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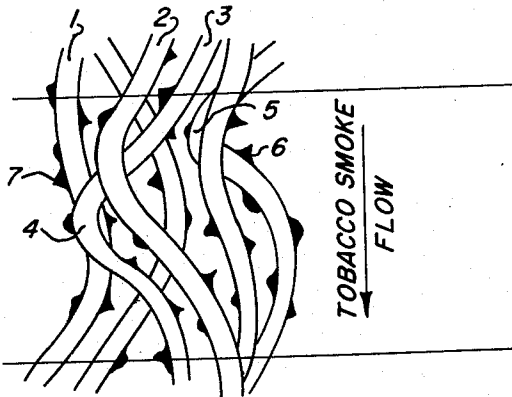
J. E. KIEFER ET AL

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TOBACCO SMOKE FILTERING ELEMENTS

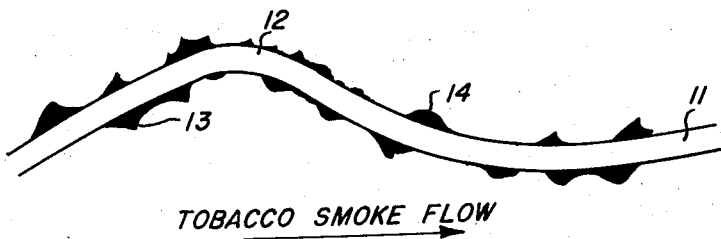
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Fig. 1



CELLULOSE ACETATE FILAMENTS (2D/FILAMENT)
CONTAINING WAX PARTICLES

Fig. 2



CELLULOSE ACETATE FILAMENT CONTAINING
WAX PARTICLES

JOHN E. KIEFER
GEORGE P. TOUEY
INVENTORS

BY *Daniel J. Mayne*
Harold W. Powell

ATTORNEYS

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TOBACCO SMOKE FILTERING ELEMENTS

John E. Kiefer and George P. Touey, Kingsport, Tenn.,
assignors to Eastman Kodak Company, Rochester,
N.Y., a corporation of New Jersey

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The present invention relates to tobacco smoke filtering material and elements thereof suitable for use in cigarettes, pipes, cigarette holders and cigar holders. More particularly this invention is concerned with an improvement in the fibrous type of tobacco smoke filter made from textile tow.

As is known, a wide variety of fibrous materials have been suggested as tobacco smoke filtering means to remove nicotine, tars and other undesired components of the tobacco smoke. Thus, materials as crepe paper, cotton and certain textile fibers have been proposed as filtering media. However, some fibrous materials have certain disadvantages either from the standpoint of their fabrication into filters or their undesirable effect on the taste of the smoke. For example, cotton and paper cannot be too conveniently processed by conventional cigarette machinery into a form that can be readily cut into filter tips and added to the end of a cigarette. Another disadvantage of tobacco smoke filters made from cotton or paper is that moisture is absorbed quite readily by the filter which makes the smoke too dry.

The use of certain textile fibers and in particular fibers of cellulose ester, overcomes to a great extent the aforementioned fabrication difficulties encountered with cotton or crepe paper. That is, textile fibers can be manufactured in a form that is easily converted by reasonable conventional cigarette processing equipment into filter tips which can be used for tobacco smoke filtering purposes. Thus, for example, it is possible to orient a large number of cellulose acetate fibers into the form of a continuous cord which is commonly known to the trade as a tow. Such tow can be plasticized, cut, and wrapped in cigarette paper to form filter rods with great rapidity on a filter make-up machine. These filter rods are then easily cut into tips of the desired length and placed on the ends of cigarettes. While, as just mentioned, textile tow has certain advantages for manufacturing tobacco smoke filtering elements, in some instances the resultant filter has not possessed as much stiffness or firmness as desired. Also, there has been some tendency of textile fibers to become soft or soggy due to the absorption of moisture from the tobacco smoke.

After investigating we have found that fibrous materials, particularly a crimped cellulose ester type of tow material may be treated in a simple manner to render it possible to obtain an improved tobacco smoke filter therefrom.

This invention therefore has as one object the production of more efficient tobacco smoke filter elements consisting of a bundle of crimped substantially longitudinally oriented textile fibers containing a wax additive. Another object is to provide means for increasing the ability of the tobacco smoke filter of the class described to remove more nicotine, tars and other undesired components of tobacco smoke without causing the smoke to be dry or distasteful. Still another object is to provide an oriented type of tobacco smoke filter element which is stiffer, more firm and otherwise possesses qualities mak-

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ing it easier to process in conventional filter make-up machinery. Still a further object is to provide an improved tobacco smoke filter of textile tow which while exhibiting good filtering qualities does not tend to become soft and soggy. A particular object of this invention is to provide a procedure for incorporating wax into cord or tow tobacco smoke filtering elements. Other objects will appear hereinafter.

We have found that the continuous cord or tow type of textile fiber can be substantially improved for tobacco smoke filtering purposes by adding to the crimped tow or cord a certain amount of wax. That is, our improved tobacco smoke filter of the present invention consists generally of a mass of substantially longitudinally aligned crimped cellulose ester fibers, the spacing of substantially all groups of adjacent fibers providing passage for tobacco smoke therethrough, said fibers carrying thereon a certain amount of wax usually between 1-30% based on the weight of the fibers.

Various means and procedures may be used for coating the fibrous surfaces with wax. Thus, for example, wax can be heated to its melting point and sprayed on the fibers. Another method is to draw the fibers through a bath containing molten wax. Still another method is to deposit solid wax on the cord or tow and then heat treat the cord or tow to melt and diffuse the wax evenly on and throughout the filter element.

For a further understanding of certain aspects of our invention reference may be made to the attached drawing forming a part of the instant application.

In this drawing, Fig. 1 is a diagrammatic illustration on a considerably enlarged scale of a segment of a plurality of crimped continuous cellulose acetate filaments carrying particles of waxy material on the filaments in accordance with the present invention.

Fig. 2 is a diagrammatic illustration on a considerably enlarged scale of a single crimped cellulose acetate filament carrying wax particles thereon in accordance with the present invention.

Referring further to Fig. 1, the plurality of individual cellulose acetate filaments are shown at 1, 2 and 3. These filaments are substantially continuous, only a segment of a small group of such continuous filaments being illustrated in the figure. These filaments contain distinct crimps as illustrated at points 4 and 5, for example. The filaments carry particles of waxy solids firmly bonded to the filaments as disclosed at 6 and 7, for example. The several thousand filaments making up a filter would be intermingled in the rod-like filter element substantially similar to the intermingling diagrammatically illustrated in Fig. 1.

Reference is now made to Fig. 2 wherein a segment of a single continuous filament is illustrated. This figure better shows some of the features referred to above. For example, in this figure, numeral 11 designates the cellulose acetate filament. The peak of a crimp is generally indicated at point 12. The solid waxy particles which are carried by the filament, which particles are firmly bonded thereto, are illustrated, for example at 13 and 14.

In carrying out any of the above methods, it is usually desirable to spread the fibers out to a width of several inches by any suitable method for facilitating the uniform application of the wax to all of the fibers. After the fibers have been properly coated with wax, they are then gathered together into the desired configuration for the filter and wrapped with a wrapper or otherwise somewhat more permanently formed and held in the desired shape. These latter operations of forming the fibers into the filter element may be very readily accomplished in conventional machinery. In other words, our wax treated fibers may be better formed into tobacco smoke filtering elements

than the untreated fibers heretofore processed in such machinery.

In carrying out our invention, we have found that various types of waxes may be used. Thus, vegetable, petroleum, insect, animal, mineral, and synthetic waxes are in general satisfactory. More specifically, some of the waxes which we have found particularly useful and prefer are as follows:

(a) *Carnauba wax*.—This is a vegetable wax and consists chiefly (about 75%) of myricyl cerotate, a small quantity of free cerotic acid, and myricyl alcohol. The physical properties are: melting point, 84–91° C.; specific gravity, 0.99; acid number, 4–9; saponification number, 78–87; soluble in hot alcohol and in benzene, ether dioxane, and isopropyl ether.

(b) *Paraffin*.—This is a petroleum wax obtained from the high boiling fractions of petroleum. It is a mixture of a great number of saturated hydrocarbons. Its physical properties are: melting range, 43–66° C.; specific gravity, 0.88–0.92 at ordinary temperatures; acid number, 0; saponification number, 0; soluble in benzene ether, chloroform, and turpentine.

(c) *Beeswax*.—This is an insect wax. Chemically, it is composed of myricyl palmitate, cerotic and homologous acids, and small amounts of hydrocarbons, cholesterol esters, ceryl alcohols, pollen, and resins. The physical properties are: melting point, 63–70° C.; specific gravity, 0.952–0.957; acid number, 16–20; saponification number, 90–96; soluble in benzene, carbon tetrachloride, chloroform, dioxane, acetone, and ether.

(d) *Spermaceti*.—This is an animal wax obtained from the sperm whale. It is composed of cetyl palmitate, cetyl alcohol, and numerous esters of high-molecular weight fatty acids. The physical properties are: melting point, 42–49° C.; specific gravity, 0.945–0.960; acid number, 0.5–1.1; saponification number, 122–129; soluble in hot alcohol, ether, chloroform, and carbon disulfide.

(e) *Montan*.—This is a mineral wax obtained by solvent extraction of woody coals or lignite. It is a monohydric ester of a high-molecular weight acid. The physical properties are: melting point, 72–92° C.; specific gravity, 1.0; acid number, 15–85; saponification number, 58–89; soluble in benzene, chloroform, naphtha, and isopropyl ether.

(f) *High-molecular weight acids and alcohols*.—A number of alcohols and acids have wax-like properties. These include cetyl and stearyl alcohols and stearic, palmitic, and myristic acids.

(g) *High-molecular weight esters*.—The stearates of polyhydric alcohols, such as ethylene glycol and diethylene glycol are high-molecular weight products of a wax-like nature.

(h) *Carbowaxes*.—These are synthetic waxes sold by Carbide and Carbon Chemicals Company and comprise a series of high-molecular weight polyethylene glycols. These waxes have a melting point range of 34–55° C. and a density range of 1.15–1.20. They are water-soluble.

(i) *Acrawaxes*.—These waxes are produced and sold by Glyco Products Company in three grades: Acrawax, Acrawax B, and Acrawax C. They are complex nitrogen derivatives of high-molecular weight fatty acids. The physical properties of these three waxes range as follows: melting point, 95–139° C.; specific gravity, 0.98–1.05; soluble in hot toluene, turpentine, and mineral oil.

(j) *Castorwax*.—This is a hydrogenated castor oil produced and sold by Baker Castor Oil Company. The physical properties are: melting point, 86–88° C.; saponification number, 175–185; acid number, 2; insoluble in most solvents.

(k) *Polyethylene*.—This is a high-molecular weight polymer of ethylene being produced by a number of chemical companies. Its melting point is 105–110° C. It is soluble in hot benzene and toluene but insoluble in practically all organic solvents in the cold.

Thus, irrespective of the particular method used of applying the wax, or the particular wax used, the fibers are readily wrapped in conventional equipment to form a smoke filtering element. The resultant filter element comprises a structurally unitary rod like mass of fibers with a wrapper encircling the mass, each fiber of the mass being substantially coextensive therewith, the fibers as a whole being all substantially aligned longitudinally of the mass. However, substantially each of the individual fibers has a plurality of short portions thereof crimped into diverging and converging relationship to the main fiber axis. A plurality of the fibers have surface bonds to contiguous fibers at random points of contact. This bonding may be accomplished either through the presence of plasticizer or the wax or a combination of wax-plasticizer.

As indicated above, we prefer to use in the instant invention fibers of cellulose esters and particularly cellulose acetate fibers which have a certain amount of crimp and have the property of bonding to some extent to adjacent fibers, either because of the thermoplastic properties of the fibers or the addition of plasticizer or the presence of wax of the present invention, or by combination of the foregoing.

For a further understanding of our invention reference may be made to the following examples which are set forth primarily for the purpose of disclosing our preferred embodiments.

Example I

A tow of cellulose acetate yarn containing approximately 20,000 fibers of five denier per filament was slowly pulled over a compressed air device which spread out the fibers to a width of six inches. While the tow was in this spread condition it was sprayed with a molten petroleum wax heated to 95° C. After this spreading and spraying treatment, the tow was pulled back to its original shape and fed into a conventional cigarette make-up machine which cut and paper-wrapped it into rods of 8.1 mm. diameter and 71 mm. length. The rods contained 24 parts wax and 76 parts cellulose acetate by weight. The rods were cut into 12-mm. filter tips. These tips were attached to standard American cigarettes by means of an adhesive tape (Scotch tape) and the cigarettes were smoked on a smoking machine similar in design and operation to the smoking machine described by J. A. Bradford, W. R. Harlan, and H. R. Hanmer in *Industrial and Engineering Chemistry*, vol. 28, pp. 836–9 (1936). The results of the smoking experiment were compared with those obtained from smoking the same brand of cigarettes containing 12-mm. filter tips of the same tow of cellulose acetate fibers without the addition of the wax.

Type of cigarette tip (12 mm.)	Mg. of tars obtained from the collected smoke of 10 filtered cigarettes	Mg. of nicotine obtained from the collected smoke of 10 filtered cigarettes
Cellulose acetate tow	132	20
Cellulose acetate tow containing 24% petroleum wax	107	18

The moisture content of the tobacco was 11.9%.

It can be seen from this Example I that the filter of this invention removed substantial amounts of tar and nicotine, remained firm and did not become soggy.

The permeability of the filters shown in Example I was measured to determine the effect of the wax additive. The measurement was made in a laboratory apparatus which provides a constant air flow of 1,050 cc. per minute and measures, by means of a simple water manometer, the pressure necessary to effect this volume of flow through one cigarette. On this basis, the average pres-

sure drop of the above cigarettes with a filter of cellulose acetate tow was 4.0 inches of water; the average pressure drop was 4.3 inches of water when a filter of cellulose acetate tow with 24% wax additive was tested.

Example II

In accordance with this example, cellulose acetate tow approximately the same as that described in Example I was spread by means of compressed air. The spread tow was treated with a wax known as castor wax to the extent of about 24% of the weight of the fibers. Thereafter the castor wax treated fibers were fed into conventional machinery for forming and wrapping the fibers into filter elements. The filter elements were attached to cigarettes and tested in the smoking machine. The test indicated that the wax treated filters of the present invention improved the removal of undesired compounds. That is, 7% more tar was removed with the filters of the present invention as compared with a filter that had no wax treatment. This was some 25% greater tar removal than with a regular cigarette having no filter whatsoever. In addition to giving improved removability of tar, the filters of the present invention were firmer and stiffer than prior art filters. This firmness persisted throughout the smoking operation and the filters of the present invention did not become soft and soggy.

Example III

A tow of cellulose acetate yarn containing approximately 10,000 filaments of 8 denier per filament was slowly pulled over a compressed air device which spread out the fibers to a width of six inches. While the tow was in this spread condition, it was dusted with powdered (300 mesh) stearic acid. After this spreading and dusting treatment, the tow was pulled back to its original shape and fed into a conventional cigarette make-up machine which cut and paper wrapped it into rods of 8.1-mm. diameter and 71-mm. length. The rods contained 25 parts stearic acid and 75 parts cellulose acetate fibers by weight. These soft rods were heated at 85° C. for ten minutes (melting point of stearic acid, 69–70° C.) in a drying oven and then allowed to return to room temperature. On cooling, the rods became quite firm. These firm rods were cut into 12-mm. filter tips. These tips were attached to standard American cigarettes by means of a cellulose tape and the cigarettes were smoked on the smoking machine. The results of the smoking experiment were compared with those obtained from smoking the same brand of cigarettes containing 12-mm. filter tips of the same tow of cellulose acetate fibers without the addition of the wax.

Type of cigarette tip (12 mm.)	Mg. tars obtained from the collected smoke of 10 filtered cigarettes	Mg. nicotine obtained from the collected smoke of 10 filtered cigarettes	Average pressure drop of the cigarettes (inches of water)
Cellulose acetate tow	145	25	3.8
Cellulose acetate tow containing 25% stearic acid	120	19	4.0

It can be seen from this Example III that the filter containing the stearic acid wax removed substantially more tar and nicotine than the corresponding control filter without the wax. Also, this filter was firmer and did not become soggy.

Example IV

A tow of regenerated cellulose yarn (Viscose) containing 16,000 filaments of 6 denier per filament was spread out to a width of 10 inches and sprayed with a solution of 25% carnauba wax in hot alcohol. After this spreading and spraying treatment, the tow was pulled back to its original shape and fed into a conventional cigarette

make-up machine which cut and paper wrapped it into rods of 8.1-mm. diameter and 71-mm. length. The rods were stored for 24 hours in a room maintained at 50° C. to remove the alcohol vapors and were then allowed to cool back to 28° C. The cooled rods were quite firm and contained 18% wax. These firm rods were cut into 12-mm. filter tips and the tips were attached to standard American cigarettes by means of cellulose tape. The filtered cigarettes were smoked on the smoking machine. The results of the smoking experiment were compared with those obtained from smoking the same brand of cigarette containing 12-mm. filter tips of the same tow of regenerated cellulose without the addition of the wax.

Type of cigarette tip (12 mm.)	Mg. tars obtained from the collected smoke of 10 filtered cigarettes	Mg. nicotine obtained from the collected smoke of 10 filtered cigarettes	Average pressure drop of the cigarettes (inches of water)
Regenerated cellulose tow	138	24	4.2
Regenerated cellulose tow containing 18% carnauba wax	118	17	4.4

It can be seen from the above description that we have provided a relatively simple but effective method of improving fibrous type of tobacco smoke filter elements. While we prefer to manufacture our filter from crimped, oriented, longitudinally positioned cellulose acetate fibers, we have found that the wax improves other types of fibers such as viscose fibers.

We claim:

1. A tobacco smoke filtering element comprised of a unitary rod-like bundle of at least 10,000 continuous cellulose acetate filaments, the bundle being approximately 8.1 mm. in diameter, the filaments of the bundle being longitudinally aligned and coextensive with the length of the filter element, and the filaments having non-oriented short portions thereof crimped into diverging and converging relationship to the main filament alignment, the spacing of the adjacent aligned continuous filaments providing longitudinal passages for smoke through the bundle, the filter element being further characterized in that the aforesaid filaments carry and have relatively uniformly distributed on the surfaces of the filament 1–30% by weight of a wax.

2. A tobacco smoke filtering element comprised of a structurally unitary rod-like bundle of at least 10,000 continuous cellulose acetate filaments of a denier of approximately 5–8 per filament, 1–30% by weight of a wax uniformly deposited on the surface of the filaments and a wrapper encircling the bundle, each wax-covered filament of the bundle being substantially co-extensive with the length of the filter element, the filaments as a whole being in substantial alignment longitudinally of the filter element and each of the individual filaments of the bundle having a plurality of short portions thereof crimped into diverging and converging relationship to the main filter element axis, the spacing of groups of adjacent continuous filaments providing longitudinal passages for smoke through the bundle, the wax occupying positions in and partially blocking said passages.

3. A filter element in accordance with claim 2 wherein the wax is paraffin wax.

4. A filter element in accordance with claim 2 wherein the wax is castor wax.

5. A tobacco smoke filtering element comprised of a rod-like bundle of at least several thousand continuous crimped synthetic filaments of a denier per filament not greater than 8, 1–30% by weight of a wax in the form of finely divided particles substantially uniformly disposed on the surface of the filaments and a wrapper encircling the bundle, each wax-covered filament of the bundle being substantially coextensive with the length of the

filter element, the filaments as a whole being in substantial alignment longitudinally of the filter element and each of the individual filaments of the bundle having a plurality of short portions thereof crimped into diverging and converging relationship to the main filter element axis, the spacing of groups of adjacent continuous filaments providing longitudinal passages for smoke through the bundle, the wax occupying positions in and partially blocking said passages.

6. A tobacco smoke filtering element comprised of a rod-like bundle of at least several thousand continuous crimped cellulose acetate filaments, 1-30% by weight of wax in the form of finely divided particles disposed on the surface of the filaments and relatively firmly bonded thereto and a wrapper encircling the bundle, each wax-covered filament of the bundle being substantially co-extensive with the length of the filter element, the filaments as a whole being in substantial alignment longitudinally of the filter element and each of the individual filaments of the bundle having a plurality of short portions thereof crimped into diverging and converging relationship to the main filter element axis, the spacing of groups of adjacent continuous filaments providing longitudinal passages for smoke through the bundle, the wax occupying positions in and partially blocking said passages.

7. A filter element in accordance with claim 6 wherein the finely divided wax is from the group consisting of carnauba, paraffin, bees, spermaceti, montan, carbo, acra, castor and polyolefin waxes.

8. A filter element in accordance with claim 6 wherein the wax is a stearyl alcohol.

9. A filter element in accordance with claim 6 wherein the wax is a polyolefin wax.

10. A filter element in accordance with claim 6 wherein there is a content of plasticizer present.

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