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APPARATUS FOR PRODUCING COMPOSITE FILAMENTS

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Fig. 1.

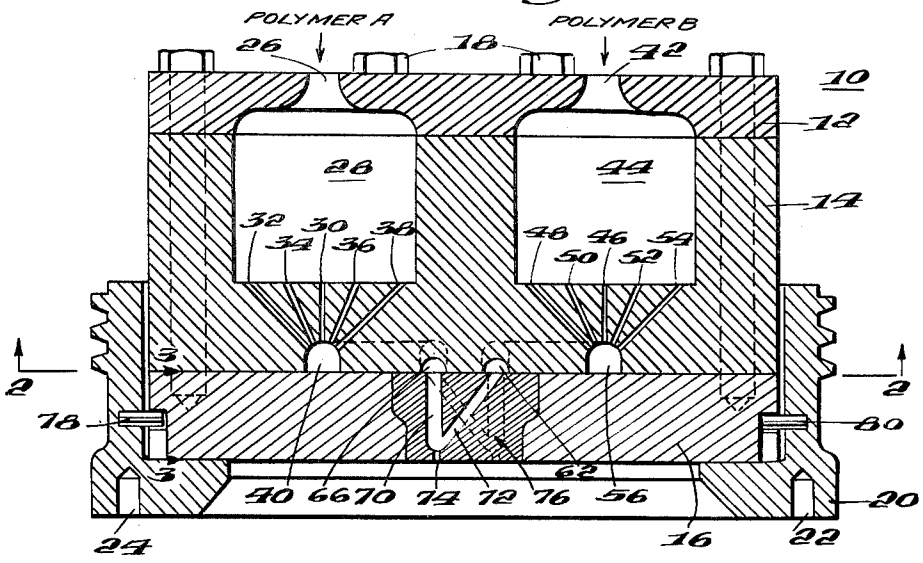


Fig. 2.

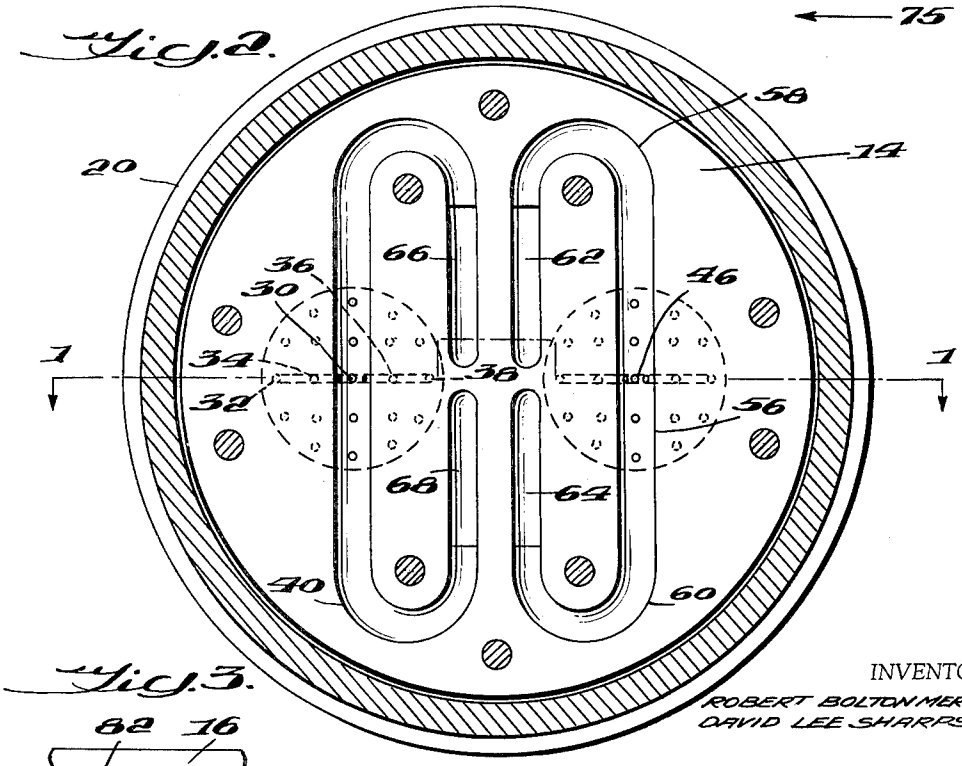
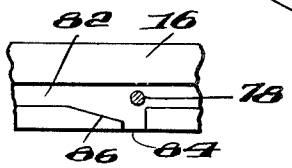


Fig. 3.



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APPARATUS FOR PRODUCING COMPOSITE FILAMENTS

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This invention relates to the production of filaments from molten organic compositions and more particularly to a spinneret assembly useful in the spinning process.

The melt spinning of synthetic linear polymers through an apparatus installation including a metering pump, a filter block, and a spinneret plate is disclosed in U.S. Patent 2,266,368, to Hull et al., issued on December 16, 1941 and in U.S. Patent 2,278,875 to Graves issued on April 7, 1942. Such installations are particularly useful in the melt spinning of polyamides and polyesters. Until quite recently most of the spinning art has been concerned with spinning homofilaments; that is, filaments which consisted of only one type of polymer from a single source. Recently, however, there has been increased interest in attaining different filament and fabric properties through the spinning of two-component fibers, particularly side-by-side to induce self crimping. Concentric sand cavities with a circular orifice pattern are used for side-by-side two-component spinning; however, with cross-flow air quenching, the interface or junction between the two components is not oriented the same, with respect to the air flow, for all filaments. It has been found that this affects the uniformity between filaments, particularly where one of the polymers being spun is sticky and needs more quenching than the other polymer.

A major concern which is often overlooked in all spinning assemblies is the requirement of good polymer distribution, whether spinning homofibers or multi-polymer fibers. Each polymer distribution system in the assembly must be as simple as possible. At first glance, a circular channel under an annular sand cavity appears to be quite simple. Actually, it is extremely complex since polymer issuing from two adjacent holes in the filter block leading to the circular cavity may have some slight variations. Moreover, there is an interface in the circular channel where these two streams meet and this interface moves whenever there are any relative variations in the polymer flow from these two holes. This can cause non-uniformities in the filaments formed in the spinneret orifices. Also, a dead spot frequently forms at the interface, permitting degradation of the molten polymer and causing poor quality yarn.

Frequently, it is desirable that the spinning equipment be sufficiently versatile so that either homofibers or multi-polymer fibers can be spun from the same machine. To accomplish this objective, the prior art has found it necessary to shut-down one polymer source and double the through-put of the second source. This, of course, requires special valving. An alternative method used was to attempt to produce identical polymers from the two sources. However, this is almost impossible to accomplish with sufficient control so that the desired homofiber, produced by spinning the two polymers in a side-by-side relationship, attains the same uniformity as a homofiber produced from a single polymer source.

Another problem associated with spinneret assemblies, particularly those used in grid melting units, occurs when such assemblies become dirty and contaminated, through off-grade product being filtered out in the filter cavity. This necessitates changing the assembly which is quite difficult since the assembly is at an elevated temperature and frequently becomes stuck in the grid melting unit. If the

spinneret assembly cannot be removed without being damaged, the entire spinning unit must be removed to regain productivity and reduce degradation in associated reduced flow polymer streams. Therefore, it is essential that any spinneret assembly be designed so that it can rapidly be changed and have means for unsticking and removing stuck spinneret assemblies.

An object of this invention is to provide a spinneret assembly with an improved polymer distribution system, particularly from filtering means (sand) to the spinneret to give improved interfilament denier uniformity. Another object is to provide good distribution when spinning two-component yarns and to orient the intercomponent junction with respect to the quenching in the same direction to avoid interfilament differences in quenching. A further object is to provide an improved means for removing the spinneret assembly from the spinning unit to reduce the number of unit failures because of stuck spinneret assemblies. A still further object is to provide a spinneret assembly which is easily changeable from two-component spinning to single-component spinning and vice versa. A still further object is to provide a simple spinneret assembly with a minimum of parts. Other objects will appear hereinafter.

The objects of this invention are accomplished by a spinneret assembly which comprises a superimposed filter block and spinneret plate, the filter block having two separate filter cavities in the upper face and two symmetrical distribution channels in the lower face, the distribution channels having portions below the filter cavities and the filter block having a series of vertical and angled holes which connect the bottom of each of the filter cavities to the respective portions of the distribution channels below the filter cavities. Each of the distribution channels define a path which extends in both directions from the portions below the filter cavities toward the periphery of the filter block and then circling toward the interior of the filter block. Each distribution channel terminates in opposed straight end portions, which are tapered and the depth is at a minimum at the extreme ends. The spinning plate has spinning orifices which are aligned with respect to the straight end portions of the distribution channels.

The embodiments of this invention and their advantages can be more readily understood by referring to the accompanying drawings in which:

FIGURE 1 is a cross sectional view of a spinneret assembly taken along line 1—1 of FIGURE 2,

FIGURE 2 is a sectional view taken along line 2—2 of FIGURE 1, i.e., a bottom view of the spinneret assembly, and

FIGURE 3 is a sectional view taken along line 3—3 of FIGURE 1.

Referring to FIGURES 1 and 2, there is shown spinneret assembly 10 which includes, as components, a top plate 12, a filter block 14 and spinneret plate 16, the three pieces being held together by bolts 18. This spinneret assembly 10 is held in position against a spinning machine (not shown) by holding ring 20. The holding ring 20 is attached to the spinning machine by Acme threads. A spanner wrench (not shown) with protruding pins engages holes 22 and 24 of the holding ring and applies the necessary torque to tighten and loosen holding ring 20.

When spinning two-component fibers, polymer A enters through port 26 in the top plate 12. Molten polymer can be supplied by any conventional means such as a screw melter or grid melter and metered by a conventional metering pump. From port 26 the molten polymer flows to the filter cavity 28, which is normally filled with screens and sand to give the necessary filtering action. In order to insure equal drainage from the filter cavity 28, there

are a series of vertical holes 30 and a series of angled holes 32, 34, 36 and 38. These holes drain the filter cavity 28 into channel 40. In a similar manner, polymer B enters through port 42 into filter cavity 44. Vertical holes 46 and angled holes 48, 50, 52 and 54 provide equal drainage of filter cavity 44 into channel 56. Channel 56 defines a path which extends in both directions toward the periphery of the filter block 14 and then circles toward the interior of filter block 14 as illustrated by the circling portions 58 and 60. The channel terminates in two straight end portions 62 and 64 which oppose each other as illustrated in FIGURE 2. In a similar manner, channel 40 extends toward the periphery, circles toward the interior and forms straight end portions 66 and 68. The width of the channel 46 and circling portions 58 and 60 and straight end portions 62 and 64 is constant. The depth of the channel 46 is constant, as well as the circling portions 58 and 60. However, the depth in straight end portions 62 and 64 is tapered, being greatest at the intersection between the circling portions 58 and 60 and straight end portions 62 and 64 and at a minimum at the end of straight end portions 62 and 64. The tapered straight end portions 62 and 64 maintain the polymer shear rate above that level required to prevent gelation and provide a pressure gradient which helps compensate for the temperature gradient across the face of the spinneret. Channel 40 is dimensionally similar to channel 46. In this manner, all of the polymer from the filter cavities 28 and 44 is brought through the respective channels 40 and 56, and a partial mixing of each polymer is accomplished in each channel. Thus any variations or non-uniformities that might occur through the filtering medium are removed by this mixing action thereby providing a more homogeneous melt which is then distributed to the end portions of the channels. A more homogeneous melt provides better interfilament uniformity in spinning.

In spinning side-by-side filaments, polymer A, having been distributed to straight end portion 66 of channel 40, is forced through capillary 70. Polymer B, from straight end portion 62 of channel 56, is forced through capillary 72. These two capillaries intersect directly ahead of the orifice 74. There are a series of these orifices in line with orifice 74. As shown in dashed outline, there is another row of orifices which are similarly fed from straight end portions 66 and 62. If the quenching air flow is in the direction of arrow 75, polymer B, which comes in port 42 and out through capillary 72, will always be closer to the quenching air, no matter through which orifice the filament is spun. This provides better quenching uniformity and also provides a more uniform end product.

With reference to FIGURES 1 and 3, holding ring 20 has inserted therein pins 78 and 80 which engage groove 82 located in the side of spinneret plate 16. When the holding ring 20 is inserted over the spinneret plate 16, pin 78 moves into groove 82 through entrance cutout 84. When the pack is assembled into the spinning machine, holding ring 20 is engaged into threads in the spinning machine; and by a spanner wrench (not shown) which engages holes 22 and 24, the spinneret assembly is tightened into the spinning machine. When it is desired to remove a used spinneret assembly which is stuck, the removal of holding ring 20 does not provide any downward force to spinneret assembly 10. At the first loosening, due to the clearance between the threads in the holding ring and the threads in the spinning machine, the pins will not provide any downward force, and the pin 78 will tend to fall into entrance cutout 84. However, continued unthreading of the holding ring 20 will cause pin 78 to engage ramp 86. Ramp 86 provides an inclined-plane action which breaks loose the spinneret assembly 10 from the spinning machine in just a portion of a revolution of holding ring 20. This provides a quick and efficient manner of removing what would normally be a stuck spinneret assembly. Frequently, the time of removal of the spinneret assembly is quite critical because the molten polymer from the melting unit is stopped and begins to degrade. Consequently, it is quite imperative that a spinneret assembly be removed and a new and clean one inserted in a matter of minutes. The simple ramp and pin arrangement described above provides this rapid and simple method.

The embodiment shown is illustrated for spinning side-by-side filaments, i.e., filaments where one portion of the cross section of a single filament is composed of polymer A while the other portion is composed of polymer B. While it is normal for a 50–50 division between the two polymers, any desired division can be attained.

Also, in this embodiment the capillaries 70 and 72 and orifices 74 are made in insert 76 which is placed in the spinneret plate 16. When it is desired to replace a damaged orifice, it is easy to change insert 76.

If it is desired to spin sheath-core filaments using two components, insert 76 can be modified as illustrated in the co-pending application to Hollandsworth, Serial No. 248,640, filed December 31, 1962, and assigned to applicant's assignee.

When it is desired to spin homofilaments, that is, spin filaments which are composed of one polymer, it is essential that the whole filament be homogenous. While it is desirable that the polymer coming in port 26 be identical with polymer coming in port 42, it is almost impossible to have two sources of molten polymer having identical characteristics in the molten state just before spinning. While the slight differences which occur do not affect the final fiber or yarn formed, these differences are very apparent when attempting to form these two similar polymers together in a side-by-side relationship. Therefore, it is highly desirable to maintain the two polymers completely separate and form each filament completely from one polymer supply. This is easily done by removing insert 76 and replacing it with a similar insert in which capillary 70 leads directly to orifice 74 and the capillary from straight end portion 62 of channel 56 leads directly downward through a similar capillary and similar orifice. All the polymer from straight end portion 66 is thereby spun in orifices directly below and all the polymer from straight end portion 62 is spun in orifices directly below it. Thus with a simple change in insert 76, it is possible to provide the flexibility to spin either side-by-side filaments or homofibers.

While no gaskets are illustrated, it is obvious that to minimize leakage for high pressure melt spinning, port 26 and port 42 should be kept as small as is practical. These ports can be sealed by any conventional gasket, for example, the delta gasket illustrated in U.S. Patent 2,960,198 to Keefe, issued on November 15, 1960. Also, the joint between top plate 12 and the filter block 14 can be sealed by any form of gasket. A preferred gasket is illustrated in U.S. Patent 2,980,284, to Gill et al., issued on April 18, 1961. Similarly, a complicated flat gasket could be used between the filter block 14 and the spinneret plate 16. However, here the pressures are relatively low as compared to the pressures in the top of fiilter cavities 28 and 44 and it has been found possible to obtain a satisfactory seal by lapping the bottom surface of the filter block 14 and the upper mating surface of spinneret plate 16.

The use of a top plate provides reduced gasket area and reduces the possibility of leaks. Also, the assembly is capable of operating at higher operating pressures, e.g., above 10,000 p.s.i. However, the use of a top plate is not essential to this invention.

While the embodiment illustrated has the width of the channels constant, it is of course recognized that the depth and the width of the channel portions may be varied. Of course, it is essential to keep the melt flowing at sufficient velocity to prevent degradation from occurring in time-temperature sensitive materials. Also, it is essential to have streamlined channels to prevent similar degradation in dead spots. Further, when dis-

similar polymers are spun, each channel should be designed for the specific polymer flowing through it. Consequently, the dimensions of the two channels may be different.

While past designs have utilized complicated plates and distribution elements in spinneret assemblies, the invention provides a simple and clean design with the parts kept at a minimum. Interchangeability is accomplished by changing one simple element, namely insert 76. Good distribution means assures that a uniform melt is provided to the spinneret orifices.

Since many different embodiments of the invention may be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited by the specific illustrations except to the extent defined in the appended claims.

What is claimed is:

1. A spinneret assembly comprising a superimposed filter block and spinneret plate, said filter block having two separate filter cavities in the upper face and two symmetrical distribution channels in the lower face, said distribution channels having portions thereof below said filter cavities, said filter block having a series of vertical and angled holes connecting the bottom of each of said filter cavities to the respective portions of said distribution channels below said filter cavities, said distribution channels each defining a path extending in both directions from the portions below said filter cavities toward the periphery of said filter block and then circling toward the interior of said filter block, each of said distribution channels terminating in opposed straight end portions, the depth of the straight end portions of said distribution channels being tapered and at a minimum at the extreme ends, and said spinneret plate having orifices therein which are aligned with respect to the straight end portions of said distribution channels.

2. A spinneret assembly comprising a superimposed top plate, filter block and spinneret plate, said filter block having two separate filter cavities in the upper face and two symmetrical distribution channels in the lower face, said distribution channels having portions thereof below said filter cavities, said top plate having ports therein aligned with said filter cavities, said filter block having a series of vertical and angled holes connecting the bottom of each of said filter cavities to the respective portions of said distribution channels below said filter cavities, said distribution channels each defining a path extending in both directions from the portions below said filter cavities toward the periphery of said filter block and then circling toward the interior of said filter block, each of said distribution channels terminating in opposed straight end portions, the depth of the straight end portions of said distribution channels being tapered and at a minimum at the extreme ends, and said spinneret plate having spinning orifices therein which are aligned with respect to the straight end portions of said distribution channels.

3. A spinneret assembly comprising a superimposed filter block, spinneret plate and holding ring, said filter block having two separate filter cavities in the upper face and two symmetrical distribution channels in the lower face, said distribution channels having portions thereof below said filter cavities, said filter block having a series of vertical and angled holes connecting the bottom of each of said filter cavities to the respective portions of said distribution channels below said filter cavities, said distribution channels each defining a path extending in both directions from the portions below said filter cavities toward the periphery of said filter block and then circling toward the interior of said filter block, each of said distribution channels terminating in opposed straight end portions, the depth of the straight end portions of said distribution channels being tapered and at a minimum at the extreme ends, said spinneret plate having spinning orifices therein which are aligned with respect to the straight end portions of said distribution channels, said holding ring having therein a plurality of pins to engage in a groove in said spinning plate and said groove having a similar number of entrance cutout portions adapted to accept said pins, the bottom edge of said groove also having ramp portions adjoining said entrance cutout portions.

4. A spinneret assembly for two component spinning comprising a superimposed filter block and spinneret plate, said filter block having two separate filter cavities in the upper face and two symmetrical distribution channels in the lower face, said distribution channels having portions thereof below said filter cavities, said filter block having a series of vertical and angled holes connecting the bottom of each of said filter cavities to the respective portions of said distribution channels below said filter cavities, said distribution channels each defining a path extending in both directions from the portions below said filter cavities toward the periphery of said filter block and then circling toward the interior of said filter block, each of said distribution channels terminating in opposed straight end portions, the depth of the straight end portions of said distribution channels being tapered and at a minimum at the extreme ends, said spinneret plate having spinning orifices therein which are aligned with respect to the straight end portions of said distribution channels and said spinning plate also having two rows of intersecting capillaries which connect said straight end portions of said distribution channels to said spinning orifices.

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