

Singapore

PATENT SPECIFICATION

DRAWINGS ATTACHED

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884203

Date of Application and filing Complete Specification: Jan. 2, 1958.

No. 150/58.

Complete Specification Published: Dec. 6, 1961.



Index at acceptance:—Classes 2(2), B(1B1: 2A1C2); 120(3), FX; and 130, C1E(2:3).
International Classification:—D01d. A24c. D01b.

COMPLETE SPECIFICATION

Improvements in and relating to Tobacco Smoke Filter Elements of Cellulose Organic Ester Filaments

We, EASTMAN KODAK COMPANY, a Corporation organised under the Laws of the State of New Jersey, United States of America, 343, State Street, Rochester, New York, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is ~~to be~~ performed, to be particularly described in and by the following statement:—

This invention relates to tobacco smoke filter elements of cellulose organic acid ester filaments.

According to the present invention there is provided a tobacco smoke filter element comprising a rod like mass of non-woven continuous filaments of a cellulose organic acid ester, wherein the filaments are of Y-shaped cross-section. Preferably, the ~~cellulosic~~ organic acid ester is cellulose acetate and the filaments are crimped.

In the specification of our Letters Patent No. 765,963 there is described and claimed a continuous method for the preparation of a structurally unitary rod-like fibrous tobacco smoke filtering element, comprising the steps of conditioning a continuously longitudinally moving crimped continuous filament tow by separating the filaments of the tow to form a dechannelized band of uniformly distributed filaments and creating an adhesive condition among the separated filaments by the application of a plasticiser which is compatible with, and is a solvent or softener for the filaments, at least at elevated temperatures, and is substantially non-volatile, and cigareting the conditioned tow. There is also described and claimed a tobacco smoke filter making apparatus comprising means for continuously feeding a continuous running length of crimped continuous filament tow to a tow conditioning assembly in which the filaments

of the tow are separated to form a dechannelized band of uniformly distributed filaments and the separated filaments are fluid treated with a plasticiser to create an adhesive condition therein, and for feeding the conditioned tow to a garniture for cigareting the conditioned tow. Such methods and apparatus may be employed in the manufacture of tobacco filter elements in accordance with the present invention from Y-shaped cross-section filaments of a cellulose organic acid ester.

In order that the invention may be clearly understood, the spinning of Y-shaped cross-section filaments will now be described with reference to the accompanying drawings, in which:

Fig. 1 is a schematic elevation, partly in section, of a spinning cabinet and auxiliary apparatus equipped with a spinneret having filament forming orifices of an equilateral triangular cross-section;

Fig. 2 is a plan, to an enlarged scale, of the face of a spinneret showing a plurality of filament forming orifices of equilateral triangular cross-section;

Fig. 3 is a greatly enlarged representation of the spinning solution coming out of the triangular orifices of the spinneret and forming first into triangular cross-section filaments and then changing into the Y-shaped cross-section filaments;

Fig. 4 is a reproduction of an actual photomicrograph showing the cross-section of several Y-shaped filaments extruded through triangular orifices;

Fig. 5 is a plan, to an enlarged scale, of a spinneret face showing a plurality of triangular filament-forming orifices each having angles of 24°, 78° and 78°;

Fig. 6 is a reproduction of an actual photomicrograph showing the cross-section of several

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modified Y-shaped filaments produced by a spinneret as shown in Fig. 5;

Fig. 7 is a plan, to an enlarged scale, of a spinneret face showing a plurality of triangular filament-forming orifices each having angles of 78°, 60° and 42°;

Fig. 8 is a reproduction of an actual photomicrograph showing a cross-section of several modified Y-shaped filaments produced by a spinneret as shown in Fig. 7;

Fig. 9 is a plan, to an enlarged scale, of a spinneret face showing a plurality of triangular filament orifices each having angles of 84°, 48° and 48°;

Fig. 10 is a reproduction of an actual photomicrograph showing the cross-section of several modified Y-shaped filaments produced by a spinneret, as shown in Fig. 9;

Fig. 11 is a plan, to an enlarged scale, of a spinneret face showing a plurality of triangular filament orifices each having angles of 48°, 66° and 66°;

Fig. 12 is a reproduction of an actual photomicrograph showing the cross-section of several modified Y-shaped filaments produced by a spinneret as shown in Fig. 11;

Figs. 13, 15 and 17 are plans, to an enlarged scale, of spinneret faces each having a plurality of orifices of different polygonal shape. These orifices may be generally considered as being derived from an equilateral triangular orifice whose sides have been reduced respectively by removal of 1/6, 1/5 and 1/4 of each side at each corner or, in other words, reduced respectively to 2/3, 3/5 and 1/2 of the length. These sides are connected by arcs and the apices of the triangle are filled in above the arc.

Figs. 14, 16 and 18 are reproductions of actual photomicrographs showing the modified Y-shaped cross-section filaments produced respectively by the spinnerets of Figs. 13, 15 and 17.

Referring to Fig. 1 there is shown schematically a side elevation view, partly in section, of a spinning cabinet 11 and its associated apparatus for spinning Y-shaped and modified Y-shaped synthetic filaments used in the manufacture of tobacco smoke filters in accordance with the present invention. Mounted at the top of the cabinet is a candle filter unit 12 to which is connected a spinneret 13 having a plurality of orifices 14 therein which are of the shape of equilateral triangles. The face of this spinneret with the equilateral triangular orifices 14 therein is shown in the greatly enlarged view of Fig. 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 spinneret 13 through the equilateral triangular orifices 14 from which it is extruded initially in the form of equilateral triangular filaments 25.

The filaments 25 pass downwardly in the cabinet 11 while progressively losing solvent by evaporation until, in a substantially solidified 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 25. From godet roll 20 the filaments pass over the usual guide 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 removal 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 spinneret 13, as illustrated.

The change of the cross-section of the filaments while in the cabinet from an initial triangular cross-section shape to the desired Y-cross section shape is illustrated in Fig. 3. As shown at 25 the filaments have just been formed by the triangular orifices and are substantially of an equilateral triangular cross-section. Further on in the downward progress of the filaments under the controlled conditions of drafting and drying they have changed to the desired Y-cross section filaments 25 Y which are depicted greatly magnified in Fig. 4.

The process is described in further detail in the following examples in which parts and percentages are by weight.

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 Y-shaped cross-section filaments of 55 denier per bundle using the apparatus and its general operation as described above in connection with Fig. 1. The spinneret had 13 equilateral triangular orifices therein. The conditions of operation are shown in the Table where they are identified as No. 1.

TABLE

No.	Denier Per Bundle	No. Filaments per Bundle	Extrusion speed metres/ min.	Candle Filter Temp. °C.	Top Air Flow cu. ft./ min.	Bottom Air Flow cu. ft./ min.	Top Air Inlet Temp. °C.	Bottom Air Inlet Temp. °C.	Spinneret Orifice mm.	Draft Ratio
1	55	13	500	65	500	500	70	85	0.067	1.10
2	75	19	500	62	500	500	70	85	0.067	1.10
3	150	38	500	65	800	800	70	85	0.067	1.10
4	150	7	211	65	500	500	60	90	0.155	1.22
5	55	36	500	58	500	500	60	85	0.047	1.43
6	75	49	500	58	500	500	60	85	0.047	1.43
7	300	7	100	65	1500	1500	60	90	0.220	1.08

In this table the air flow in cubic feet per minute is in respect of one hundred spinning cabinets. The figures under the spinneret orifice column represent one side of the equilateral triangle. The extrusion speed in metres per minute represents the rate at which the spinning solution is forced out of the spinneret. Draft ratio 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 ratio 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 spinneret 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 spinneret, 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 the Table are more or less self-explanatory when considered in connection with Fig. 1 of the drawings and the related description. Temperatures in the drying cabinets averaging from 60 to 90°C are usable.



operation

25



Speed

30

35

40



EXAMPLE 2.

The cellulose acetate spinning solution of Example 1 was spun into Y-shaped cross-section filaments of 75 denier per bundle using the apparatus and its general operation as previously described. The spinneret had 19 equilateral triangular orifices. The conditions of operation are shown in the Table, where they are identified as No. 2.

EXAMPLE 3.

The cellulose acetate spinning solution of Example 1 was spun into Y-shaped cross-section filaments of 150 denier per bundle. The spinneret had 38 equilateral triangular orifices. The above described spinning equipment was used with the operating conditions shown as No. 3 in the Table.

EXAMPLE 4.

A different spinning solution consisting of 30.0% cellulose acetate, 1.75% water and the remainder being acetone solvent was spun into Y-shaped cross-section filaments of 150 denier per bundle. The spinneret had 7 equilateral triangular orifices. The above-described spinning equipment was used with the operating conditions shown as No. 4 in the Table.

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 Y-shaped cross-section filaments of 55 denier per bundle. The same spinning equipment was employed with the operating conditions shown as No. 5 in the Table.

EXAMPLE 6.

A spinning solution of the composition shown in Example 5 was spun into Y-shaped cross-section filaments of 75 denier per bundle. The same spinning equipment was employed with the operating conditions shown as No. 6 in the Table.

EXAMPLE 7.

A spinning solution consisting of 26.5% cellulose acetate, 1.75% water, the remainder being acetone was spun into Y-shaped cross-section filaments of 300 denier per bundle. The spinning equipment herein described was employed using a spinneret having 7 equilateral triangular orifices. Conditions of operation are shown as No. 7 in the Table.

We have found that satisfactory Y-shaped cross-section filaments can be prepared under a satisfactory range of spinning and solution conditions. A primary requisite for optimum Y-shaped cross-section filaments is that the spinning draft should be above 1.0 and preferably above 1.2. However, somewhat deformed Y-shaped 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.

The temperatures listed in the Table are

temperatures employed to produce a quality product with a particular cellulose ester-acetone solution. These temperatures may vary somewhat. Changes in cellulose ester composition or changes in cellulose ester to acetone ratios may require some changes in these temperatures.

We have also found that the spinning process hereinbefore described employing spinnerets having equilateral triangular 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 the process.

The bulk of the Y-shaped cross-section filaments, because of its increased area, is greater than the bulk of normal round cross-section filaments. It was found possible with Y-shaped cross-section filaments to produce a cigarette filter which was more tightly packed, without increasing the pressure drop, than with normal round cross-section filaments.

Less uniform Y-shaped cross-section filaments are produced with spinnerets having triangular orifices other than equilateral.

A spinning solution of the composition described in Example 1 was spun through the individual spinnerets which have triangular orifices other than equilateral as shown in Figs. 5, 7, 9 and 11 each of which was installed in a separate spinning cabinet like that shown in Fig. 1. The cross-section of the filaments thus produced are shown respectively in Figs. 6, 8, 10 and 12.

The cross-section of the filaments shown in Fig. 6 has a long centre leg which is a little more than twice the length of the other two legs which are of similar size. The cross-section of the filament of Fig. 8 has a centre leg somewhat longer than the other two legs which are symmetrical. The angle between the other two legs is greater than in the case of the cross-section shown in Fig. 6. The cross-section of Fig. 10 has the centre leg half as long as the other two symmetrical legs. In Fig. 12 the cross-section of the filament approaches that of a true Y-shaped cross-section in that the centre leg is about the length and size of the other two legs but the angles between the legs are not quite equal.

Filaments were spun from each of the odd triangular-shaped orifices at both 65° and 70°C candle filter temperatures, a spinning draft ratio of 1.25, an extrusion speed of 300 metres per minute and a bottom air inlet temperature of 85°C, the equivalent diameter of each spinneret hole being .110 mm.

The cellulose acetate spinning solution of the compositions described in Example 1 was also spun through the spinnerets which have the modified triangular orifices shown in Figs. 13, 15 and 17, each of which was installed in a separate spinning cabinet of the type shown in Fig. 1. The cross-sections of the filaments thus produced are shown respec-



Spinning





tively in Figs. 14, 16 and 18. In Figs. 14 and 16 the cross-sections nearly resemble one another. In Fig. 16 the Y has bulbs on the ends of the legs of the Y.

While particular emphasis has been made to employing cellulose acetate spinning solutions, other single and mixed organic acid esters of cellulose, as for example those of acids containing 2 to 4 carbon atoms, may be employed.

We have noted that yarns composed of Y-shaped cross-section and modified Y-shaped cross-section filaments are much stiffer and more resilient than ~~yarn~~ having normal or clover-leaf cross-sections. The effect on stiffness of cross-sectional shape can be estimated by comparing moments of inertia of fibres having different shapes but the same cross-sectional area. By this method we have determined that Y-shaped cross-section filaments are approximately 60% stiffer than regular filaments of equal size. Furthermore, we have found that when a plurality of Y-shaped cross-section filaments are collected in a bundle, a greatly increased resilience or stiffness is noted which is more than would be expected from the increase in stiffness of individual filaments. We attribute this effect to the inter-locking or tongue and groove mingling of the legs of the Y-shaped cross-section filaments making up

the mass of filaments. This interlocking of filaments causes much greater resistance to interfibre slippage than can be obtained in a bundle of normal filaments. Thus the aggregate stiffness of a bundle of Y-shaped cross-section filaments is much greater than the sum of the stiffness of the individual filaments.

Bundles of Y-shaped cross-section filaments prepared as hereinbefore described were formed into rod-like tobacco smoke filters. Moreover, the filaments were crimped and formed into rod-like tobacco smoke filters using the method and apparatus described and claimed in our Letters Patent No. 765,963.

WHAT WE CLAIM IS:—

1. A tobacco smoke filter element comprising a rod-like mass of non-woven continuous filaments of a cellulose organic acid ester, wherein the filaments are of Y-shaped cross-section.

2. A tobacco smoke filter element according to claim 1, wherein the cellulose organic acid ester is cellulose acetate.

3. A tobacco smoke filter element according to claim 1 or 2, wherein the filaments are crimped.

4. Tobacco smoke filter elements according to claim 1, as hereinbefore described.

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WHAT WE CLAIM IS:—

1. A tobacco smoke filter element comprising a rod-like mass of non-woven continuous filaments of a cellulose organic acid ester, wherein the filaments are of Y-shaped cross-section.
2. A tobacco smoke filter element according to claim 1, wherein the cellulose organic acid ester is cellulose acetate.
3. A tobacco smoke filter element according to claim 1 or 2, wherein the filaments are crimped.
4. Tobacco smoke filter elements according to claim 1, as hereinbefore described.

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Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press.—1961.
Published by The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

