

July 9, 1957

P. W. CUMMINGS, JR

2,798,252

SPINNERETTE

Filed Sept. 23, 1955

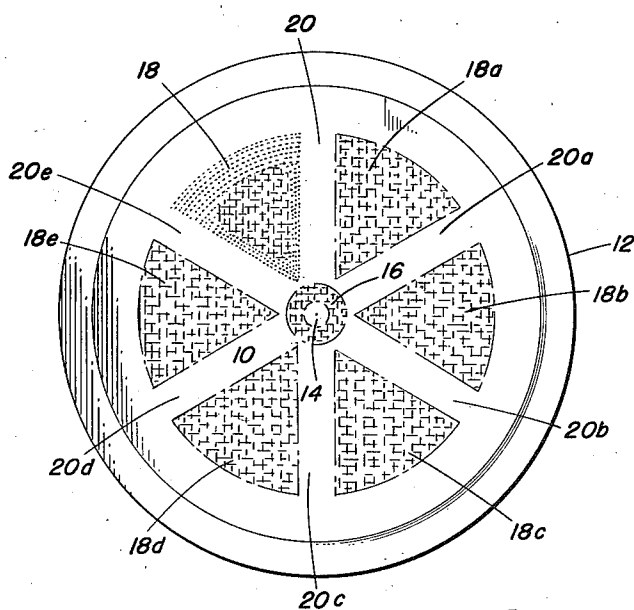


Fig. 1.

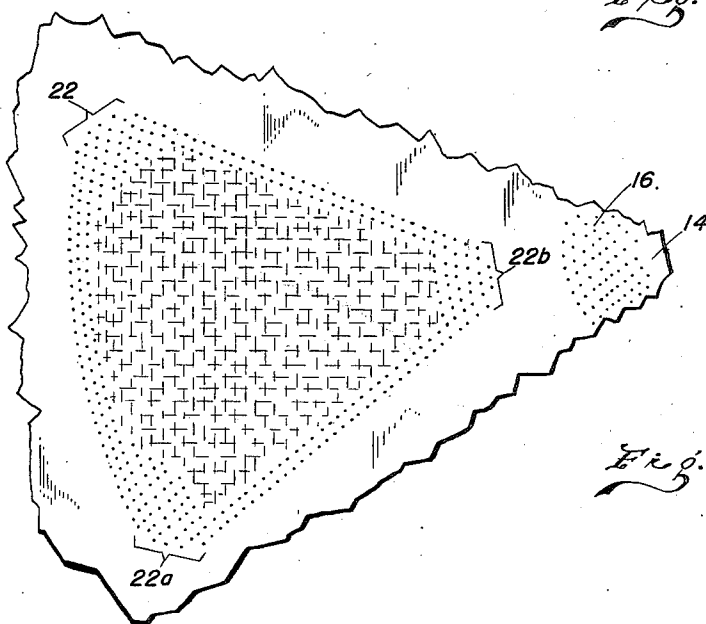


Fig. 2.

INVENTOR.

PERCIVAL W. CUMMINGS JR.

BY

Harold L. Kauffman

ATTORNEY.

1

2,798,252

SPINNERETTE

Percival W. Cummings, Jr., Cos Cob, Conn., assignor to American Cyanamid Company, New York, N. Y., a corporation of Maine

Application September 23, 1955, Serial No. 536,173

1 Claim. (Cl. 18—8)

This invention relates to improved spinnerettes (formed usually of platinum or a platinum alloy) and more particularly to certain new and useful improvements in spinnerettes adapted for use in the production of multifilaments, for example, those formed of a synthetic material such as regenerated cellulose (rayon), a polymer (homopolymer or copolymer) of acrylonitrile, etc. The spinnerettes of the present invention are particularly suitable for use in the wet-spinning of tow (rope or bundle of continuous filamentary material).

In the production of artificial or synthetic filaments or fibers, a dope or solution of the coagulable material is extruded through a spinnerette containing a number of minute orifices into a coagulating chamber where the filamentary material is formed or coagulated either by evaporation of the volatile solvent in which the solid component has been dissolved (so-called "dry-spinning") or into a bath of liquid coagulant in the case of so-called "wet-spinning." With the usual continuous-filament yarn, little difficulty ordinarily is encountered in coagulating the comparatively small number of individual filaments (e. g., 30 to 240 filaments) that make up the strand formed by extrusion through a single spinnerette, since the coagulating medium easily penetrates to all of the filaments that comprise these relatively small bundles. However, the problem is more troublesome in the case of tow, which is chiefly used in the production of staple fibers.

In producing tow, an extremely large number of filaments of comparatively small diameter is desired. Furthermore, the larger the number of these filaments that can be produced by a single spinnerette, the greater is the manufacturing efficiency for the simple reason that fewer spinnerettes and, therefore, fewer spinning positions are required. Although the number of filaments produced by a single spinnerette can be increased by increasing the area of the spinnerette face, other considerations limit the feasible size of spinnerette faces to a maximum diameter of a few inches. Additional problems arise in wet-spinning when employing a low-temperature coagulating bath and which is maintained at a temperature considerably lower, e. g., 40° to 100° C. lower, than the temperature of the dope being extruded. Such a process is described in Cresswell U. S. Patent No. 2,558,730, dated July 3, 1951. In this Cresswell process solutions of homopolymeric acrylonitrile and of various copolymers of acrylonitrile are extruded at about 90° C. into an aqueous coagulating bath maintained at about 0° C. In using the spinnerettes of the prior art for making tow by the Cresswell process, the concomitant transfer of heat in the zone of extrusion results in such a difference in the effective orifice temperatures among the various orifices in a single spinnerette that unacceptable or unsatisfactory divergencies of filament deniers often occur. Furthermore, in many cases the heating effect of the spinning solution elevates or tends to elevate the temperature of the coagulating liquid in the immediate zone of extrusion to a point where, even with proper tempera-

2

ture control in the main bath, the ambient temperature conditions of some of the orifices, and filaments extruded therefrom, may be above the desired maximum temperature of +10° C. In such instances the gel characteristics of the filamentary polyacrylonitrile are generally unsatisfactory, as evidenced by the milky, opaque cast of the filaments and by their lower stretchability. Adequate stretchability of the filamentary material is a requisite in order to orient the molecules along the fiber axis and thereby increase its tensile strength and other useful properties. The spinnerettes of the present invention are especially adapted for use in the production of tow by the aforementioned Cresswell process, but they also can be used in other processes for making multifilaments. The number of orifices in their spinning face may range, for instance, from 3000 to 10,000 or more, and each opening may be, for example, from 30 to 120 microns in diameter.

It is a primary object of the present invention to provide an improved spinnerette for the production of artificial or synthetic filamentary material.

Another object of the invention is to provide an improved spinnerette for the wet-spinning of tow of synthetic filamentary material by extruding a relatively hot dope solution into a relatively cold coagulating bath.

Other objects of the invention will be apparent to those skilled in the art from the following more detailed description and accompanying drawing.

The novel features of my invention are set forth in the appended claim. The invention itself, however, will best be understood by reference to the following more detailed description when considered in connection with the accompanying drawing illustrating a preferred embodiment of the invention, and in which

Fig. 1 is a diagrammatic plan view of a spinnerette embodying the invention; and

Fig. 2 is a fragmentary diagrammatic plan view of a portion of the spinnerette shown in Fig. 1 and showing a modification thereof.

The present invention provides a spinnerette for use in the production of multifilaments comprising a wall, more particularly a circular wall, having an imperforate center area; and an annular area surrounding said center area. The annular area just mentioned is uniformly perforated with a plurality of spinning orifices, which are preferably arranged in a plurality of circles. The aforementioned wall or spinning face of the spinnerette also is provided with at least six sectors of a circle, e. g., from six to eight, inclusive, and preferably six. These sectors are disposed radially about the aforementioned annular area and are spaced therefrom. Preferably each of the sectors is spaced approximately equidistant from the aforesaid annular area. Each of these sectors is uniformly perforated with a plurality of spinning orifices. The spinning face of the spinnerette is additionally provided with a plurality of imperforate radial channels separating each of the aforesaid sectors, the widths of the said radial channels being approximately the same throughout. In the preferred embodiment of the invention the spinnerette has each of the corners of each perforated sector rounded off by omission of orifices from these corners.

If the number of perforated sectors of a circle is less than six, the number of imperforate radial channels between the individual sectors is insufficient for the rapid and uniform distribution of the extrudable mass to the spinning orifices. The number of the sectors may be in excess of eight, but in general this is undesirable because the area of imperforate platinum then becomes excessive from an economic standpoint.

The spinnerette shown in the accompanying drawing

3

is a shallow cup having a flat exterior wall or spinning face 10 and a flange 12 for reinforcement and convenience in mounting. Although the spinnerette shown is of circular configuration, which is a preferred form because of greater ease of manufacture and for other reasons, it should be understood that the spinnerette also may take other forms, such as square, rectangular, or even various irregular shapes, as desired or as conditions may require.

The wall or face 10 is provided with an imperforate center area 14, a perforated annular area 16, perforated sectors (of a circle) 18, 18a, 18b, 18c, 18d and 18e, and imperforate radial channels 20, 20a, 20b, 20c, 20d and 20e.

It is an important and essential aspects of my invention that the face 10 be provided with a perforated annular area, such as that shown at 16 in the accompanying drawing. By using a spinnerette having such a perforated area, the formation of a zone of cooled dope in the central region of the spinnerette is obviated or minimized. Otherwise, a large area of relatively cold dope will form at the center and will gradually flow to and pass through the innermost holes of the aforementioned sectors, resulting in frequent filament breakage at these points due to the excessive viscosity of the cold dope. Another advantage of my improved spinnerette with a spinning face having a perforated annular area 16 results from the pumping action of the rapidly moving tow bundle produced at this center area. This pumping effect creates a greater inward flow of liquid coagulant through the radial channels and results in a more rapid and uniform distribution of the spinning solution to the innermost portions of the aforesaid sectors as well as to the perforated annular area 16.

It would be desirable from an operating viewpoint to have the area 14 perforated in the same manner as the area 16. However, this is precluded, at present, by manufacturing difficulties and the fact that the strength of the center portion of the spinning face thereby would be unduly weakened.

As shown in Fig. 2 the corners of each perforated sector are preferably rounded off, in the spinnerettes of the invention, by omission of orifices from these corners.

Because of their small size and close spacing the individual orifices are only shown in a portion of each of the figures and are suitably indicated, where present, in other portions.

In a typical spinnerette of the invention having a total of 6372 holes, there are 378 holes on 9 circles in the perforated annular area 16 and 999 holes on the arcs of each of the six perforated sectors. The average pitch between circles is 0.024 inch and the average pitch between holes is 0.025 inch. The diameter of the wall or face 10 of the spinnerette is 3.5 inches; the diameter of the imperforate center area 14 is 0.144 inch; the diameter of the circle embracing the perforated annular area 16 and the imperforate center area 14 is 0.528 inch; the diameter of each of the imperforate radial channels 20, 20a, 20b, 20c, 20d and 20e is 5/16 inch; and the diameter of the circle embracing the outer peripheries of the aforementioned sectors is 2.736 inches.

4

The centers of all of the orifices are arranged on concentric circles. This greatly expedites the manufacture of the spinnerettes, especially those having an orifice pattern as complex as that embraced by the present invention, since it permits the use of a circular pantograph in the initial steps of locating and starting to pierce these closely spaced fine holes.

By omission of some of the holes from each of the corners of the sectors, as shown in Fig. 2, filament breakage is obviated or minimized. Otherwise, the sharp corners of the apertured areas of the sectors cause or tend to cause filament breakage under critical operating conditions which are sometimes encountered in the production of tow.

With further reference to the accompanying drawing it will be noted that in Fig. 1 perforated sector 18 is shown with some of the orifices indicated therein while the remainder of the perforated area of the sector is shown diagrammatically. In the remaining sectors of the spinnerette illustrated in Fig. 1 the perforated areas thereof are each shown diagrammatically, as is also the perforated annular area 16. Likewise in Fig. 2, some of the orifices of the perforated sector are indicated as such while the remaining area of the perforated sector is shown diagrammatically. In Fig. 2 the corners 22, 22a and 22b are the portions which have been rounded off (that is, rendered free from sharp corners) by omission of orifices from these corners, which orifices appear in the sectors of the spinnerette illustrated in Fig. 1.

I claim:

A spinnerette for use in the production of multifilaments comprising a circular wall having an imperforate center area; an annular area surrounding said center area, said annular area being uniformly perforated with a plurality of spinning orifices arranged in a plurality of concentric circles; six sectors of a circle disposed radially about the said annular area and each being spaced approximately equidistant therefrom, each of said sectors being uniformly perforated with a plurality of spinning orifices, the number of spinning orifices in the said sectors and annular area totaling between 3,000 and 10,000 and each of the corners of each perforated sector being rounded off by omission of orifices from these corners; and six imperforate radial channels separating each of said sectors, each channel being of constant width throughout and all channels being of the same width.

References Cited in the file of this patent

UNITED STATES PATENTS

2,034,009	Taylor	Mar. 17, 1936
2,558,730	Cresswell	July 3, 1951
2,736,920	Wicker	Mar. 6, 1956

FOREIGN PATENTS

319,444	Germany	Mar. 5, 1920
809,230	Germany	July 26, 1951
820,948	Germany	Nov. 15, 1951
876,135	Germany	May 11, 1953