 1000. The inner nozzles **4** mounted in plate **5** had an outside diameter of 0.020" and an inside diameter of 0.010". The outside nozzles **6** mounted in plate **7** had an outside diameter of 0.035" and an inside diameter of 0.023". Air cavity **10** had a height of 0.500", air cover plate **15** a thickness of 0.063". Air holes **17** shown in **FIGS. 1 and 2**A had a diameter of 0.020". Air cavity **19** had a height of 0.100" and air cover plate **20** a thickness of 0.063". The air holes **21** in plate **20** had a diameter of 0.048". The resin inlets **2** and **8** were each connected to a 1" (24/1 length/diameter ratio) extruder, subsequently referred to as extruder A and B, respectively each capable of extruding approximately 10 lb/hr of polymer resin.

[**0017**] Extruder B (sheath polymer) was charged with high density polyethylene of Melt Index 105 (Dow Chemical Co's "ASPUN" 6808A) and the resin was extruded into the spinnerette at a rate of 30 gram per minute; Extruder A (core polymer) was charges with polypropylene of MFR 70 (Melt Flow Rate, as determined by ASTM-Method D-1238-65T)(HIMONT "HIH442") and extruded at a rate of 45 gram per minute, 3% of blue polypropylene color concentrate was added to the polypropylene resin to give the core fiber a blue appearance. The spinnerette temperature and the air temperature were 480 degree Fahrenheit, and the air pressure was 20 psi. 12" below the spinnerette there was a moving screen that collected a web of highly entangled blue fibers of 3 to 6 micrometer diameter. The web had a typical slick, silklike polyethylene feel, indicating that the polyethylene from extruder B was on the outside. Parallel strands of fibers were imbedded and cured into an epoxy resin, and cross sections were cut therefrom. Microscopic examination showed a concentric sheat/core fiber structure, with the blue color visible in the core section. When the fibrous web was heated to a temperature of 250 degree F, most of the point of intersection bonded by coalescence and the web formed a stiff, shape-retaining structure.

EXAMPLE II

[**0018**] Additional experiments were conducted using polymer pairs as shown in Table 1:

TABLE 1

Experiment No.:	1	2	3	4
Polymer from Extruder A	PET Polyester* 0.59 IV****	6/6 Nylon** 35 RV*****	PBT Polyester*** 0.59 IV	Polypropylene 70 MFR
Extrusion rate	30 g/min	35 g/min	45 g/min	40 g/min
Polymer from Extruder B	6,6 Nylon 35RV	PET Polyester 0.59W	Nylon 6****** 4ORV	Nylon 6 4ORV
Extrusion rate	45 g/min	50 g/min	30 g/min	25 g/min
Spinnerette Temp. (F.)	520	520	480	470
Air Temp.(F.)	510	520	480	470
Air pressure (psi)	25	25	23	24

*Poly-(ethylene) terephthalate
**Poly-(hexamethylene adipamide)
***Poly-(butylene) terephthalate
****Intrinsic Viscosity
*****Relative Viscosity
******Poly (caproamide)

[**0019**] Microscopic examination of the fiber cross sections, which ranged from 3 to 7 micrometer in diameter, revealed that the sheat/core structure was concentric or near concentric.

EXAMPLE III

[**0020**] Example I was repeated using identical polymers and process conditions, but with a spinnerette described in **FIG. 1B** where the inner nozzles **4** where recessed by the length **22** of 0.150". Under a microscope, the fiber cross sections showed the same concentric sheath/core structure as in Example I, with the blue polypropylene inside.

EXAMPLE IV

[**0021**] EXAMPLE I was repeated using a nozzle arrangement as shown in **FIG. 3**. Upon microscopic examination, the fiber cross-section showed that the two polymers had each formed a semi-circle in a side-by-side configuration.

[**0022**] While the invention has been described in connection with several examplary embodiments thereof, it will be under stood that many modifications will be apparent to those of ordinary skill in the art, and that this application is intended to cover any adaptations and variations thereof. Therefore, it is manifestly intended that this invention be only limited by the claims and the equivalents thereof.

What is claimed is:

1. A fibrous web comprising a coherent entangled mass of melt-blown bi-component fibers, said fibers individually comprise a first polymeric material extending longitudinally along the fiber through a first circular portion of the cross-sectional area of said fibers and a second polymeric material adhered to said first polymeric material and extending logitudinally along said fiber through a second cylindrical portion of the cross-sectional area of the fiber surrounding said first circular portion of the cross-sectional area of the fiber, said fibers being prepared by

(a) extruding a mass of said first polymeric material through a first set of nozzles arranged in multiple rows and being fed from a first polymer feed chamber, and a mass of said second polymeric material being fed through a second set of nozzles arranged in multiple rows and being fed from a second polymer feed chamber, said second set of nozzles surrounding each of said first nozzles thus forming nozzle pairs, and said second nozzles having a larger inside diameter than the outside diameter of said first nozzles to form a bi-component extrudate

(b) advancing said extrudate into high velocity gas streams surrounding circumferencially each individual nozzle pair of said first and second set of nozzles and

(c) attenuating said bi-component extrudate from each of said nozzle pairs to form said bi-component fibers,

(d) said fibers being collected on a moving screen to form said fibrous web.

2. A fibrous web as of claim 1 wherein said fibers being prepared by

(a) extruding a mass of said first polymeric material through said first set of nozzles arranged in multiple rows, and a mass of said second polymeric material through said second set of nozzles arranged in multiple rows,

(b) whereby said first set of nozzles is recessed into said second set of nozzles by at least 0.030".

3. A fibrous web as of claim 1 wherein said fibers being prepared by

(a) extruding a mass of said first polymeric material through said first set of nozzles arranged in multiple rows, and a mass of said second polymeric material through said second set of nozzles arranged in multiple rows,

(b) whereby the ends of said first set of nozzles are shaped into a semi-circle fitting into said second set of nozzles thus shaping a fiber having a cross-section in which each of said first and second polymeric materials occupy approximately a side-by-side semi-circle.

4. A fibrous web of claim 1 where the points of fiber intersection are bonded by coalescence of polymeric material.

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