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J. E. OPFELL ETAL

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SPINNERET PLATE FOR MELT-SPINNING

Filed March 8, 1965

FIG. 1.

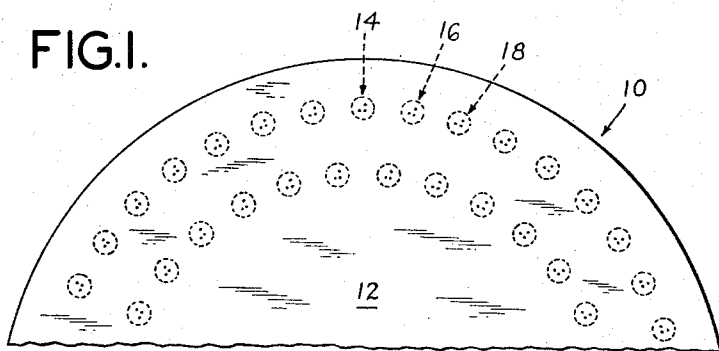


FIG. 2.

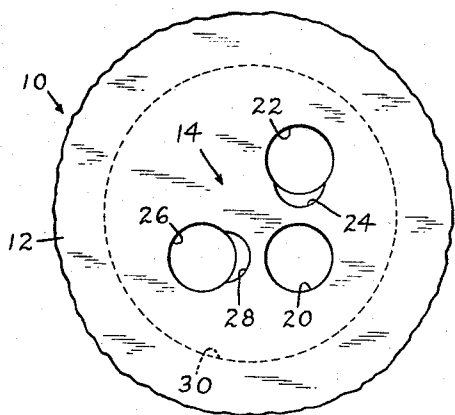


FIG. 3.

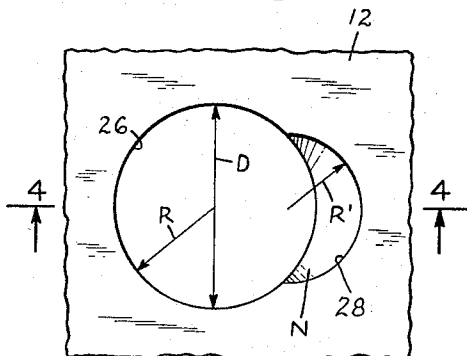
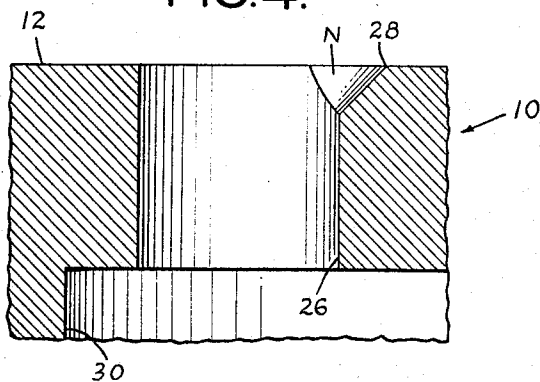


FIG. 4.



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SPINNERET PLATE FOR MELT-SPINNING

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3 Claims. (Cl. 18—8)

This invention relates to apparatus for the spinning of a synthetic funicular body. More particularly, it relates to a spinneret which is useful in the formation of a multilobal funicular body of a melt-spun, fiber-forming synthetic polymer. By the term "funicular body" is meant a filament, fiber, staple, yarn, tow, cord or the like which is suitable for textile and other uses.

Generally, cloverleaf cross-section filaments, e.g., trifilament yarns, are processed from fiber-forming synthetic polymer by melt-spinning through a spinneret containing single or multiple patterned arrangements of holes of such proximity and size that as the filaments emerge, coalescence occurs among the strands of each patterned arrangement. Thereafter, the extrusions are subjected to rapid quenching to arrest plastic flow. Further, deviation from a circular cross-section is obtained by drawing the extruded filaments. It has been observed that the completeness with which the individual strands are coalesced to a composite filament may be improved by modifying the spinneret plate so as to reduce the web thickness (i.e., the closest distance between the circumference of adjacent holes) within the patterned arrangement. However, any such decrease in web thickness will be accompanied by a corresponding loss of spinneret plate strength, and in addition using this method there is a tendency for the molten polymer to "blob" as it emerges from the spinneret holes, thereby losing the desired trifilament type yarn. U.S. Patent 2,804,645 to Wilfong, September 3, 1957, describes an apparatus which improves coalescence among individual strands wherein the individual orifices on the spinneret plate are flared outwardly toward the extrusion face. U.S. Patent 2,891,277 to Sutor, June 23, 1959, describes an apparatus similar to the above-mentioned patent, except that the patterned arrangement on the spinneret plate is protruded so that it tapers outwardly from the extrusion face.

Using known methods, the distance the holes are spaced apart depends on the viscosity and throughput of the polymer. For instance, if the polymer is highly viscous it will flow straight down out of the spinneret hole. On the other hand, low viscosity polymer will "swell" up and "blob" as it flows out of the hole, and return to a circular cross-section.

It is an object of this invention to provide a novel spinneret useful in the art of melt-spinning.

It is another object of this invention to provide a novel spinneret useful in the production of a multilobal funicular body.

It is still another object of this invention to provide a novel spinneret useful in the production of a trifilament yarn.

These and other objects will become apparent and flow from the following specification and claims.

In accordance with the present invention, we have found that the completeness with which individual strands are coalesced to a composite filament may be improved by modifying individual orifices on the spinneret plate so that they cause the exiting semimolten filaments to flow toward one another and form a cloverleaf pattern upon coalescence of each set of strands. This is accomplished by having a spinneret plate with a plurality of orifices, these orifices being preferably in groups of three, separate from but adjacent to other orifices within the group, each

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group having a counterbore or recessed back, and the outermost orifices of the group being notched or grooved on the innermost side of the capillary wall, so as to cause a deflection inwardly from a perpendicular path in the flow of molten material passing through the orifices. The three orifices form a right angle triangle, with the unnotched orifice being at the right angle. However, the invention is not necessarily limited to groups of three orifices, each group may have a plurality of orifices.

The notching has the effect of bending the filaments and allowing a cooling before all three fuse, thereby preventing a return to a circular cross-section, i.e., aiding in the formation of the cloverleaf pattern. Notching of the outermost orifice is done on the edge adjacent to the innermost orifice, preferably the notch having an average radius of between one half and three-fourths the orifice radius and extending no more than one-fourth the diameter of the orifice away from the projected edge of the orifice. It will readily be seen that the smaller the notch, i.e., the lesser the deflection, the more pronounced is the cloverleaf design, to the point whereby a hollow trifilament yarn can be obtained if desired. On the other hand, obviously, the larger the notch, the greater the deflection, with a resultant lesser pronounced cloverleaf design. However, it is to be understood that the size of the notch is not critical, it may extend out from the projected edge of the orifice as far or as little as desired, depending on the type yarn desired, the only limitation being that the notch not touch the unnotched hole.

The cloverleaf design yarn is particularly advantageous in that it is brighter looking and reflects light, and more important, uses less product, i.e., takes up less polymer and covers more space. The advantages of this particular pattern yarn are further described in copending U.S. application Serial No. 280,321 of Opfell, now Patent No. 3,216,186, granted November 9, 1965, also assigned to this assignee.

This invention will be understood more readily by reference to the accompanying drawing wherein a preferred embodiment is illustrated, but it is to be understood that it is capable of modification without departing from the scope therefrom.

FIGURE 1 is a plan view of a section of the spinneret plate showing a typical patterned arrangement of orifices which may be employed in accordance with the present invention.

FIGURE 2 is a magnified fragmentary plan view of a group of three orifices; showing the two notched outermost orifices.

FIGURE 3 is a magnified fragmentary plan view of a single notched orifice.

FIGURE 4 is a magnified cross-sectional view of FIGURE 3, along line 4.

Referring to the drawing, a spinneret plate 10 containing 240 holes on extrusion face 12 consisting of 2 rows of 40 groups of three orifices, for example 14, 16, 18, as shown in FIGURE 1, is drilled. The patterned arrangements are laid out on concentric circles. The orifices have diameters D of 0.0014 inch, and the distance between the unnotched orifice 20 and the notched orifices 22, 26, at their center is 0.0023 inch, respectively. Prior to drilling the orifices, a counterbore 30 having a $\frac{3}{32}$ -inch diameter is drilled on the polymer melt face (not shown) for each patterned arrangement. Thereafter, the orifices are drilled through the counterbore.

The relationship of a typical orifice 26 with notch 28 is shown in FIGURE 3, D being the diameter of the orifice, R being the radius thereof, and R' being the radius of the notch. The notch N may be any depth, but preferably it is cut about 0.004 inch deep at any angle.

It will be seen that as melt polymer enters the spinneret plate at counterbore 30 and exits from the orifices 20, 22 and 26, the polymer will be deflected inwardly by

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notches 24 and 28 towards the orifice 20. A slight cooling will ensue before the semimolten filaments fuse just below the extrusion face 12 to form a trifilament yarn, of cloverleaf cross-section.

Many other modifications within the scope of the disclosed invention, without a departure therefrom, will be apparent to those skilled in the art.

We claim:

1. A spinneret plate for melt-spinning which comprises a plate containing at least one group of a plurality of orifices, all except one of said orifices being notched inwardly towards the one said orifice, said orifices being so spaced that coalescence occurs among the extruded strands of each group resulting in a multilobal funicular body of cloverleaf cross-section; with the outer edge of the notches of said orifices approaching the edge of the unnotched orifice but never touching it; and with each group of said orifices having a counterbore on the polymer melt face of said plate.

2. The structure of claim 1 wherein the notches have a radii, respectively, of between about one-half and three-fourths the orifice radius, and their respective outer edges extend no more than about one-fourth the diameter of said orifice away from the projected edge of their respective orifices.

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3. The structure of claim 1 wherein said plate contains at least one group of three orifices and said three orifices are in the relation of a right angle triangle, with the unnotched orifice being at the right angle; and the distance between the centers of the notched orifices and said unnotched orifice is about 0.0023 inch, respectively; with the notches having a radii, respectively, of between about 0.0004 and about 0.0006 inch and their respective outer edges extending no more than about 0.0004 inch away from the projected edge of their respective orifices.

References Cited by the Examiner

UNITED STATES PATENTS

15	2,149,425	3/1939	Draemann	-----	161—177	XR
	3,174,364	3/1965	Sims	-----	18—8	XR
	3,181,201	5/1965	Seiz	-----	18—8	
	3,216,186	11/1965	Opfell	-----	57—140	

OTHER REFERENCES

A.P.C. application of Aschenbrenner et al., published Apr. 27, 1943.

WILLIAM J. STEPHENSON, *Primary Examiner*.

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