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(12) # EUROPEAN PATENT SPECIFICATION

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(54) **Spinneret.**

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EP 0 369 460 B1

Description

This invention relates to a spinneret comprising tapering capillaries with straight sidewalls.

The most common method of making spinneret capillary passageways is to counterbore a hole partway through the plate, then to complete the hole by punching through the remaining thickness. Of the known methods for forming capillaries, the counterbore and punch method is generally recognized as being the least expensive, being versatile in the shapes which can be formed, and giving the most uniform capillaries.

Preparation of spinneret capillaries by drilling and by electric discharge machining (EDM) are also known. Both of these methods are relatively slow (and therefore expensive) and give poorer hole-to-hole uniformity than does the counterbore-punch method. Hole-to-hole uniformity is critical in obtaining filament-to-filament uniformity, required for the spinning of high quality yarns.

Further, because drills are more fragile than punches, their use is generally limited to forming larger sized holes.

The capillary portion of the passageway has been limited either to short length or to relatively large diameter by the physical characteristics of the punch, drill, or other tools used to form the passageway. Because of the short length of the capillary when made by methods of the prior art, insufficient molecular orientation is imparted to the filaments during spinning or extrusion of the filaments, causing their cross-sectional shapes to change considerably from the designed shape of the hole. Particularly in the spinning of hollow filaments, a short capillary reduces significantly the amount of structural support to the internal element or obstruction in the passageway which produces the hollow interior portion of the filament. This limits the number of times a spinneret face can be lapped or polished, in order to remove nicks or other minor imperfections. In addition, failure to impart sufficient orientation to the hollow filaments during spinning or extrusion causes many undesired opened or split filaments to be formed instead of the desired true hollow filaments.

The ideal spinneret would have complete capillary-to-capillary uniformity, as well as uniformity along the length of the capillary. Each capillary would have a length to width ratio of at least 1.5, and preferably 2 or more, for adequate molecular orientation during spinning. The holes would be as small as practical for accurate metering of the polymer streams, and the capillary walls would be straight for the same reason. The spinneret would be made from hard metal for long life. Further, the spinneret would operate at low pressures (e.g., at less than 14,000 kPa) to reduce pack leaks and pumping requirements.) Unfortunately, the requirement for good metering (small, straight-sided holes with long length-to-width dimensions) conflicts with low pressure operation.

The invention as claimed in claim 1 solves the problem of how to reduce the pressure drop through the spinneret capillary and to improve metering (filament-to-filament uniformity).

Preferred embodiments of the invention are the subject matter of subclaim 2.

Examples of the invention are described thereafter with reference to the drawings, in which:

Fig. 1 is a plan view of the portion of the exit face of a spinneret plate and

Fig. 2 is a section through the spinneret of Fig. 1 along line 2-2.

While this invention can produce any of a great number of complex slot type spinneret capillaries, it is described hereinafter with reference to one particular form. It is to be understood, however, that the invention is in no way limited to the particular form of capillary illustrated.

Fig. 1 is a plan view of the portion of the exit face of a spinneret plate 10 having one complex slot type spinneret capillary 12. Ordinarily, finished spinneret plates have from several to a multiplicity of capillaries identical to the one shown. As is apparent, "spinneret capillary" as herein defined is a complex arrangement of slot type openings together providing for the extrusion of one filament. The capillary 12 comprises four peripheral slot type openings 14 generally surrounding an inner minute area. Extending radially inward short of a common intersection are four straight slot type openings 18 each joining the peripheral openings 14 at their centers. Air vents 16, coextensive with the surrounding spinneret plate 10, separate peripheral openings 14. Preferably, the peripheral width of air vents 16 is less than the radial width of each opening 14.

During extrusion of, e.g., a molten polymer through capillary 12, four T-shaped streams are formed at and immediately downstream of the exit face of spinneret plate 10. Adjacent ends of the T-shaped streams then coalesce to form a continuous integral filament having four uniform voids extending continuously therealong. Air vents 16 allow entrance of air into the voids before coalescence, thus, preventing the collapse of the filament due to the internal vacuum which otherwise would result.

In Fig. 2, peripheral openings 14 are shown at exit face 28 leading to their simultaneously machined tapered counterbores 22. Likewise shown are radial openings 18 with counterbores 26 separated by unmachined area 24. Spinneret plate 10 is ordinarily much thicker than the thickness between entrance 30 of the capillary and exit face 28. Before machining the capillary, larger counterbore 20

with flat entrance face 30 is machined into plate 10 at each location where a spinneret capillary is to be formed. The ratio of length 14a of the capillary to the width 18a of the capillary slot is preferably greater than 2 and the sidewalls of the capillary slots are tapered in the direction of the lower surface 28 of the spinneret plate 10 at an included angle A which is in the range of from about 3 to about 20 degrees.

By way of providing a scale to desirable spinneret capillaries the slots 14 and 18 are between about 0.050 mm and 0.130 mm in width (18a) and between about 0.40 mm and 1.0 mm in length (14a). The slot openings 14 are preferably equal to slot openings 18.

The capillaries are made by cutting the holes with a laser beam (150 watt pulsed Nd YAG Laser by Lasag, followed by polishing the inside of the holes, using fluid machining equipment such as supplied by Extrude Hone Corporation of Irwin, PA.

The spinneret capillary shown in Figs. 1 and 2 is exemplary of the variety of complicated capillaries which can utilize the principles of this invention.

Claims

1. A spinneret comprising
   a metal plate (10) having upper and lower surfaces connected by a passage, said passage exiting said lower surface (28) in a capillary length (12)
   with sidewalls having directly opposed portions that taper to said lower surface at an included angle from 3 degrees to 20 degrees,
   characterized by
   said capillary length (12) having a slotted configuration formed of a one piece structure and comprising air vents (16) coextensive with the surrounding spinneret plate (10) and separating peripheral openings (14) and
   said capillary length having a length (14a) of between 0.40 mm to 1.0 mm and a width (18a) at the lower metal plate surface (28) of between 0.050 mm and 0.130 mm.

2. The spinneret of claim 1, wherein said metal plate (10) has a hardness greater than 150 Brinell.

Patentansprüche

1. Spinndüse mit
   einer Metallplatte (10), die Ober- und Unterseiten aufweist, die durch einen Kanal verbunden sind, der an der Unterseite (28) in einer Kapillare (12) austritt, die Seitenwände mit unmittelbar gegenüberliegenden Bereichen aufweisen, die zur Unterseite hin unter einem eingeschlossenen Winkel von 3 bis 20 ° zusammenlaufen,
   dadurch gekennzeichnet,
   daß die Kapillare (12) eine Schlitzform aus einem einteiligen Aufbau hat und Luftzuführungen (16) aufweist, die sich entlang der umgebenden Spinndüsenplatte (10) erstrecken und Umfangsöffnungen (14) trennen, und
   daß die Kapillare eine Länge (14a) zwischen 0,40 und 1,0 mm und eine Breite (18a) an der Unterseite (28) der Metallplatte zwischen 0,050 mm und 0,130 mm hat.

2. Spinndüse nach Anspruch 1, wobei die Metallplatte (10) eine Härte von größer als 150 Brinell hat.

Revendications

1. Une filière comprenant une plaque métallique (10) munie de surfaces supérieure et inférieure reliées par un passage, ledit passage sortant de ladite surface inférieure (28) sur une longueur capillaire (12) avec des parois latérales munies de parties directement opposées qui convergent vers ladite surface inférieure selon un angle inclus de 3 ° à 20 °, caractérisé en ce que ladite longueur capillaire (12) présente une configuration de fente formée d'une structure en une pièce et comprenant des ouvertures de ventilation (16) qui font partie de la plaque de filière (10) les entourant et séparant des ouvertures périphériques (14) et en ce que ladite longueur capillaire présente une longueur (14a) comprise entre 0,40 mm et 1,0 mm et une largeur (18a) sur la surface inférieure de la plaque métallique (28) comprise entre 0,050 mm et 0,130 mm.

2. La filière de la revendication 1, dans laquelle ladite plaque métallique (10) présente une dureté supérieure à 150 Brinell.

Fig. 1

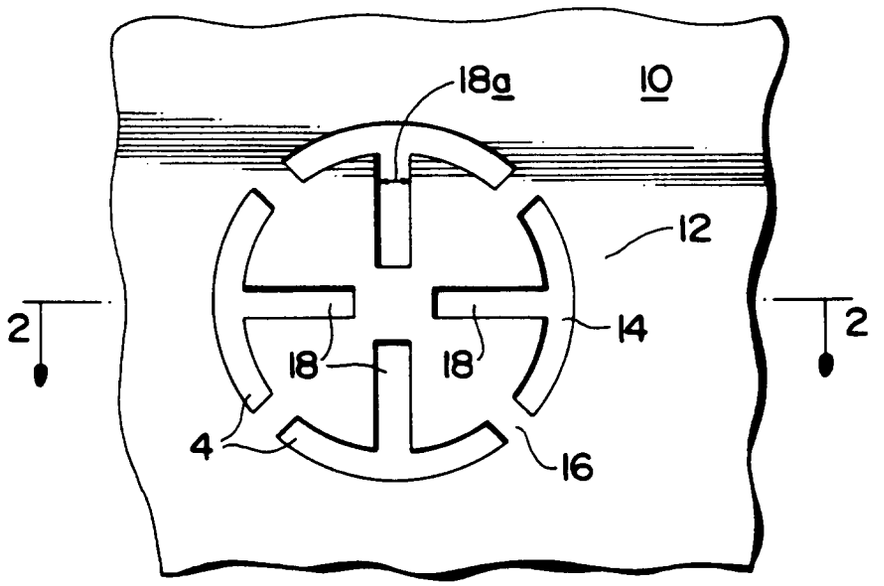

Fig. 2