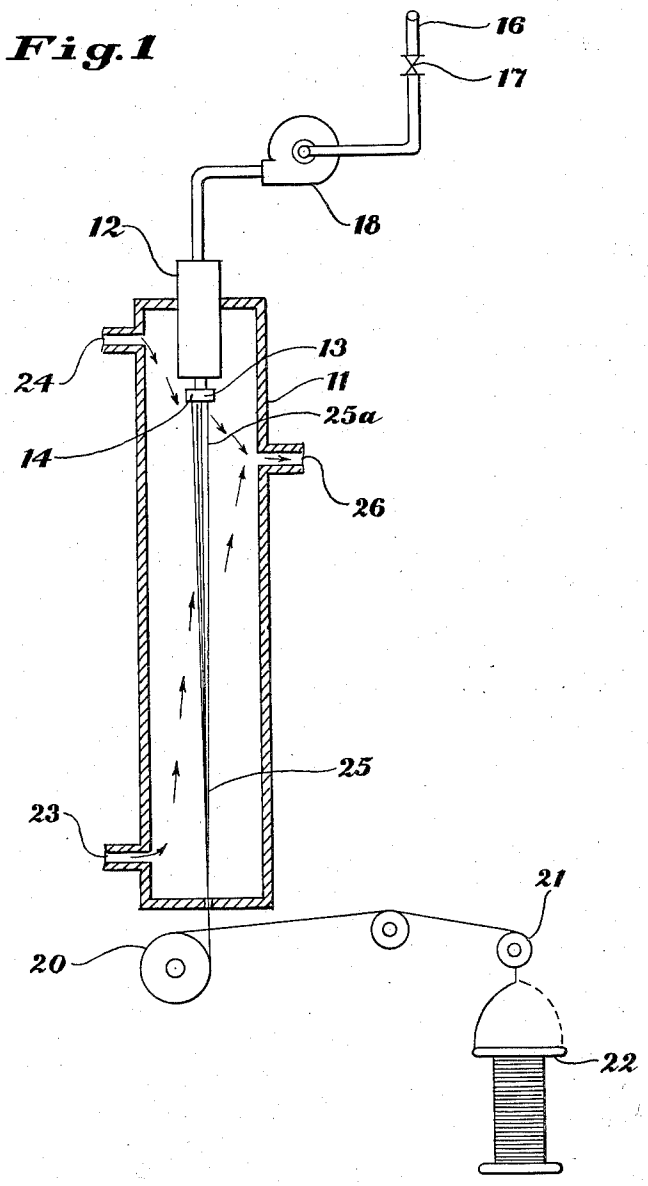
July 15, 1958 D. W. RAYNOLDS 2,843,449

DRY SPINNING PROCESS

Filed April 13, 1954 2 Sheets-Sheet 1

Fig. 1



David W. Raynolds
INVENTOR.

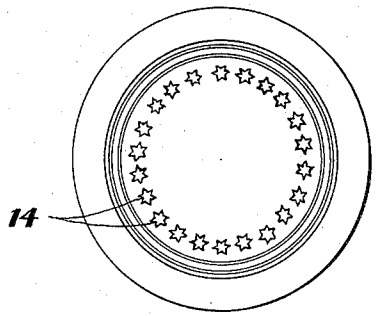
Daniel I. Wayne,
BY Watts, O'Donnell & Hobson
ATTORNEYS

July 15, 1958 D. W. RAYNOLDS 2,843,449

DRY SPINNING PROCESS

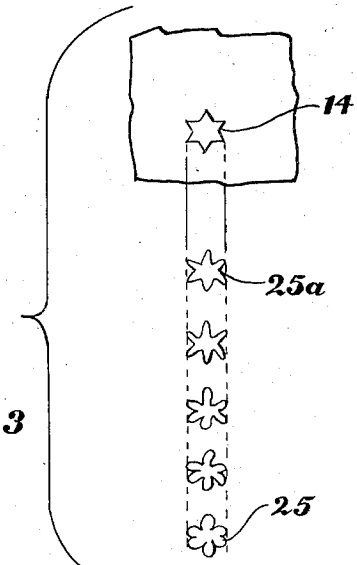
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Fig. 2



SECTION OF SPINNERETTE SHOWING ONE ORIFICE

Fig. 3



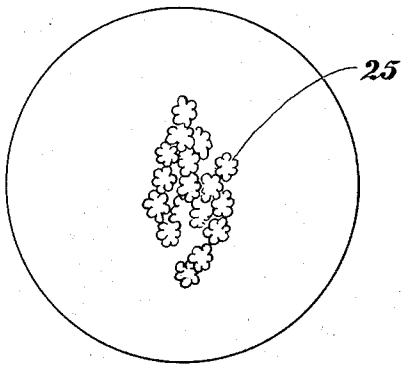
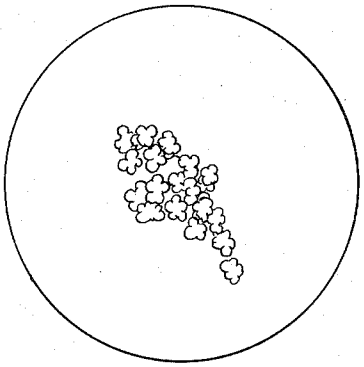


Fig. 4

Fig 5
PRIOR ART



David W. Raynolds
INVENTOR.
Daniel I. Wayne
BY Walter O. Hodsdon
ATTORNEYS

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2,843,449

DRY SPINNING PROCESS

David W. Raynolds, Kingsport, Tenn., assignor to Eastman Kodak Company, Rochester, N. Y., a corporation of New Jersey

Application April 13, 1954, Serial No. 422,963

5 Claims. (Cl. 18—54)

This invention relates to the preparation of filaments and fibers of increased luster and more particularly to improved dry spinning methods and apparatus for producing from cellulose ester spinning solutions filaments and fibers having a surface of uniform configuration. This invention also relates to fabrics and other articles of manufacture made of, or containing such high luster filaments and fibers.

Heretofore, various processes and apparatus have been provided for the production of synthetic filaments and fibers of various cross-sections and surface configurations. A cellulose acetate fiber spun from an acetone solution will form a multitude of cross-section configurations, depending upon the configuration of the spinnerette orifice. The dry spinning method and apparatus described in Stone Patents 2,000,047 and 2,000,048 of May 7, 1935, produce cellulose acetate fibers of cloverleaf cross-section by employing circular orifices in the spinnerette. This cloverleaf cross-section may be regarded for comparsion as a normal cross-section produced from a normal spinnerette. The cloverleaf fiber also may be regarded for the purposes of comparison as a fiber of normal luster.

If the same spinning solution is spun through a spinnerette having rectangular orifices in which the ratio of the sides is 1½ to 1, a fiber is formed with an I-beam type of configuration, as is described in Hickey Patent 2,373,892 of April 17, 1945. If the ratio is increased to 2 to 1 and above, a flat-type ribbon configuration is obtained.

There is a marked difference in luster level of the fibers produced from the different geometric shapes and it is an object of the present invention to provide filaments and fibers with surface configurations having superior luster. Another object of the invention is to provide filaments of a cross-section corresponding to that shown in Fig. 4 of this application. Another object of the invention is to provide a process for preparing filaments and fibers of such improved cross-section and luster. Still another object of this invention is to provide a spinnerette having extrusion orifices comprising symmetrical six-pointed star configurations. Other objects will appear hereinafter.

In accordance with one feature of the present invention, these and other objects may be attained by forcing a suitable spinning solution through a spinnerette having a plurality of symmetrical six-pointed star shaped filament-forming orifices therein and evaporating the solvent by drying the resulting filaments in a spinning cabinet under controlled conditions of temperature while subjecting the filaments to predetermined drafting. The temperature of the solution and its rate of extrusion are so controlled as to secure optimum results as is explained more fully hereinafter.

Under the optimum conditions of solution temperature and composition and of extrusion, drying and drafting, the wet filaments after they leave the symmetrical six-pointed star orifices gradually change in cross-section to that shown in Figs. 3 and 4. The surface of filament has six spaced lobes thereon which account for the high luster characteristic of this particular type of filament.

In general, the spinnerette having the novel symmetrical six-pointed star orifices may be employed with any suitable spinning cabinet such as, for example, one of the forms of the spinning cabinet illustrated in U. S. Patents 2,000,047 and 2,000,048, referred to above.

The novel cross-section filaments of the present invention, however, can be prepared in accordance with my invention within a satisfactory range of spinning, drafting and solution conditions as is described hereinafter.

Another interesting feature of my invention is the discovery that filaments produced in accordance therewith by extruding solutions of cellulose acetate through symmetrical six-pointed star orifices have a more symmetrical cross-section than when a spinnerette has a cross-section configuration of the desired filament. In fact, in the latter case, the filaments generally fall within the class of well-known rounded and irregular, non-uniform cross-section filaments of the prior art. They do not have the high luster characteristics possessed by filaments of my present invention.

The present invention will be further illustrated by reference to the following detailed description in which several examples of my invention are given and to the related drawings in which:

Fig. 1 is a schematic elevational view, partly in section, showing a spinnerette which has a plurality of symmetrical six-pointed, star-shaped orifices therein.

Fig. 2 is a view of the face of a spinnerette showing a plurality of filament-forming orifices of symmetrical six-pointed, star-shapes.

Fig. 3 is a greatly enlarged representation of the spinning solution coming out of a six-pointed star orifice and forming into the six-lobe cross-section filament.

Fig. 4 is a reproduction of an actual photomicrograph showing the cross-section of several six-lobe filaments made by spinning through the six-pointed star orifices, and drafting in accordance with my invention.

Fig. 5 is a reproduction of an actual photomicrograph showing the cross-section of several prior art filaments made by spinning through the circular orifices of the type shown in Stone Patent 2,000,048.

The similar elements in the several figures are identified by the same numerals.

Referring to Figure 1 there is shown schematically a side elevation view, partly in section, of a spinning cabinet 11 and its associated apparatus by which the high luster synthetic filaments and fibers of the instant invention may be manufactured. Mounted at the top of the cabinet is a candle filter unit 12 to which is connected a spinnerette 13 which in accordance with my invention has a plurality of orifices 14 therein which are of the shape of symmetrical six-pointed stars. The face of this novel type of spinnerette with the star-shaped orifices 14 therein is shown in the greatly enlarged view of Figure 2. The candle filter may be uniformly heated by means of heating coils, not shown, which are positioned so as to surround candle filter 12, and through which coils may be circulated any appropriate heat exchange medium such as water maintained at the desired temperature.

Spinning solution of composition described hereinafter is supplied from conduit 16 through valve 17 to pump 18 which forces the solution at the desired rate to the candle filter unit 12, thence to spinnerette 13 through the star-shaped orifices 14 from which it is extruded in the form of filaments 25a.

The filaments 25*a* pass downwardly in the cabinet 11 while progressively losing solvent by evaporation until, in a substantially solidified and dried condition they leave the cabinet 11 and pass around godet roll 20, which is positioned below the lower end of the spinning cabinet 11. Godet roll 20 is driven at a uniform speed by means, not shown, to give the desired draft to the filaments. From godet roll 20 the filaments pass in the usual guide and rolls, one of which is shown at 21, and are finally wound onto a bobbin 22 after an appropriate twist has been imparted thereto, by means not shown.

To facilitate the evaporation of solvent from the filaments during their travel through the cabinet, heated air is supplied to the cabinet 11 by means of inlet conduits 23 and 24 positioned respectively adjacent the lower and upper ends thereof, the air passing through the cabinet and emerging through outlet conduit 26 positioned at a substantial distance below spinnerette 13, as illustrated.

The change of the cross-section of the filaments while in the cabinet from an approximate six-pointed star cross-section to the desired six-lobe cross-section is illustrated in Fig. 3. As shown at 25*a* the filaments have just been formed by the six-pointed star orifice and are substantially of such a cross-section. Further on in the downward progress of the filaments under the controlled condition of drafting and drying, they have changed to the desired six-lobe cross-section filaments 25 which are shown greatly magnified in Fig. 4.

Our process is described in further detail in the following examples.

EXAMPLE 1

A spinning solution consisting of 26.5% cellulose acetate, 1.25% titanium dioxide, based on the weight of the cellulose acetate, 1.75% water and the remainder being the solvent, acetone was spun into six-lobe shaped cross-section filaments using the apparatus and its general operation as described above in connection with Figure 1. The spinnerette had six-pointed star orifices therein. The conditions of operation are shown in Table I where they are identified as No. 1.

In this table the air flow in cubic feet per minute is calculated for one hundred spinning cabinets. The figures under the spinnerette orifice column represent one side of the star. The extrusion speed in meters per minute represents the rate at which the spinning solution is forced out of the spinnerette. This, in cooperation with the draft rate enables the filaments to change from the initial six-pointed star cross-section to the six-lobe cross-section while properly drying.

Draft may be defined rather broadly as the ratio of the linear velocity of wind-up of the filaments to the linear velocity of extrusion of the spinning solution. More specifically, draft may be defined as the ratio of the linear velocity at which the filaments are wound onto and off the godet roll of a dry spinning cabinet to the calculated average linear velocity at which the quantity of spinning solution necessary to the formation of any one of the plurality of filaments comprising the bundle of filaments wound onto and off the godet roll is extruded through any one of the plurality of orifices in the spinnerette employed in the spinning operation, the velocities being expressed in the same units of distance per unit time. For example, if the filaments are wound up at the godet roll at the same linear velocity that the spinning solution is extruded from the spinnerette, the draft is 1.0, thus signifying that the linear speed of wind-up is 100% of the extrusion speed. Similarly, if the filaments are wound up or withdrawn from the cabinet at the godet roll at a linear speed 50% greater than the speed of extrusion, the draft is 1.5, and so on.

Other columns of Table I are more or less self-explanatory when considered in connection with Figure 1 of the drawings and the related description.

EXAMPLE 2

The cellulose acetate spinning solution of Example 1 was spun into six-lobe shaped cross-section filaments of 75 denier per strand using the apparatus and its general operation as previously described. The spinnerette had 19 six-pointed star orifices. The conditions of operation are shown in Table I where they are identified as No. 2.

EXAMPLE 3

The cellulose acetate spinning solution of Example 1 was spun into six-lobed cross-section filaments of 150 denier per strand. The spinnerette had 38 six-pointed star orifices. The above described spinning equipment was used with the operating conditions shown as No. 3 in Table I.

EXAMPLE 4

A different spinning solution consisting of 30.0% cellulose acetate, 1.75% water and the remainder being acetone solvent was spun into six-lobe shaped cross-section filaments of 150 denier. The spinnerette had 7 six-pointed star orifices. The above described spinning equipment was used with the operating conditions shown as No. 4 in Table I.

EXAMPLE 5

Another spinning solution consisting of 26.5% cellulose acetate, 0.6% titanium dioxide pigment, based on the weight of the cellulose acetate, 1.75% water and the remainder being acetone solvent was spun into six-lobe shaped cross-section filaments of 55 denier. The same spinning equipment was employed with the operating conditions shown as No. 5 in Table I.

EXAMPLE 6

A spinning solution of the composition shown in Example 5 was spun into six-lobe shaped cross-section filaments of 75 denier. The same spinning equipment was employed with the operation conditions shown as No. 6 in Table I.

EXAMPLE 7

A spinning solution consisting of 26.5% cellulose acetate, 1.75% water, the remainder being acetone was spun into six-lobe shaped cross-section filaments of 300 denier. The spinning equipment herein described was employed using a spinnerette having 7 six-pointed star-shaped orifices. Conditions of operation are shown as No. 7 in Table I.

We have found that excellent six-lobe shaped cross-section filaments can be prepared under a relatively wide range of spinning and dope conditions. A primary re-

Table I

No.	Denier Per Strand	No. Filaments Per Strand	Extrusion Speed, M./M.	Candle Filter Temp., ° C.	Extrusion Temp., ° C.	Top Air Flow, C. F. M.	Bottom Air Flow, C. F. M.	Top Air Inlet Temp., ° C.	Bottom Air Inlet Temp., ° C.	Spinnerette Orifice	Draft
1	55	13	500	65	62	500	500	70	85	0.061"	1.10
2	75	19	500	62	62	500	500	70	85	0.061"	1.10
3	150	38	500	65	61	800	800	70	85	0.061"	1.10
4	150	7	211	65	----------	500	500	60	90	0.141"	1.22
5	55	36	500	58	----------	500	500	60	85	0.043"	1.43
6	75	49	500	58	----------	500	500	60	85	0.043"	1.43
7	300	7	100	65	----------	1,500	1,500	60	90	0.200"	1.08

quisite for optimum six-lobe shaped cross-section yarn is that the spinning draft should be above 1.0 and preferably above 1.2. However, somewhat deformed cross-section filaments may be obtained using spinning drafts of 0.7 to 1.0. But as indicated above, for purposes of attaining uniformity of cross-section a draft above 1.0 is preferable.

We have also found that our spinning process employing spinnerettes having six-point star orifices operates very well over a range of deniers per filament of 1.5 to 43, although higher denier filaments can be satisfactorily made by our invention.

I have found there is a marked difference in the luster level of fibers of the same composition and denier when produced from the different geometric shapes. Difference in luster level is apparent by visual observation of yarns that have been wound in 1½ inch bands side by side on flat panels for comparison. Luster level may be measured by means of a photoelectric cell. Light reflected from panels to the photoelectric cell imparts a potential which is used to determine a numerical luster level.

Table II gives a comparison of the luster levels of filaments of well-known cross-section with the luster level of the filaments produced from the six-point star orifice in accordance with my invention.

Table II

Denier	No. Fil.	Filament Cross-Section	Volts
75	19	Normal Filament	0.77
75	19	I-Beam Filament	0.80
75	19	Flat Filament	0.77
75	19	Six-Lobe Filament	0.93

It is apparent from the data in the above Table II that the six-lobe filament gives the highest luster level. I have also found that uniformity of luster from fiber to fiber produced from the same spinning cabinet and from different cabinets is improved when spun from six-pointed star orifices than when produced from circular orifices. An over-all variation of 0.12 volt was obtained in an experiment for the normal yarn and an over-all variation of 0.08 volt was obtained for the yarn from the six-pointed star-shaped orifice in comparable tests. This is a 33% increase in luster uniformity.

Yarn from the star-shaped orifice can be spun in all deniers in which cellulose acetate fibers are normally produced and at comparable drafting rates. The preferred draft is 1.0.

I claim:

1. The method of forming cellulose organic acid ester filaments having a six-lobe shaped cross-section, which comprises extruding a cellulose organic acid ester filament-forming solution through a spinnerette equipped with six-point star-shaped extrusion orifices and into a dry spinning cabinet, drafting the filaments at a draft ratio within the range of approximately 0.7 to 1.4 while drying the filaments at a temperature within the range of 60 to 90° C.

2. The method of forming cellulose organic acid ester filaments with a six-lobe shaped cross-section which comprises extruding a cellulose organic acid ester filament-forming solution through a spinnerette equipped with six-point star-shaped extrusion orifices and into a dry spinning cabinet, drafting the thus formed filaments at a draft ratio within the range of approximately 1.10 to 1.43 while drying the filaments at a temperature within the range of 60 to 90° C. whereby the cross-section of the filaments becomes a six lobe cross-section.

3. The method of forming cellulose acetate filaments with a six-lobe shaped cross-section which comprises extruding a cellulose acetate filament-forming solution through a spinnerette equipped with six-point star-shaped extrusion orifices and into a dry spinning cabinet, drafting the thus formed filaments at a draft ratio of approximately 1.2 while drying the filaments at a temperature within the range of 60 to 90° C. whereby the cross-section of the filaments becomes a six lobe cross-section.

4. The method of forming cellulose acetate filaments with a six-lobe shaped cross-section, which comprises extruding a cellulose acetate filament-forming solution through a spinnerette equipped with six-point star orifices of the same size and into a dry spinning cabinet, drafting the filaments at a ratio of approximately 1.1 while drying the filaments at a temperature within the range of 60 to 90° C.

5. The method of forming cellulose acetate filaments with a six-lobe shaped cross-section, which comprises extruding a cellulose acetate filament-forming solution through a spinnerette equipped with six-point star orifices of the same size and into a dry spinning cabinet, drafting the filaments at a ratio of approximately 1.4 while drying the filaments at a temperature within the range of 60 to 90° C.

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