June 22, 1971 H. J. McDERMOTT 3,585,685

SPINNERET ASSEMBLY FOR MAKING COMPOSITE FILAMENTS

Filed July 1, 1969

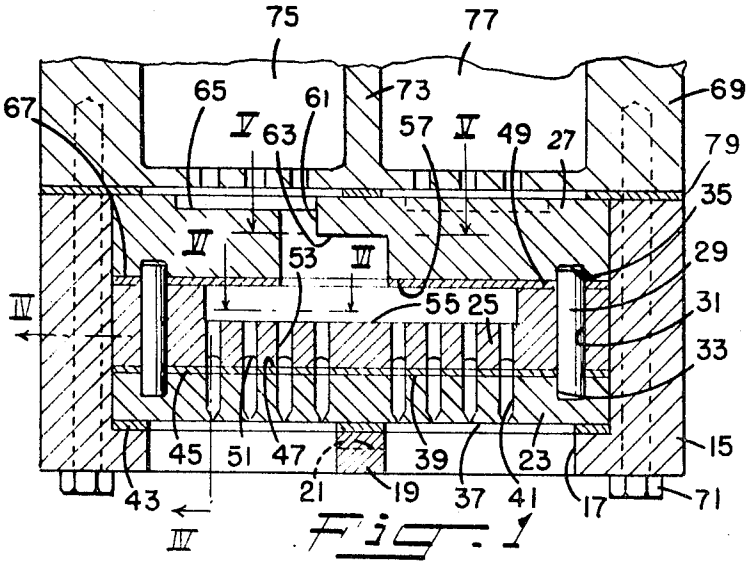

Fig. 1

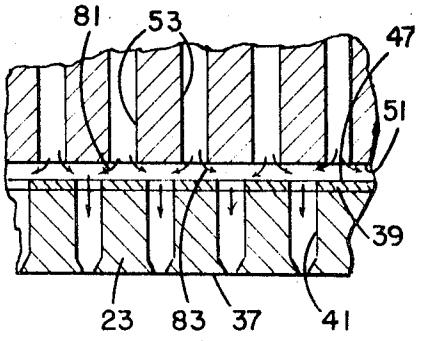

Fig. 4

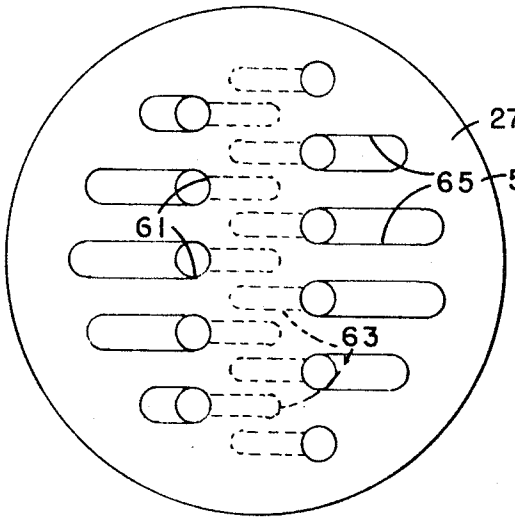

Fig. 3

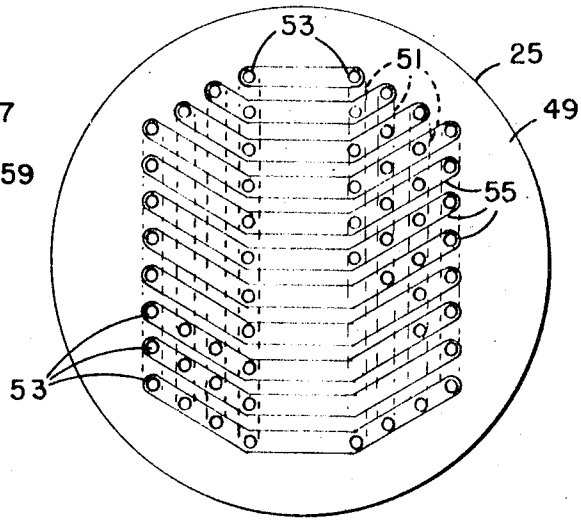

Fig. 2

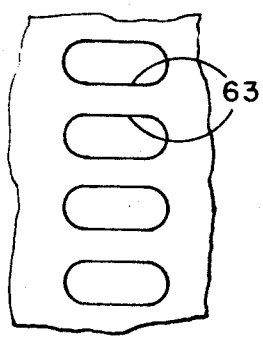

Fig. 5

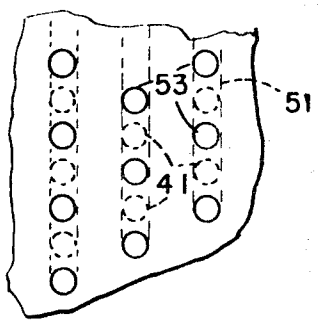

Fig. 6

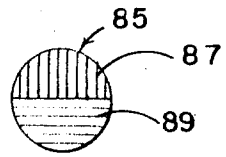

Fig. 7

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SPINNERET ASSEMBLY FOR MAKING COMPOSITE FILAMENTS

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ABSTRACT OF THE DISCLOSURE

A spinneret assembly for producing composite filaments having sharply defined components or segments extending longitudinally thereof in side-by-side relationship.

The present invention is directed to a spinneret assembly for making composite filaments.

Known in the prior art are various spinneret assemblies for making composite filaments having components disposed in side-by-side relationship. In some of such assemblies areas exist at which filament-forming materials remain stagnant. In others, intermixing of the different filament-forming materials is often encountered within the assembly itself so that continuous production of composite filaments having uniform properties along their respective lengths is generally not achieved. In still other known spinneret assemblies, extremely fine and often tortuous passages are employed for feeding different filament-forming materials to extrusion orifices. Aside from such passages being easily plugged, high back pressures are induced on the filament-forming materials and may cause intermixing of such materials as well as distortion and perhaps leakage of the assembly itself.

In general, the larger the number of composite filaments produced by a single spinneret assembly, the lower are the costs of production. Lacking in the art, however, are spinneret assemblies which are capable of producing a tow containing a relatively large number of composite filaments in which the individual filaments are of substantially like character along their respective lengths and which are substantially the same as the other filaments in such two of filaments. Accordingly, a primary object of this invention is the provision of a generally new or improved and more satisfactory apparatus for making composite filaments.

Another object is the provision of an improved spinneret assembly for use in simultaneously making a relative large number of composite filaments which are of substantially like character.

Still another object is the provision of an improved spinneret assembly for making composite filaments in which different filament-forming materials are delivered to each of a plurality of extrusion orifices under generally uniform and controllable pressures.

A further object is to provide an improved spinneret assembly for making composite filaments having sharply defined components disposed in side-by-side relationship.

A still further object is to provide an improved spinneret assembly which is capable of operating satisfactorily under a generally wide range of pressures applied to filament-forming materials flowing therethrough, is of simple and economical construction, and is adapted to be easily disassembled for cleaning and repair.

These objects are accomplished in accordance with the present invention by a spinneret assembly which includes a spinneret plate having a downstream face and an upstream face, between which extends a row of extrusion orifices. A feeder plate, also having a downstream face and an upstream face, is positioned adjacent to the upstream face on the spinneret plate and includes a slot in its downstream face which is aligned with the row of orifices in the spinneret plate. Extending through the feeder plate is a row of openings which are aligned with and open into the slot thereof at locations inbetween adjacent orifices in the spinneret plate. Means are provided for supplying, under pressure, one flowable filament-forming material to alternate of such openings and a different flowable filament-forming material to the remainder of such openings.

Desirably, the spinneret plate is formed with a plurality of substantially parallel rows of extrusion orifices and the downstream face of the feeder plate is likewise formed with a plurality of parallel slots which are aligned with the rows of extrusion orifices in the spinneret plate. Parallel rows of openings extend through the feeder plate and are aligned with the respective feeder plate slots at locations inbetween adjacent orifices in the spinneret plate. Different flowable filament-forming materials are supplied under pressure, with one such material being directed to alternate openings in each row of openings while another of such materials is delivered to the remainder of such openings.

To facilitate proper spinning and setting of the extruded filament-forming materials, the extrusion orifices in each row of orifices are preferably disposed in staggered relationship relative to the orifices in the rows adjacent thereto. In view of the locations of the openings in the feeder plate relative to the extrusion orifices in the spinneret plate, as mentioned above, the openings in each row of openings are also in staggered relationship relative to the openings in the rows adjacent thereto.

The means for supplying the different filament-forming materials to the rows of openings include a plurality of independent channels in the upstream face of the feeder plate. Each of these channels extends across at least some of the rows of openings and is aligned with a single opening in each of the rows of openings with which it crosses, with adjacent channels being aligned with adjacent openings in the respective rows of openings.

Positioned adjacent to the upstream face of the feeder plate, and constituting part of the supply means, is a distributor plate having a downstream face and an upstream face. Two rows of passages extend through the distributor plate with the passages in one of such rows being aligned with alternate channels in the feeder plate. The passages in the other of such rows of passages are aligned with the remaining channels in the feeder plate. Separate supplies of different flowable filament-forming materials are delivered to each row of passages at the upstream face of the distributor plate. Along the downstream face of the distributor plate, each passage includes a groove which extends at least along a portion of the length of the particular channel with which such passage is aligned.

The different plates of the spinneret assembly of the present invention are held together in a single housing and, from the standpoints of economy, ease of operation and space requirements, these plates are made as thin as possible. To avoid any significant flexing or distortion of such plates, a reinforcing bar extends substantially centrally across the downstream face of the spinneret plate, removed from the orifices extending therethrough.

The spinneret assembly and extrusion orifices contained therein may be of any desired configuration. Further, the assembly may be employed in dry or wet spinning operations; that is, with either molten thermoplastic filament-forming materials which are set by cooling, or filament-forming materials which are set by chemically reacting with a fluid coagulating medium. The spinneret assembly of the present invention which is hereafter described in detail is of circular configuration and is intended for use in producing circular composite filaments from molten thermoplastic filament-forming materials.

In the drawing, FIG. 1 is a section taken vertically through the apparatus of the present invention;

FIG. 2 is a top view of one element of the apparatus shown in FIG. 1;

FIG. 3 is a top view of another element of the apparatus shown in FIG. 1;

FIG. 4 is a section taken through the apparatus along the line IV—IV in FIG. 1;

FIG. 5 is a fragmentary section taken along the line V—V of FIG. 1;

FIG. 6 is a further section taken along the line VI—VI; and

FIG. 7 is a transverse section taken through the composite filament produced by the apparatus of the present invention.

With reference to FIG. 1 of the drawing, the spinneret assembly of the present invention includes a unitary cylindrical housing **15** having a continuous inwardly directed flange **17** at one end thereof. A reinforcing bar **19**, having ends which are of reduced thickness, extends diametrically across one end of the housing **15**, with its ends seated within recesses **21** formed in the housing flange **17**. Except for the portions seated within the flanged recesses **21**, the reinforcing bar **19** is of substantially the same thickness as the housing flange **17** and serves to prevent distortion of other elements of the assembly under the pressures of filament-forming materials flowing therethrough, as more fully described hereafter.

Disposed within the housing **15**, and supported by the flange **17** and the reinforcing bar **19**, is a spinneret plate **23** on which are stacked a feeder plate **25** and a distributor plate **27**. At least a pair of dowel pins **29** extends through holes **31** in the feeder plate **25** and are received in recesses **33** and **35** formed in the spinneret and distributor plates **23** and **27**, respectively, for maintaining these plates in desired orientation relative to each other. Alternatively, and preferably in addition to the dowel pins **29**, the plates **23**, **25** and **27** are keyed to the housing **15** to prevent such plates from rotating relative to the housing and the reinforcing bar.

The spinneret plate **23** has a downstream face **37** and an upstream face **39** between which extend rows of like circular extrusion orifices **41**. These extrusion orifices **41** are of reduced diameter at their ends adjacent to the downstream face **37** of the spinneret plate and, as shown in FIG. 6, the orifices **41** in each such row of orifices are preferably in staggered relationship relative to the orifices in the rows of orifices which are adjacent thereto. In order that a maximum number of orifices **41** may be provided in the circular spinneret plate **23**, all rows of orifices will not include a like number of orifices.

The staggered arrangement of orifices **41**, as distinguished from an array in which orifices in one row are aligned with orifices in adjacent rows, is not essential for satisfactory use of the spinneret assembly of the present invention. This arrangement is preferred, however, since streams of filament-forming material extruded from such orifices can be set at substantially the same distance away from the spinneret assembly and, more important, facilitates greater production by permitting the orifices **41** to be more closely spaced without risk of contact between extruded streams or other spinning problems. Of course, no extrusion orifices are formed in the portion of the spinneret plate **23** which overlies the reinforcing bar **19**.

A gasket **43**, which conforms with the housing flange **17** and the reinforcing bar **19**, is provided to insure proper seating of the spinneret plate. Another gasket **45** is interposed between spinneret and feeder plates **23** and **25** to insure proper sealing therebetween and includes a plurality of circular holes which correspond in size, shape and spacing to the extrusion orifices **41** in the spinneret plate **23**.

The feeder plate **25** also has a downstream face **47** and an upstream face **49**. The downstream face **47** of the feeder plate is provided with straight and substantially

parallel slots **51** which, as shown by broken lines in FIG. 2, are aligned with the rows of orifices **41** in the spinneret plate **23**. The lengths of the slots **51** are substantially equal to the respective rows of orifices **41** which they overlie and are of like cross-sectional size.

Rows of like, circular uniformly spaced openings **53** extend through the feeder plate **25** and are aligned with and open into the slots **51**. As shown in FIGS. 4 and 6, the openings **53** in each row of openings enter the respective slots **51** at locations between, and preferably midway between, the extrusion orifices **41** with which such slots **51** are aligned. For reasons as more fully described hereafter, each row of openings includes one opening more than the number of orifices in the row of orifices which it overlies.

The upstream face **49** of the feeder plate **25** is formed with independent channels **55** which extend across at least some of the rows of openings **53**. As shown in FIG. 2, each channel **55** is aligned with a separate opening **53** in each of the rows of openings with which it crosses, with adjacent of such channels being aligned with adjacent openings in the respective rows of openings.

Overlying the feeder plate **25** is the distributor plate **27** which has a downstream face **57** and upstream face **59**. Between these faces **57** and **59** extend two rows of passages **61**. The passages **61** are equal in number to the channels **55** in the feeder plate **25** and are aligned with such channels. More particularly, the passages **61** in one of such rows open into alternate channels **55** in the feeder plate **23** while the passages of the other of such rows open into the remaining of such channels **55**.

As shown in FIG. 1, the downstream face **57** of the distributor plate **27** is provided with a plurality of parallel grooves **63** which are aligned with portions of the feeder plate channels **55**. Each of the grooves **63** communicates, at one end thereof, with a separate passage **61** and, as illustrated by broken lines in FIG. 3, extends from such communicating passage **61** toward and beyond the center line of the distributor plate. The upstream face **59** of the distributor plate **27** includes a plurality of parallel recesses **65** which open at one end thereof into the passages **61** but extend from such respective passages **61** toward the periphery of the distributor plate. As will be more fully apparent hereafter, the recesses **65** assist in funneling flowable filament-forming material into the passages **61** while the grooves **63** facilitate the distribution or spreading of filament-forming material along the lengths of the channels **55** with which they are aligned. A sealing gasket **67**, conforming with the downstream face **57** of the distributor plate **27**, is disposed between the feeder and distributor plates **25** and **27** to prevent any intermixing of the different filament-forming materials passing through the passages **61** and into the channels **55**.

The spinneret assembly of the present invention is adapted to be attached to a tubular sand pack holder **69** by a series of bolts **71** which extend through suitable openings in the housing **15**. The sand pack holder **69** is itself part of a conventional extrusion apparatus and includes a perforated bottom wall and a partition **73** which defines, in such holder, two chambers **75** and **77** into which different molten thermoplastic filament-forming materials are delivered under pressure. A gasket **79** is positioned between the spinneret assembly of the present invention and the holder **69** to provide for a good seal therebetween. Heating means may be provided along the periphery of the spinneret assembly to maintain the materials flowing therethrough at a desired temperature.

With the spinneret assembly mounted onto the sand pack holder **69** as shown in FIG. 1, one molten thermoplastic filament-forming material is continuously delivered into the chamber **75** simultaneously with the continuous delivery of a different molten thermoplastic material into the chamber **77**. Flowing through the perforated bottom wall of the holder **69** and the passages **61** in the distributor plate **27**, the molten material from

the respective chambers **75** and **77** passes into and along the feeder plate channels **55**. The distributor plate recesses **65** encourage the flow of the molten material into the passages **61** and thus prevent the same from remaining stagnant along any areas of the upstream face of the distributor plate. The grooves **63** along the downstream face of the distributor plate **27** facilitates the spreading of the molten materials along the lengths of the respective channels **55** so as to avoid any significant differences in pressure on the molten materials in the individual channels.

As described above, the passages **61** in each such row of passages are aligned with separate channels **55** in the feeder plate **25**, with the passages **61** in one such row opening into channels **55** which alternate with the channels into which open the passages of the other of such row of passages. Thus, all channels **55** in the feeder plate **25** will be filled with molten materials, with like molten material flowing only in alternate of such channels. The gasket **67** prevents communication between any of the feeder plate channels **55** so that no mixing of the molten materials in such channels occurs.

The openings **53** convey the molten materials from channels **55** in the upstream face **49** of the feeder plate **25** to the slots **51** in the downstream face **47** of such plate. It will be noted from FIG. 2 that an opening **53** is located at each end of each of the channels **55**, to avoid stagnant areas in the molten materials.

As heretofore described and shown in FIG. 2, the openings **53** are disposed in rows, each of which is aligned and communicates with an individual slot **51**. Adjacent openings **53** in each such row of openings extend from adjacent channels **55** and, since such adjacent channels **55** contain different molten materials, the adjacent openings **53** in each such rows of openings will likewise contain different molten materials.

The molten materials flowing through the openings **53** toward the upstream face **39** of the spinneret plate **23** impinge against the portions of the gasket **45** which are opposite to such openings and are thereby deflected in directions extending lengthwise of the respective slots **51** with which such openings are aligned. Except for the endmost openings **53** as shown in each row of openings, the molten material issuing from each of the remaining openings **53** is divided into two flows, as indicated by arrows **81** and **83** in FIG. 4, which flows travel in opposite directions lengthwise of the respective slots **51**. Thus, the different molten materials discharged into a common slot **51** from adjacent openings **53** flow lengthwise of such slot, meet at the upstream end of an orifice **41** and are extruded therefrom in side-by-side relationship.

The endmost openings **53** of each row of openings communicate with the respective slots **51** at the ends thereof. Thus, the molten material issuing from each of the endmost openings **53** of each row of openings impinges against the portion of the gasket **45** opposite thereto and is deflected into the slot **51** with which such endmost opening **53** communicates and flows toward an adjacent extrusion orifice **41**.

As heretofore mentioned, each row of openings **53** includes one opening more than the number of orifices **41** in the row of orifices which it overlies. Therefore, in each of the slots **51**, the molten materials delivered by the endmost openings **53** of the row of openings which communicates therewith and the openings **53** in such row which are adjacent to the endmost openings will meet at the upstream ends of orifices **41** and will be extruded therefrom in side-by-side relationship.

With the arrangement of the rows of extrusion orifices **41** and rows of openings **53**, each of the extruded streams will consist of different molten materials in side-by-side relationship. These streams are quenched outwardly of the spinneret assembly by cool wall or air to provide individual composite filaments **85** as shown in FIG. 7, each having components **87** and **89** which are formed of the different thermoplastic materials originally supplied to the assembly.

The absence of turbulence in the different molten materials especially at the upstream ends of the extrusion orifices insures that so significant intermixing occurs between such different molten materials. As a result, components **87** and **89** of the composite filaments **85** are sharply defined. The pressure applied to each of the two molten thermoplastic materials delivered to the spinneret assembly may be the same or may differ. Like pressure applied to each of the two different molten materials will provide a filament as shown in FIG. 7 in which the components **87** and **89** are of substantially the same cross-sectional size. By increasing the pressure of one of such molten materials, the filament component formed from such one molten material will be larger than the other of such components in cross-sectional size, without affecting the size or shape of the composite filament itself.

I claim:

1. A spinneret assembly for producing composite filaments including a spinneret plate having a downstream face and an upstream face, a row of extrusion orifices extending through said spinneret plate, a feeder plate positioned adjacent to the upstream face of said spinneret plate and having a downstream face and an upstream face, a slot in the downstream face of said feeder plate aligned with said row of orifices in said spinneret plate, a row of openings in said feeder plate aligned with said slot, each of said openings extending through said feeder plate and communicating with said slot inbetween adjacent orifices in said spinneret plate, and supply means upstream of said feeder plate for delivering under pressure one flowable filament-forming material to alternate of said openings and a different flowable filament-forming material to the remainder of said openings.

2. An assembly as defined in claim **1** wherein said spinneret plate includes a plurality of substantially parallel rows of extrusion orifices and said feeder plate includes a plurality of slots in the downstream face thereof and rows of openings extending therethrough, said slots extending parallel to and being aligned with the rows of extrusion orifices and said rows of openings extending parallel to and being aligned with and communicating with said slots at locations inbetween adjacent orifices in said spinneret plate and wherein said supply means delivers under pressure one flowable filament-forming material to alternate openings in each row of openings and a different filament-forming material to the remainder of said openings.

3. An assembly as defined in claim **2** wherein the orifices in each row of orifices are in staggered relationship relative to the orifices in the rows adjacent thereto.

4. An assembly as defined in claim **2** wherein said supply means includes a plurality of independent channels in the upstream face of said feeder plate, each of said channels extending across at least some of the rows of openings with the respective channels being aligned with a separate opening in each of the rows of openings with which it crosses and with adjacent of said channels being aligned with adjacent openings in the respective rows of openings.

5. An assembly as defined in claim **4** wherein said supply means includes a distributor plate positioned adjacent to the upstream face of said feeder plate and having a downstream face and an upstream face, two rows of passages extending through said distributor plate, the passages in one of said rows of passages being aligned with alternate channels in said feeder plate and the passages in the other of said rows of passages being aligned with remaining channels in said feeder plate.

6. An assembly as defined in claim **5** wherein said passages each open into a separate groove in the downstream face of said distributor plate, each of said grooves extend-

ing at least along a portion of the length of the respective channels with which said passages are aligned.

7. An assembly as defined in claim 6 wherein the orifices in each row of orifices are in staggered relationship relative to the orifices in the rows adjacent thereto.

8. An assembly as defined in claim 2 wherein the openings in each row of openings communicate with the individual slots at locations midway between adjacent orifices with which the respective slots are aligned.

9. An assembly as defined in claim 1 further including means for supporting said spinneret plate, feeder plate and supply means in fixed relationship, said supporting means

including a reinforcing bar extending substantially centrally across the downstream face of said spinneret plate and removed from the orifices therein for preventing distortion of said spinneret plate under the pressures of the flowable filament-forming materials passing therethrough.

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