United States Patent [19]

Chimura et al.

[11] **3,792,944**

[45] **Feb. 19, 1974**

[54] **SPINNERET FOR COMPOSITE SPINNING**

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[22] Filed: **June 30, 1971**

[21] Appl. No.: **158,484**

[30] **Foreign Application Priority Data**

July 20, 1970 Japan............................... 45-63432
Sept. 1, 1970 Japan............................... 45-76438

[52] **U.S. Cl.**.............................. **425/131,** 425/463
[51] **Int. Cl.**........................... **B29f 3/12,** D01d 3/00
[58] **Field of Search**.. 425/131, 132, 463; 264/177 F

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[57] **ABSTRACT**

The kneeling phenomenon caused in spinning two polymers having great difference in the viscosities can be prevented by using a spinneret which comprises introduction capillaries for separately introducing the different polymers and an extrusion capillary which communicates with said introduction capillaries, said introduction capillaries and extrusion capillary being arranged in a spinneret plate in such a manner that they satisfy the following inequality, $L_0 < L_1 \leq 5.7\sqrt{S}$ (wherein S = sectional area of the extrusion capillary, L_1 = length of the extrusion capillary and L_0 = thickness of a part of spinneret plate under the bottom of introduction capillary).
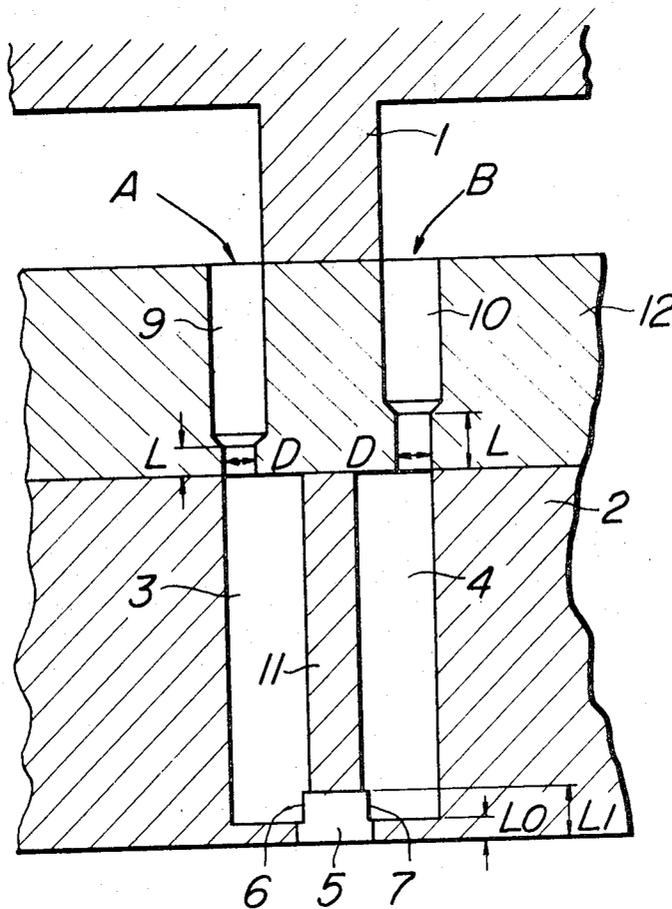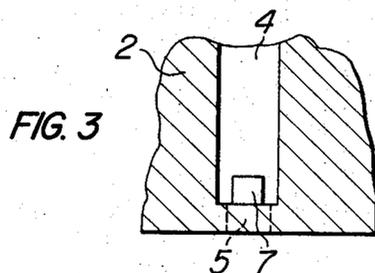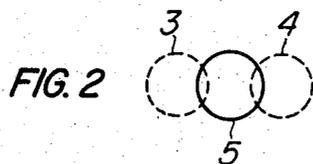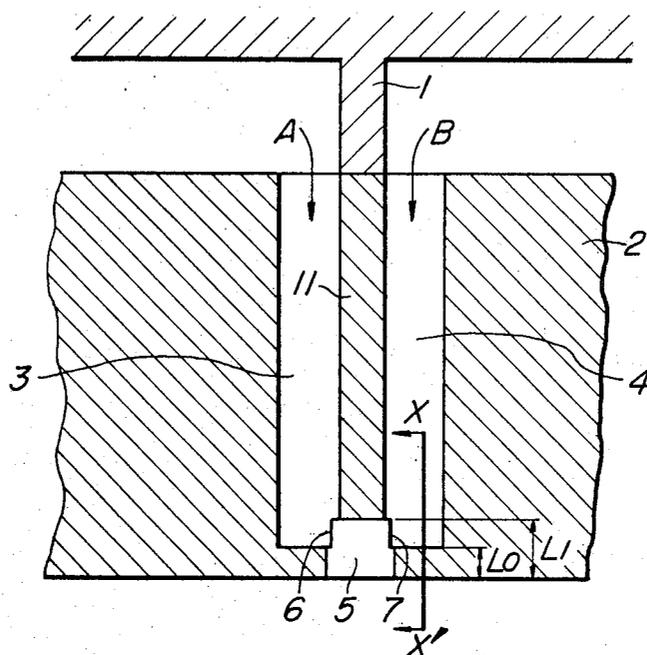
6 Claims, 10 Drawing Figures

FIG. 1

FIG. 2

FIG. 3

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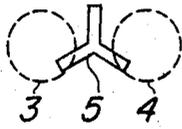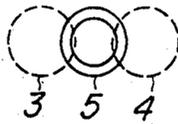
FIG. 4a   FIG. 4b   FIG. 4c
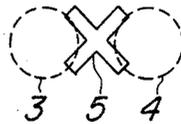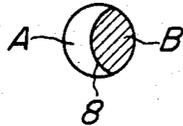
FIG. 5   FIG. 6

FIG. 7

FIG. 8

SPINNERET FOR COMPOSITE SPINNING

This invention relates to an improvement in a spinneret for composite spinning.

In general, when two polymers having different viscosities and the difference in the viscosities is great, a so-called kneeling phenomenon occurs, whereby stable spinning cannot be attained.

Many methods have been proposed to prevent said kneeling phenomenon. One method involves adding a third component to one of the two polymers to control melt viscosities and ther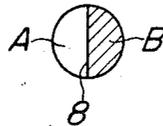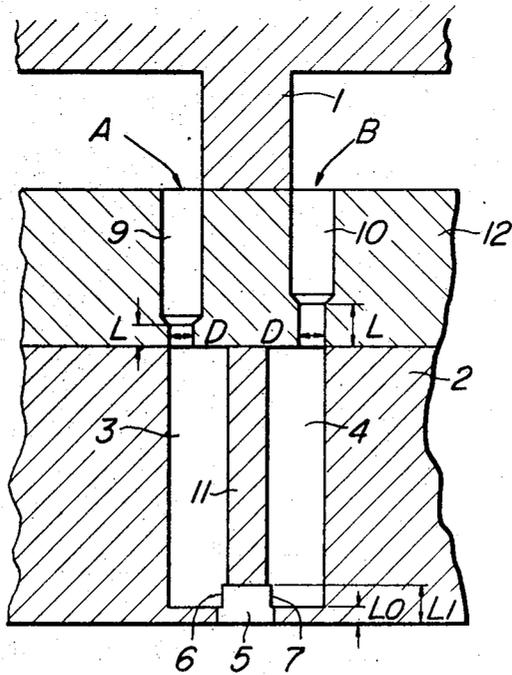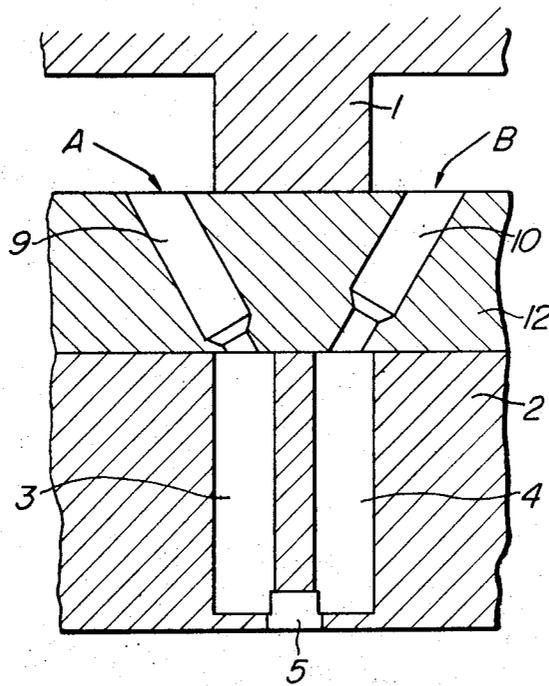eby to decrease the difference in extrusion linear velocities of the two polymers. Another method is to change the shapes of extrusion orifices so that the linear velocities of the two components at extrusion become nearly equal. However, according to the former method, adjustment of the amount of the third component to be added is very difficult and processability is detrimentally influenced. According to the latter method, the arrangement of the extrusion orifice is extremely difficult and yarn unevenness is caused.

It is an object of this invention to provide a spinneret for composite spinning which has the following advantages: namely, assembling of the spinneret is very easy; said kneeling phenomenon can be greatly reduced; and no detrimental effects result to spinnability and stretchability.

A primary aspect of this invention resides in a spinneret for composite spinning which comprises introduction capillaries for separately introducing the different polymers and an extrusion capillary which communicates with said introduction capillaries, said two kinds of capillaries being arranged in a spinneret plate in such a manner that they satisfy the following inequality, $L_0 < L_1 \leq 5.7 \sqrt{S} ...$ (I), wherein S = cross sectional area (mm^2) of the extrusion capillary, L_1 = length (mm) of the extrusion capillary and L_0 = thickness (mm) of the portion of the spinneret plate located beneath the lowest points of the introduction capillaries.

Another primary feature of this invention resides in a spinneret for composite spinning in which the introduction capillaries for separately guiding the different polymers and the extrusion capillary which communicates with said introduction capillaries are arranged in the spinneret plate in such a manner that they satisfy said inequality (I) and furthermore a front plate having guide holes which communicate with the introduction capillaries and have different L/D is provided above said spinneret plate.

Referring to the drawings:

FIG. 1 is a partial vertical cross-sectional side view of a spinneret of this invention;

FIG. 2 is a partial plan view of the spinneret of FIG. 1;

FIG. 3 is a cross-sectional view of the spinneret of FIG. 1 taken at X–X' thereof;

FIGS. 4a, 4b and 4c show various shapes of cross section of the extrusion capillary in the spinneret of the present invention;

FIG. 5 shows a cross section of fibers obtained by the conventional spinneret;

FIG. 6 shows a cross section of fibers obtained by the spinneret of the present invention;

FIG. 7 is a partial vertical cross-sectional side view of a spinneret of one embodiment of the present invention; and

FIG. 8 is a partial vertical cross-sectional side view of a spinneret of another embodiment of the present invention.

In FIGS. 1 to 3, 1 is a separating plate for separating two components A and B, 2 is a spinneret plate, in which two introduction capillaries 3 and 4 which guide the components A and B to extrusion capillary 5 without permitting blending of the two components. The introduction capillaries 3 and 4 communicate with the extrusion capillary 5 at their lower portions. Thus, the components A and B are introduced into the extrusion capillary 5 through openings 6 and 7 from the introduction capillaries 3 and 4 and they are initially joined in said extrusion capillary. In this invention, it is necessary that the sectional area S of extrusion capillary 5, length L_1 of the extrusion capillary 5 and thickness L_0 of the portion of the spinneret plate located beneath the lowest points of the introduction capillaries satisfy the inequality $L_0 < L_1 \leq 5.7 \sqrt{S}$. When L_1 exceeds $5.7 \sqrt{S}$, the pressure within the extrusion capillary 5 is increased and the two components are extruded in such a manner that the component B having a higher flowability and a lower viscosity surrounds the component A having a lower flowability and a higher viscosity. Therefore, the kneeling phenomenon occurs conspicuously and crimpability is greatly decreased. On the other hand, L_0 is preferably smaller, but the lower limit is determined depending upon the mechanical strength. Thus, the value of L_0 is preferably 0.1 to 5 mm, more preferably 0.2 to 1.0 mm. The value of sectional area S of extrusion capillary 3 may be optionally chosen depending upon melting characteristics of the two components, spinning conditions and size and sectional shape of the desired filaments. Furthermore, area of the openings 6 and 7 may be optionally varied by adjusting the length of the introduction capillaries 3 and 4 or extrusion capillary 5 depending upon the proportion of the two components. The shape of extrusion capillary 5 may be circular and moreover it may be non-circular as shown in (a) and (c) in FIG. 4 or annular as shown in (b) in FIG. 4, wherein 3 and 4 show introduction capillaries and 5 shows the extrusion capillary.

Moreover, in this invention, if the number of the introduction capillaries is increased to three or more and separation of each component before introduction into the introduction capillaries is suitably carried out, more than two polymers may be easily composite-spun.

In the spinneret for composite spinning as shown in FIG. 7, front plate 12 which has guide hole 9 having a smaller L/D for guiding component A of high viscosity to introduction capillary 3 and guide hole 10 having a greater L/D for guiding component B of lower viscosity to extrusion capillary 5 is provided above spinneret plate 2 and separating plate 1 for separation of the components A and B is provided above said front plate 12. The action of said front plate 12 will be explained in detail below.

That is, spinneret plate 2 of this embodiment of the invention is constructed in such a manner that the components A and B are first joined to the extrusion capillary 5 for prevention of the kneeling phenomenon and said plate is subjected to a dynamical interaction of the components A and B within an extremely short period

of time. Thus, each component A and B is nearly separately extruded and back pressure caused by the component B of the lower viscosity is extremely reduced depending upon the ratio of the viscosities. Under low back pressure, the effect of flow resistance becomes great in the passage to extrusion capillary 5. Therefore, it becomes impossible to uniformly distribute the component B of the lower viscosity to the extrusion capillary and unevenness in the composite ratio between individual filaments and unevenness in size of filaments are caused. Furthermore, the thickness partition 11 is limited because of restriction in diameter of extrusion capillary 5 that would result. If front plate 12 is not provided, the separating plate 1 must be thin. Therefore, in such a case, the separating plate 1 contacts the partition 11 in an extremely small area. When the difference in extrusion back pressure of the two components becomes great under the conditions mentioned above, the so-called short-pass phenomenon tends to occur, namely, the component A of higher pressure and higher viscosity is incorporated into the component B of the lower viscosity through the part at which the separating plate 1 contacts the upstream face of the partition 11.

The difficulty as mentioned above can be overcome by providing said front plate 12 between the separating plate 1 and spinneret plate 2. That is, uniform distribution of the components to each extrusion capillary can be attained by making L/D of guide hole 10 for the component B of the lower viscosity in front plate 12 greater than L/D of guide hole 9 for the component A of the higher viscosity in front plate 12 to increase the back pressure of the component B. Moreover, prevention of the short-pass even when the area at which separating plate 1 in contact with front plate 12 is small can be attained by suitably setting the ratio of L/D in guide hole 9 and in guide hole 10 to make the difference between the back pressure for distribution of the component A and that of the component B smaller.

Furthermore, as shown in FIG. 8, when front plate 12 in which guide holes 9 and 10 are arranged in an inclined fashion is used, the width of the separating plate 1 can further be made greater and the separation of each component can more advantageously effected.

This invention is constructed as mentioned above. According to this invention, the introduction capillaries of each component are separately provided and the introduction capillaries communicate with the extrusion capillary at the lower part of the former. Therefore, each component is initially joined to the extrusion capillary and thus the time during which the spinneret is subjected to the dynamical interaction of each component becomes extremely short. Therefore, even if the difference between the melt viscosities of each component is considerably great, the two components are extruded in a state such that the interface of the two components is maintained at nearly the center of cross-section of the filament as shown in FIG. 6. Therefore, the kneeling phenomenon is substantially completely prevented and composite filaments having excellent crimpability can be produced. Furthermore, the introduction capillaries may of simple cylindrical construction and the extrusion capillary may be simply arranged in the perpendicular direction downwardly from the spinneret plate. Therefore, the spinneret can easily be assembled. Moreover, the extrusion capillary is arranged at the center part between the introduction capillaries and hence the spinneret of this invention is very suitable as the spinneret for production of the non-circular composite fibers and the hollow composite fibers.

What is claimed is:

1. A spinneret for composite spinning which comprises a plurality of introduction capillaries for separately introducing different polymers and a hollow extrusion capillary which communicates with said introduction capillaries, said introduction capillaries and extrusion capillaries being contained in a spinneret plate in a vertical direction relative to the lower surface of the spinneret plate in such a manner that they satisfy the following inequality, $L_0 < L_1 \leqq 5.7 \sqrt{S}$, wherein S = sectional area (mm²) of the extrusion capillary, L_1 = length (mm) of the extrusion capillary and L_0 = distance (mm) between lower end of the introduction capillaries and the lower surface of the spinneret plate.

2. A spinneret according to claim 1, wherein the shape of cross-section of the extrusion capillary is non-circular.

3. A spinneret according to claim 1, wherein the shape of cross section of the extrusion capillary is circular.

4. A spinneret according to claim 1, wherein there is a front plate having guide holes which communicate with said introduction capillaries, respectively, and wherein said guide holes have a different L/D, provided above said spinneret plate.

5. A spinneret according to claim 4, wherein the shape of the cross section of the extrusion capillary is non-circular.

6. A spinneret according to claim 4, wherein the shape of the cross section of the extrusion capillary is circular.

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