April 23, 1957 W. I. TAYLOR ET AL 2,789,563

FILTER ELEMENTS

Original Filed Dec. 6, 1949

Fig. 1.

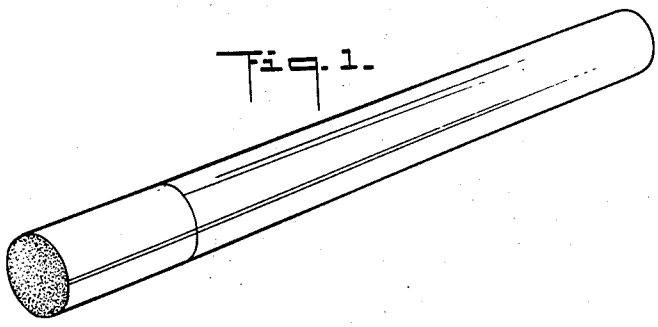
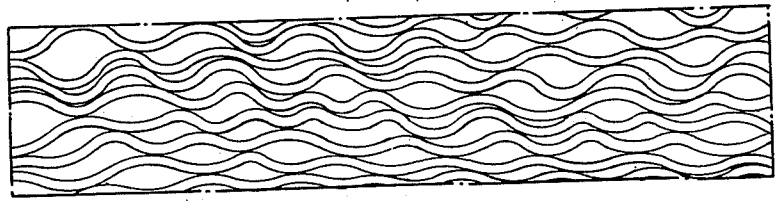


Fig. 2.



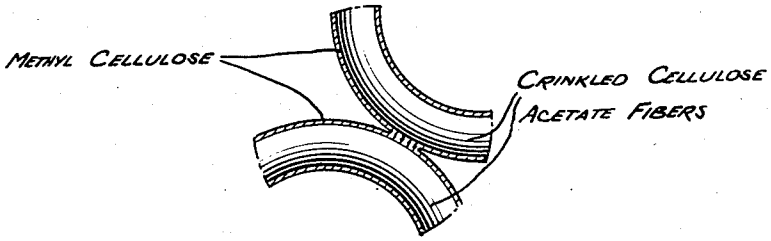


Fig. 3.

INVENTORS
WILLIAM IVAN TAYLOR
BY JOHN WILLIAM GREBBY

Foley, Klass + Abner Shaffer
ATTORNEYS

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FILTER ELEMENTS

William Ivan Taylor and John William Grebby, Spondon, near Derby, England, assignors to British Celanese Limited, a corporation of Great Britain

Original application December 6, 1949, Serial No. 131,491, now Patent No. 2,707,308, dated May 3, 1955. Divided and this application February 24, 1954, Serial No. 415,694

Claims priority, application Great Britain December 10, 1948

6 Claims. (Cl. 131—10)

This invention relates to improvements in pervious materials and, although of wider application, has special reference to novel filter tips for cigarettes and to the production of such filter tips.

This application is a divisional of our application S. No. 131,491, filed December 6, 1949, now U. S. Patent 2,707,308 issued May 3, 1955.

Filter tips for cigarettes normally consist of a plug of cotton wool or corrugated paper which, as the name implies, serve to filter the smoke drawn into the mouth by the smoker. Cigarettes are sold with the filter tips already in place in one end of the cigarette, and also filter tips are sold separately for the use of smokers who make their own cigarettes. Such filter tips must necessarily be made of materials which are tasteless and non-toxic and, in addition, should be of a firm but resilient nature, offer no noticeable impedance during smoking, remain satisfactory during storage or use and be made from relatively inexpensive materials.

The present invention is concerned with novel filter elements which meet these requirements in a satisfactory manner and which, when made in suitable dimensions, are eminently suitable for use as cigarette filter tips. The invention comprises novel filter elements and a description of a process for their production is provided.

According to the invention, a filter element comprises a rod of aligned crinkled fibres bonded together by a film-forming material and pervious to air in the general direction of the length of the fibres. Such filter elements may be produced by a novel process which comprises forming a lap of aligned crinkled fibres, wetting the fibres with a film-forming solution, drawing the wet lap through one or more dies so as to produce a rod of the required dimensions, and drying the rod by evaporation of the solvent in the film-forming solution.

Crinkled artificial filaments can be produced cheaply by a variety of processes and are generally satisfactory for use in putting the invention into practice. Of outstanding merit in this connection are crinkled filaments of cellulose acetate and excellent results have been obtained using "direct spun" crinkled filaments of cellulose acetate produced by dry spinning a solution of cellulose acetate in acetone or other volatile solvent, using extrusion speeds very much higher than those normally employed, for example extrusion speeds of 700 to 1100 metres per minute, and collecting the extruded filaments without tension. By such a process filaments can be produced having about 10 to 15 crinkles per inch and these filaments have been found to be admirably suited to the purposes of the invention. Filaments made from cellulose or cellulose derivatives other than cellulose acetate may, however, be used, including both "direct spun" crinkled filaments and filaments crinkled in other ways.

The production of staple fibres by a process comprising feeding forward a mass of randomly orientated continuous filaments at a controlled speed to a combing point and combing the mass onwards through that point at a higher speed, whereby the filaments are torn into staple fibres, is described in U. S. patent application S. No. 755,629 (now U. S. Patent No. 2,641,027 issued June 9, 1954) filed June 19, 1947, and it is stated that the process can be applied to "direct spun" continuous filaments.The preferred process of the invention embodies the process of the said last mentioned application. For instance, a solution of cellulose acetate in acetone of about 26% concentration may be spun at a linear speed of from 700 to 800 metres per minute through a spinning jet having a large number of holes of 0.05 to 0.06 millimetre diameter, the filaments formed being allowed to fall naturally down the cabinet and collect at the bottom thereof. In this way crinkled filaments having approximately 10 to 15 crinkles per inch and of a denier approximately 16 may be produced. In general a denier of 10 to 20 is quite satisfactory. The mass of crinkled filaments thus produced is taken from the bottom of the spinning cabinet or from a number of spinning cabinets and passed through a sheeter gill box, the operation of which is to bring the filaments into alignment and, at the same time, to break up the filaments into staple fibre, the product being collected in the form of a crude lap. Laps made in this way are then taken to a carding machine adjusted to give a sliver of suitable density. For the purposes of the invention it has been found convenient to operate these stages so as to produce laps of about 18 inches in width which, as a result of the combing operation, yield a sliver weighing approximately 8 to 9 grams per yard.

Water-soluble cellulose derivatives, for example methyl cellulose or methyl hydroxy ethyl cellulose, have been found to be particularly satisfactory for use as the film-forming material for binding together the crinkled fibres to form the filter element. Excellent results have been obtained using a methyl cellulose of fairly low viscosity, say about 50 to 100 centipoises (measured in 2% aqueous solution at 25° C.) in the form of an aqueous solution of fairly low concentration, preferably from 1 to 2%. Whatever film-forming substance is used, it is desirable that it should be one capable of effecting the binding when applied in solutions of low concentration, as solutions of high concentration tend to render the final filter element impervious and therefore unsatisfactory for the purpose for which it is intended. Any desired method may be employed for applying the film-forming solution to the fibres, but in practice it has been found most satisfactory to soak the fibres in the solution and to squeeze out excess solution during the subsequent shaping stage employed to form the fibres into a rod. In any case, the quantity of solution and its concentration, in the case of an aqueous methyl cellulose solution, is preferably such that in the final product the methyl cellulose represents from 5 to 10% by weight of the finished filter element. A similar amount of any other suitable film-forming material will usually give satisfactory results.

The shaping of the fibres wet with the film-forming solution is preferably carried out by drawing them through three dies of successively smaller diameter. In practice the springy nature of the crinkled fibres results in the rod produced by the die drawing being slightly larger in diameter than the diameter of the orifice in the last die. It has been found that by using a set of dies having diameters of ⅜ inch, 11/16 inch and ¼ inch, a final product can be obtained which, after drying, measures rather more than ¼ inch in diameter, usually being approximately ⅜ inch in diameter. Such a product can very easily be compressed slightly, e. g. to the diameter of a normal cigarette, during the cigarette-making

operation, and the somewhat resilient nature of the element ensures that it is firmly held in the cigarette after this compression. The effect of the dies is not only to shape the sliver into rod form and squeeze out excess film-forming solution, but also to effect a small amount of drawing. Thus, using a lap approximately 18 inches in width, carding it to produce a sliver weighing 8 to 9 grams per yard, soaking it in a 1 to 2% solution of methyl cellulose, and then drawing it successively through three dies having orifices of the size mentioned above, results in the production of a rod which, after drying, weighs approximately 6.5 to 7.5 grams per yard or perhaps a little more, of which about 0.5 gram per yard is represented by the methyl cellulose present.

The drying operation is carried out under conditions which are suitable for the particular film-forming solution used, and with an equeous solution such as that previously mentioned the rod can be dried at room temperature in a period of approximately 24 hours, although the drying can be accelerated if desired by circulating warm or hot air round the rods. The dry rods can, of course, be cut up into lengths suitable for their subsequent use, e. g. where they are to be used for the production of filter tips for cigarettes the rods may be cut up into pieces measuring 3/8 inch or more in length.

As previously indicated, although the present invention is of importance in connection with the production of novel filter tips for cigarettes, the invention is of wider application than this. Thus, the invention may be applied to the production of filter elements for use in other connections, more particularly for the filtration of air and gases for the removal therefrom of particulate solids. The production of the filter elements in cylindrical rod-like form is generally useful, but the dimensions of the rod produced may be varied according to the purpose to which the product is to be applied. Likewise where such a product is more useful the material may be shaped into filter elements of square, hexagonal or other cross-section.

In the accompanying drawing illustrating this invention,

Fig. 1 shows an overall view of the cigarette,

Fig. 2 is an enlarged view of the arrangement of the fibres in the filter tip, and

Fig. 3 is a greatly enlarged view of a portion of the filter tip, showing the bonding of the fibres.

The following example illustrates the production of filter elements suitable for use as filter tips for cigarettes:

Example

A solution of cellulose acetate in acetone of about 26% concentration is dry spun at a linear speed of 700 to 800 metres per minute through a spinning jet having a large number of holes of approximately 0.055 millimetre diameter, the filaments formed being allowed to fall naturally down the cabinet and collect at the bottom. In this way crinkled fibres having 10 to 15 crinkles per inch and of a denier of approximately 16 are produced, the filaments forming a tangled mass at the bottom of the spinning cabinet. The mass of crinkled fibres is passed through a sheeter gill box wherein it is drawn out by two pairs of rollers rotating at different speeds and, while passing from the slower to the faster pair, is penetrated near the first pair by the successive comb-like elements of the gill box which are drawn through the material towards the second pair of rollers at a speed intermediate between the peripheral speeds of the two pairs. By the action of the rollers and the teeth of the gill box the filaments of the mass are partially parallelised or aligned in the direction of motion of the teeth and at the same time broken into staple fibre. The product emerges from the second pair of rollers to be collected as a crude lap of about 18 inches width and is passed through a carding machine adjusted to give a sliver, weighing approximately 8.5 grams per yard, of crinkled

fibres oriented substantially longitudinally of the sliver. The sliver is then soaked for 5 minutes in a 1.5% aqueous solution of methyl cellulose (viscosity 69 centipoises measured in 2% aqueous solution at 25° C.) and then slowly drawn successively through three dies of 3/8 inch, 11/16 inch and 1/4 inch diameter respectively. By this operation excess methyl cellulose solution is squeezed out of the product which, at the same time, is shaped into the form of a rod. The rod produced is cut into convenient lengths which are hung vertically in a current of warm air to dry.

The rod expands slightly as it leaves the three dies so that the final dry product is approximately 3/8 inch in diameter, thus allowing for compression to approximately 5/16 inch in a cigarette-making machine.

The inexpensive nature of the filter tips produced is apparent from the fact that 6000 tips of the type described above and measuring approximately 3/8 inch in length weigh less than one pound. The tips so formed do not soften in use, permit cigarettes containing them to draw readily and are of highly absorbent nature.

Having described our invention, what we desire to secure by Letters Patent is:

1. A cigarette having a filter tip, said filter tip comprising a consolidated rod of crinkled cellulose ester fibres oriented substantially longitudinally of the rod and longitudinally of said cigarette, individual fibres being united at points of contact by cellulose derivative bonds.

2. A tobacco smoke filtering element comprising a consolidated rod of crinkled cellulose ester fibres oriented substantially longitudinally of the rod and coated with a water-soluble cellulose derivative film, individual fibres being united at random points of contact to other fibres by said film.

3. A tobacco smoke filtering element comprising a consolidated rod of crinkled cellulose acetate fibres oriented substantially longitudinally of the rod and coated with a methyl cellulose film, individual fibres being united at random points of contact to other fibres by said film.

4. A tobacco smoke filtering element comprising a consolidated rod of crinkled cellulose acetate fibres oriented substantially longitudinally of the rod and coated with a methyl cellulose film, individual fibres being united at random points of contact to other fibres by said film, the methyl cellulose present representing 5 to 10% by weight of the product.

5. A cigarette having a filter tip, said filter tip comprising a consolidated rod of crinkled cellulose acetate fibres oriented substantially longitudinally of said rod and longitudinally of said cigarette, said crinkled fibres being bonded together at points of contact by cellulose derivative bonds.

6. A cigarette having a filter tip, said filter tip comprising a consolidated rod of crinkled cellulose acetate fibres oriented substantially longitudinally of said rod and longitudinally of said cigarette, said crinkled fibres being bonded together at points of contact by cellulose derivative bonds, said fibres having about 10 to 15 crinkles per inch.

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