(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 277 619 A2**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **88101406.2**

(51) Int. Cl.4: **D01D 5/24** , D01D 4/02

(22) Date of filing: **01.02.88**

(30) Priority: **05.02.87 US 11172**

(43) Date of publication of application:
10.08.88 Bulletin 88/32

(84) Designated Contracting States:
AT BE CH DE FR GB IT LI NL

(71) Applicant: **AIR PRODUCTS AND CHEMICALS, INC.**
Allentown Route 222
Trexlertown, PA 18087(US)

(72) Inventor: **Puri, Pushpinder Singh**
2253 Stonewall Drive
Macungie PA 18062(US)

(74) Representative: **Dipl.-Ing. Schwabe, Dr. Dr. Sandmair, Dr. Marx**
Stuntzstrasse 16
D-8000 München 80(DE)

(54) Spinneret for making hollow fibers having different wall thicknesses.

(57) The present invention is a spinneret for making hollow fibers from polymeric spinning solutions and/or melts. The spinneret is characterized in that it comprises a pin mounting means for detachably securing a core fluid pin. The detachable pin mounting design allows for the manufacture of hollow fibers having different wall thicknesses by simply changing the core fluid pins.

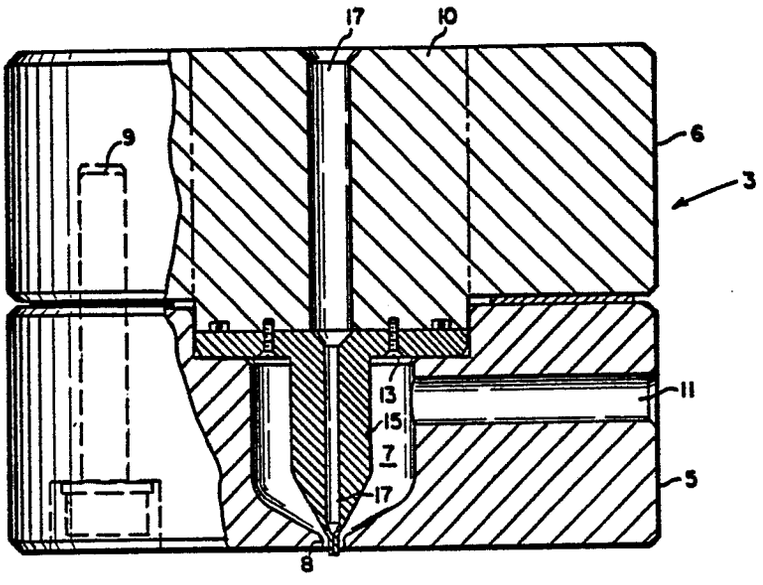

FIG. 1

EP 0 277 619 A2

SPINNERET FOR MAKING HOLLOW FIBERS HAVING DIFFERENT WALL THICKNESSES

TECHNICAL FIELD OF THE INVENTION

The present invention relates to spinnerets for making hollow fibers or filaments from polymeric spinning solutions or melts. More particularly it relates to a spinneret design for making hollow fibers having various wall thicknesses.

BACKGROUND OF THE INVENTION

Synthetic filaments or fibers are spun by forcing a polymeric solution or melt, under pressure, through a plurality of extension orifices formed in a spinneret from which the polymeric material issues in the form of continuous filaments which solidify on cooling or coagulation with an appropriate non-solvent. Spinneret designs for producing filaments having irregular shaped cross-sections are described in U.S. Patents 3,313,000; 3,323,168 and 3,600,491. The spinneret designs disclosed in the above references consist of a plate having one or more slit-shaped spinning orifices, with each spinning orifice consisting of two or more arc-like slits which, in combination, partially surround a section of the spinneret. The arc-like slits are non-continuous and surround a solid center portion which is an extension of the face of the spinneret plate.

Japanese patent publication no. 2,928/1967 discloses a process for producing hollow fibers by inserting an extremely fine tube into an orifice so that the delivery orifice is of a concentric double tube type, and feeding a gas through the fine tube when a spinning solution is extruded through the annular orifice slit.

U.S. Patent 4,229,154 discloses a spinneret design for the production of hollow filaments that includes a cylindrical shaped insert swagged into each passage of the spinneret to effect a seal between the insert and the spinneret. The insert is constructed to contain the polymer entirely within the insert to prevent leakage of polymer into the core gas supply passages of the spinneret.

With all the spinneret designs described above, variations in the wall thickness of the hollow filaments are achieved either by using spinnerets of different dimensions or by varying the process variables such as polymer feed or draw rate.

BRIEF SUMMARY OF THE INVENTION

The present invention is a spinneret design for making synthetic polymeric hollow fibers having different wall thicknesses. The spinneret comprises a housing enclosing a reservoir for holding a polymeric solution, said reservoir designed to taper into an orifice in fluid communication with the exterior of the housing. A passageway runs through the housing connecting the exterior of the housing with the reservoir, through which the polymeric solution can be introduced into the reservoir. A pin mounting means is located on an interior wall of the housing on which a pin can be mounted so as to extend into the reservoir. The pin has a tapered end which extends into the orifice to form an annular slit through which the polymer solution in the reservoir can be extruded to the exterior of the housing.

The pin is demountably secured on the mounting means such that a variety of pins having different dimensions at the tapered end may be successively secured on the mounting means so as to alter the dimension of the annular slit and this alter the wall thickness of the hollow fibers produced from the polymeric material being extruded through the slit. A tubular passageway extending from the exterior of the housing to the reservoir is aligned with a tubular passageway running axially through the pin to form a continuous passageway through which a fluid may be introduced from the exterior of the housing and exit the housing at the orifice formed by the reservoir. Fluid is passed through this passageway and exits the orifice where it flows through the interior of the extruded polymeric fiber thus aiding in both maintaining the structure of the fiber and also cooling and coagulating the fiber material.

The spinneret design of the present invention allows for the manufacture of hollow fibers having different wall thicknesses by simply changing the core fluid pin mounted so as to protrude into the reservoir; thus eliminating the need for multiple spinnerets or performing the difficult task of accurately varying the pump rate of the polymer through a fixed annular or the draw rate of the hollow filament.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawing of Figure 1 is a cross sectional view of the apparatus of the present invention.

The drawing of Figure 2 is a cross sectional view of the reservoir orifice and the tapered end of the core fluid pin.

DETAILED DESCRIPTION OF THE INVENTION

The present invention is a spinneret for making hollow fibers from a polymer dope. The spinneret is designed such that hollow fibers having various wall thicknesses can be made by the simple replacement of the core fluid pin, rather than requiring many different spinnerets. Thus, by using different size pine, one can alter the annular opening through which the polymer dope is extruded, thereby altering the wall thickness of the hollow fiber formed.

The drawing of Figure 1 illustrates a typical spinneret design in accordance with the present invention. The spinneret 3 comprises a housing made of any suitable material such as metal, plastic and the like, which encloses a reservoir 7 for containing a polymer dope. The reservoir 7 tapers to form an orifice 8 in fluid communication with the exterior of the housing. The housing can be a single structural unit, or typically can comprise two or more sections 5 and 6, connected by a securing means 9. A passageway 11 runs through one section of the housing 5 and connects the exterior of the housing with the reservoir 7, through which a polymer dope can be introduced into said reservoir. The diameter of the passageway will vary depending upon the size of the reservoir 7 and the general overall size of the spinneret 3. The polymer dope can be one or more polymer melts or polymer solution in an appropriate solvent or solvent mixture which is capable of flowing into the reservoir and subsequently being spun to form a hollow fiber filament. Typically, any polymer which can be spun as a solid filament can also be spun as a hollow filament. Examples of such polymers include polyesters, polyamides, polysulfones, polyacrylonitriles, polysulfonamides, polyacetylenes, and substituted polyacetylenes such as polytrimethylsilylpropyne.

A pin mounting means 13 is located on an interior wall of the spinneret housing for demountably securing a core fluid pin 15. The pin mounting means 13 can be any suitable system which allows the core fluid pin 15 to be easily detached from the interior wall of the housing, such as a bracket or a screw and bolt type assembly. Alternatively, the pin mounting means may simply comprise a bore in the housing having screw threads into which a core fluid pin having a threaded shaft may be directly screwed from the exterior of the housing. A core fluid pin 15, having a tapered end, is secured on the pin mounting means 13, such that said pin 15 extends into the reservoir 7, and the tapered end of the pin 15 extends into the orifice 8 to form an annular slit through which the polymer solution can be extruded from the reservoir 7 to the exterior of the housing to form the hollow fiber. The core fluid pin 15 having a tapered end, can easily be demounted from the pin mounting means 13, and replaced with other core fluid pins having tapered ends of different diameters, thereby altering the dimension of the annular slit and thus altering the wall thickness of the hollow fibers formed by the polymeric material being extruded through the slit. The various core fluid pins 15 can be secured and unsecured from the interior wall of the housing by simply separating the sections of the housing 5 and 6, to replace the pin, or a separate section of the housing may form a removable cylinder 10, which can be dislodged from the other housing components in order to change the various pins 15. Alternatively, the core fluid pin itself can comprise a threaded shaft which can be screwed directly into a threaded bore of the housing from the exterior thereby allowing the core fluid pin to be replaced without disengaging any of the the housing components thereby also providing any easy method for adjusting the position of the pin into the orifice.

When the core fluid pin 15 is mounted on the pin mounting means 13, a continuous tubular fluid passageway 17 extends axially through both the housing section containing the pin mounting means 13 and the pins 15 through which a fluid may be introduced from the exterior of the housing and exit the housing at the orifice 8 formed by the reservoir 7. This continuous passageway 17 is used to supply fluid to the interior of the hollow filament as it is being extruded through the annular slit formed at the orifice 8. Any type of fluid may be employed which is inert with respect to the polymeric material being extruded, with typical examples being air or some inert gas such as nitrogen. This fluid aids maintaining the shape of the hollow fiber being formed, and also aids in coagulation of the polymer dope to form the fiber. In some embodiments, a gas or liquid which is reactive with the polymeric material may be used, allowing the fibers to be treated as they are formed. The reactive gas used will depend upon the treatment desired and the particular polymer dope employed.

In the operation of the present invention, a fluid core pine 15 is secured to the pin mounting means 13 and the housing sections 5 and 6 are secured together to form a single unit 3. A polymer dope, is then passed through passageway 11 and is col-

lected in reservoir 7. the polymer dope is then extruded from the reservoir 7 through the orifice 8 in a continuous manner to form the hollow fiber filaments. The filaments are formed as the polymer dope solidifies by drying, freezing or coagulating upon leaving reservoir 7 and is exposed to the exterior environment of the spinneret 3. Preferably, as it is being extruded, the interior of the hollow fiber is contacted with some type of fluid being passed through passageway 17.

The drawing of Figure 2 is a cross sectional view of the extrusion orifice of the spinneret. As can be seen from the drawing of Figure 2, the spinneret housing 5 enclosing the reservoir 7 tapers to form a narrow orifice 8 in fluid communication with the exterior of the housing. The size of this orifice is not critical and will vary depending upon the desired outside diameter of the hollow fiber to be produced. Typically such orifices range between 10u and 1000u, although, as stated above, this is not critical. The fluid core pin 15 extends into said orifice 8, and preferably extends slightly beyond the wall of the spinneret housing 5 and forms an annular slit 19 through which the polymer dope is extruded from the reservoir 7 to the exterior of the housing. The diameter of the tapered end of the core fluid pin 15 will determine the width of the annular slit 19, and consequently determine the wall thickness of the hollow fiber produced. Although a wide range of wall thicknesses can theoretically be produced, typically they will range between 2u and 400u. The fluid passageway 17 runs axially through the core fluid pin 15 and provides a means for aiding both the coagulation and formation of the hollow fibers which are formed by extruding the polymer dope from the reservoir 7. It is obvious that, while the accompanying drawings illustrate for round cross-section fibers, other fibers whose inner or outer surface cross-sections are non-round; i.e., trilobal, tetralobal, serrated, etc., may be produced by using an appropriately formed outer wall of the orifice, for altering the outer surface of the hollow fiber or by altering the configuration of the tapered end of the core fluid pin, for altering the interior wall configuration of the hollow fiber, or both.

The spinneret design of the present invention, allows for the manufacture of hollow fibers having different wall thicknesses by simply changing the core fluid pin mounted on the interior wall, of or screwed directly into, the spinneret housing. This design eliminates the need for multiple spinnerets, or for regulating wall thickness by polymer pump rate or extrusion and draw rate through a fixed annular opening. The hollow fibers produced by the spinneret have a wide variety of commercial applications and are especially useful in the form of bundles for membrane applications.

Having thus described the present invention, what is now deemed appropriate for Letters Patent is set out in the following appended claims.

Claims

1. A spinneret for making hollow fibers from a polymer dope, said spinneret comprising:

a) a housing enclosing a reservoir for a polymer dope, said reservoir tapering into an orifice in fluid communication with the exterior of the housing;

b) a passageway running through said housing connecting the exterior of the housing with the reservoir, through which a polymer dope can be introduced into said reservoir;

c) a pin mounting means located on an interior wall of the housing;

d) a core fluid pin secured on said pin mounting means, said core fluid pin having a tapered end and being positioned to extend into the reservoir such that the tapered end of the core fluid pin extends into the orifice to form an annular slit through which the polymer solution can be extruded from the reservoir to the exterior of the housing, said core fluid pin being demountably secured, such that a variety of core fluid pins having different dimensions at the tapered end may be successively secured on said mounting means so as to alter the dimension of the annular slit and thus alter the wall thickness of the polymeric material being extruded through said slit; and

e) a tubular fluid passageway extending axially through both the housing and the core fluid pin through which a fluid may be introduced from the exterior of the housing and exit the housing at the orifice formed by the reservoir.

2. The spinneret in accordance with Claim 1 wherein both the orifice formed by the reservoir and the tapered end of the core fluid pin are round.

3. The spinneret in accordance with Claim 1 wherein the housing comprises two detachable sections.

4. The spinneret in accordance with Claim 1 wherein the orifice formed by the reservoir has a diameter between 10u and 1000u.

5. The spinneret in accordance with Claim 1 wherein the annular slit has a width capable of forming hollow fibers having a wall thickness between 10u and 400u.

6. The spinneret in accordance with Claim 1 wherein the tapered end of the core fluid core fluid pin extends beyond the orifice formed by the reservoir.

7. The spinneret in accordance with Claim 1 wherein the pin mounting the means comprises a bore in the housing having screw threads into which a core fluid pin having a threaded shaft may be directly screwed from the exterior of the housing.

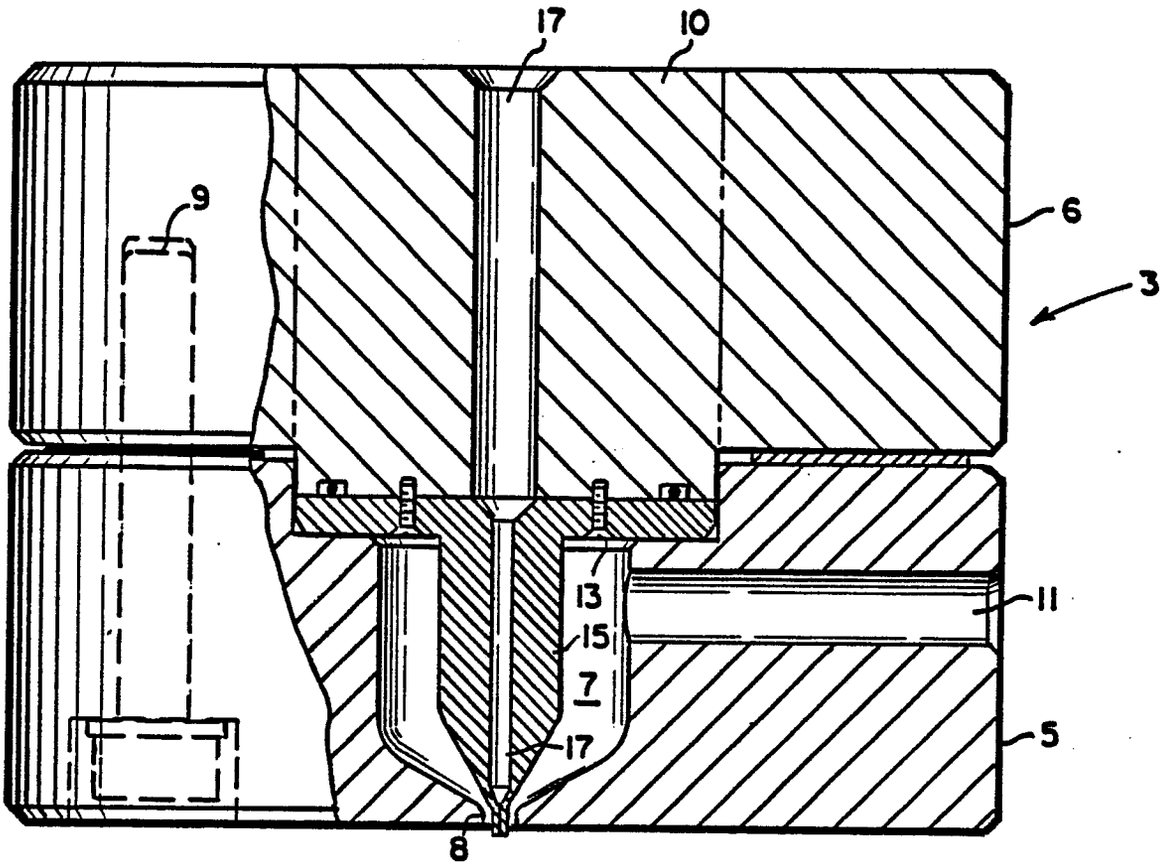

FIG. 1

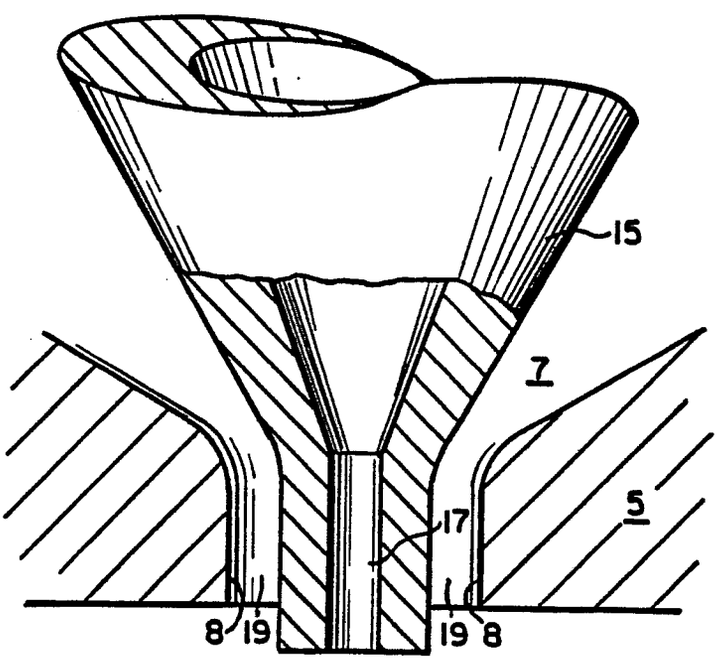

FIG. 2