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Hawkins

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[54] **SPINNERET CAPILLARY METERING PLUGS**

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[52] **U.S. Cl.** **425/461,** 425/464

[51] **Int. Cl.** **D01d 3/00**

[58] **Field of Search** ..... 425/198, 382.2, 463, 464, 425/461; 264/177 F

[56] **References Cited**

UNITED STATES PATENTS

3,081,519 3/1963 Blades et al. 425/464

3,249,669 5/1966 Jamieson ..... 264/177 F

Primary Examiner—Robert D. Baldwin

[57] **ABSTRACT**

A spinneret for the extrusion of fiber-forming material into shaped filaments is formed from a plate that has its upper and lower surfaces connected by a passage having successive cylindrical and capillary lengths. An insert is fitted in the cylindrical length of the passage to serve as a metering orifice with a resistance to flow at least twice that of the capillary.

3 Claims, 3 Drawing Figures

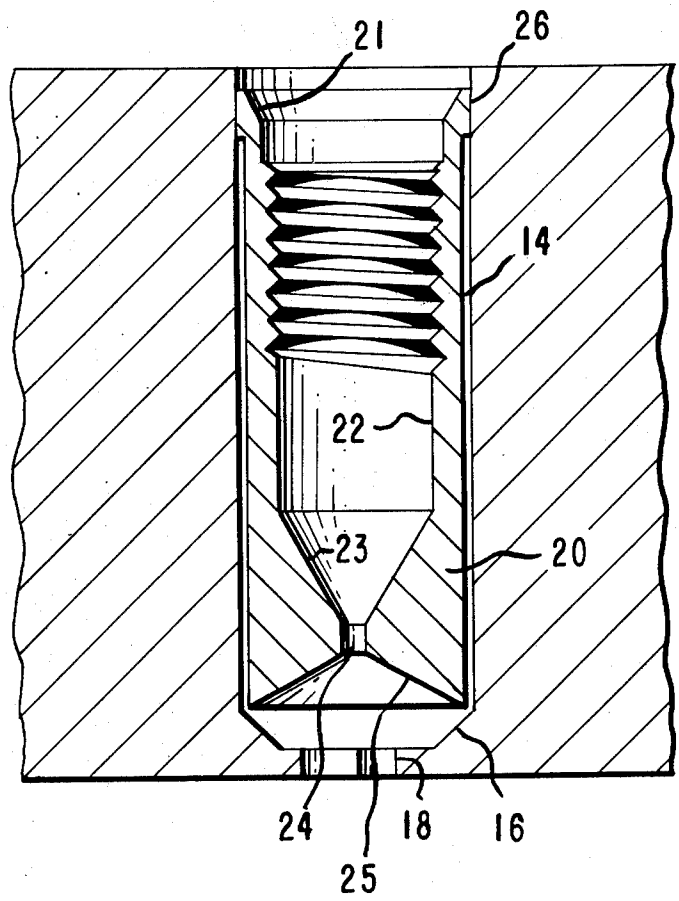


FIG. 1

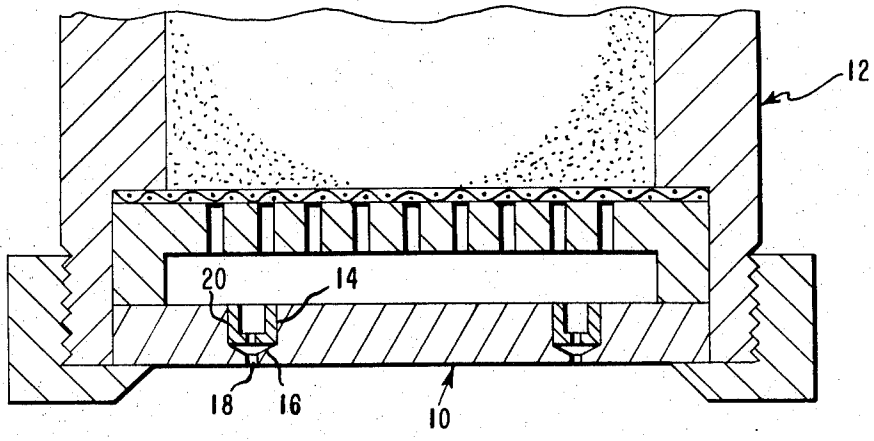


FIG. 3
(PRIOR ART)

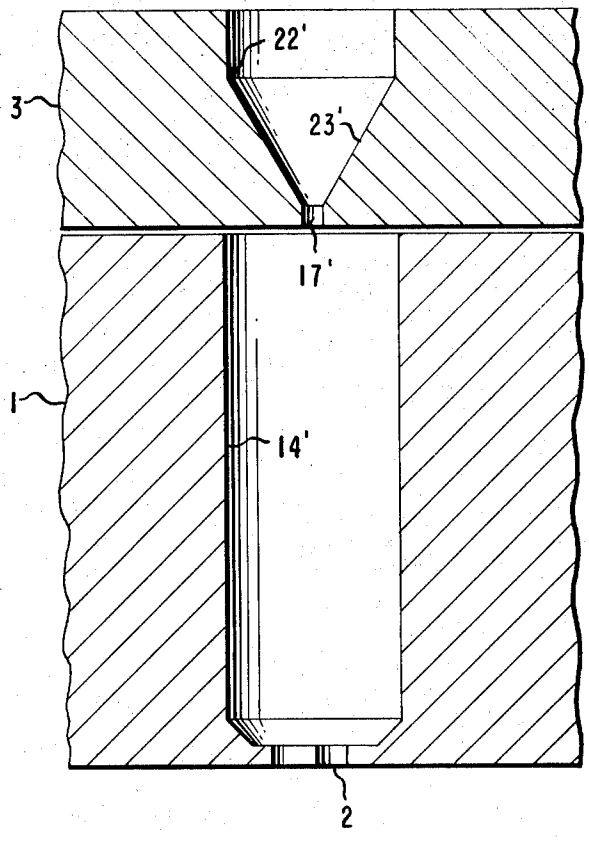
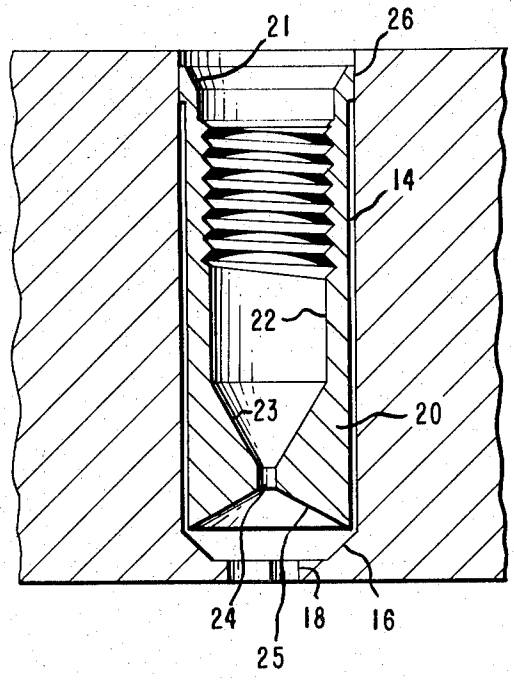


FIG. 2



SPINNERET CAPILLARY METERING PLUGS

BACKGROUND OF THE INVENTION

This invention relates to extrusion of fiber forming compositions into filamentary form, and more particularly to an improvement in multifilament spinneret assemblies leading to increased filament uniformity.

The improvement of filament uniformity in filaments extruded from multiple orifice spinnerets has been and continues to be a goal of synthetic fiber producers. Generally, the observable nonuniformities are one or the other of two types: end-to-end or along-the-end nonuniformity. End-to-end nonuniformity refers to denier differences between two filaments spun in a group of multifilaments intended to be identical. Along-the-end nonuniformity refers to variations in denier along a single filament. Difficulty in controlling nonuniformities generally increases with the complexity in cross-sectional shape of spinning capillaries both because more complex shapes must ordinarily be larger and because capillary-to-capillary precision in forming is necessarily less.

In U.S. Pat. No. 3,095,607, J. S. Cobb, Jr., disclosed an improved spinneret assembly which sharply improves end-to-end uniformity during multifilament extrusion. It comprises a metering plate directly adjacent the upstream face of the spinneret plate. The metering plate has a plurality of substantially identical circular apertures, each one in alignment with one of the like plurality of orifices in the spinneret plate. Each aperture provides at least twice the resistance to fluid flow as does its aligned orifice in the spinneret plate.

SUMMARY OF THE INVENTION

The present invention is an improvement over the above-mentioned spinneret assembly. It retains all of the advantages of improved end-to-end uniformity while additionally providing capability for improved along-the-end uniformity. Moreover, it reduces the volume of fiber forming composition at its hottest state between filtering and final extrusion, with the result that high temperature degradation and its consequent problems are diminished.

According to this invention, there is provided a spinneret for forming fibers from a polymeric material comprising: a plate having upper and lower surfaces connected by a passage, said passage having successive cylindrical, tapered and capillary lengths, and an insert fitted in said passage, said insert having a central axis bore in alignment with said capillary length, there being a concentric restriction in said bore, said restriction being sized to provide a resistance to flow of the fiber former polymeric material which is greater than the resistance to flow of the fiber forming material to the capillary length.

Tapered passage-transitions to the restriction in the bore of the insert may be provided.

Preferably, the outside diameter of the insert over most of its length is enough small than the cylindrical length of the spinneret passage to provide a sliding fit while that portion immediately adjacent the upper surface of the spinneret is enlarged so as to require a forced fit in the passage. Still more preferably, the upper portion of the bore of the insert is threaded so that a threaded tool may be used for removing the insert from the passage.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cross section of a typical spinneret assembly according to this invention.

FIG. **2** is an enlarged cross section of the assembly of FIG. **1** restricted to the immediate vicinity of one extrusion orifice.

FIG. **3**, similarly to FIG. **2**, shows for comparison the pertinent portion of a prior art spinneret assembly as disclosed in U.S. Pat. No. 3,095,607.

DESCRIPTION OF THE ILLUSTRATED EMBODIMENT

Referring to the drawing, spinneret plate **10** is adapted to be mounted in a filter pack assembly **12** similar to the one disclosed in U.S. Pat. No. 3,095,607. The spinneret plate **10** is provided with a plurality of passages connecting its upper and lower surfaces with each passage including a cylindrical length **14** and a tapered length **16** continuing to capillary length **18.** Inserts **20** are fitted into these passages. Each insert includes its own axial bore **22** with a concentric restriction **24** therein. Restriction **24** is sized to provide at least twice as much flow resistance as does capillary **18** to the flow of fiber forming polymeric material.

It is seen that cylindrical insert **20** actually has a portion **26** of larger outside diameter which provides a forced fit in counterbore or cylindrical length **14** of the spinneret passage. The remainder of insert **20** is slightly undersized to allow for a sliding fit in the passage. Preferred, but optional, passage transistions **21, 23,** and **25** are employed within the bore of insert **20.** In a further preferred version, bore **22** is preferably threaded inside from its top partially down its length so that a tool can be threaded into insert **20** for removal of the insert from the passage of the spinneret.

FIG. **3** is a cross-section through the flow axis of an orifice similar to that disclosed in U.S. Pat. No. 3,095,607. It has the same spinneret passage, i.e., cylindrical,tapered and capillary lengths; but no metering plug is employed. Instead, there is provided a metering plate **3** clamped to spinneret plate **1.** Centered above each orifice **2** in metering plate **3** is a metering orifice **17.** Thus, it can be seen that orifice **17** of FIG. **3** is equivalent to restriction **24** of FIG. **2** if both are the same size and all else is constant. The main difference in structure being the different in volume between the metering orifice **17** and the capillary in FIG. **3** and the restriction **24** and the capillary in FIG. **2.**

It is believed that pulsations in the fiber forming material upstream of the capillary are responsible chiefly for along the end variations and that the severity and frequency of pulsation increase with increasing volume of fiber forming material between metering orifice and extrusion capillary. Metering insert **20** of this invention minimizes the volume in question.

A second advantage of the present invention is the reduction of thermal degradation by reducing the time during which the fiber forming material is held up at its hottest state. The reduction in time is due to reduction in volume assuming constant flow rate. For the assembly of this invention (FIG. **2**), the volume in question is the volume of cylindrical length **14** less the volume occupied by metering insert **20.** For the prior art assembly (FIG. **3**), the corresponding volume includes not only all of the volume of its counterbore **14'** but ad-

ditionally the whole volume of metering orifice **17** (including transition **23'** and counterbore **22'**).

A still further advantage is that the spinneret plate of FIG. **2** may be cleaned, inventoried, and reused with metering inserts **20** still installed. With the prior art assembly of FIG. **3**, spinneret plates and metering plates must be cleaned and inventoried separately. The additional plate **3** moreover, increases the chances of leakage in assembled packs.

Fiber forming materials suitables for extrusion through the assembly of this invention include synthetic polymer melts and hot synthetic polymer solutions. Specific materials include, but are in no way restricted to, polyamides such as polyhexamethylene adipamide, polyesters such as polyethylene terephthalate, polyacrylics such as polyacrylonitrile and the like.

I claim:

1. A spinneret for melt spinning fibers from a polymeric material comprising: a plate having upper and

lower surfaces connected by a passage, said passage have successive cylindrical, tapered and capillary lengths, and an insert fitted in said passage, said insert having a central axial bore in alignment with said capillary length, there being a concentric restriction in one end of said bore, said one end being adjacent said tapered length, said restriction being sized to provide a resistance to flow of the fiber forming polymeric material which is greater than the resistance to flow of the fiber forming material by the capillary length.

2. The spinneret of claim **1**, said restriction being sized with respect to said capillary length to provide a resistance to flow at least twice as large the resistance to flow by the capillary length.

3. The spinneret of claim **1**, said central bore in said insert being provided with tapered lengths before and after said restriction to form tapered transitions from the bore to the restriction.

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