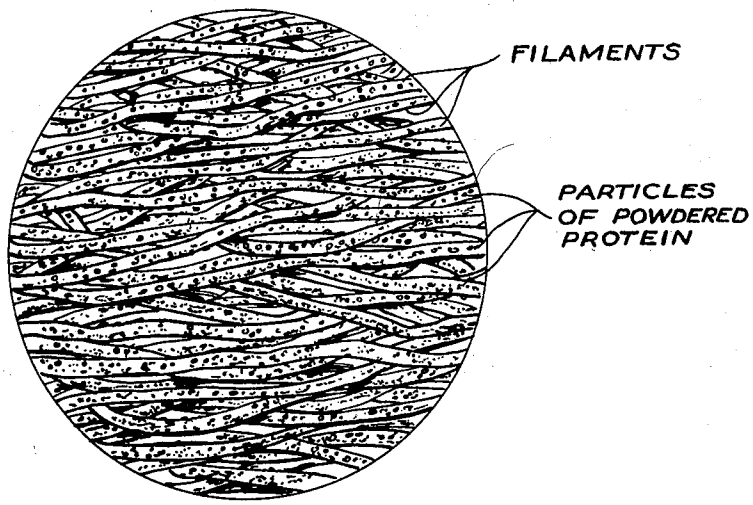
March 15, 1960 G. P. TOUEY 2,928,399

FIBROUS TOBACCO SMOKE FILTER

Filed May 27, 1954 2 Sheets-Sheet 1

FIG. 1.



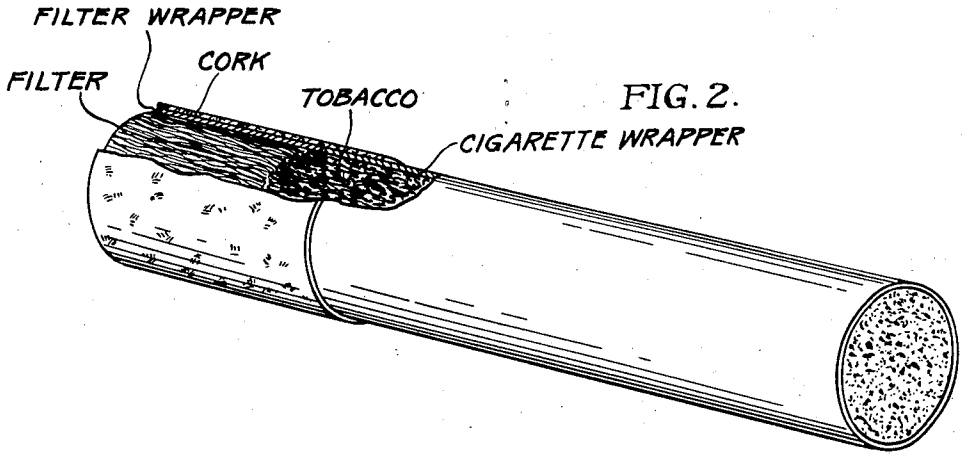


FIG. 2.

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FIG. 3

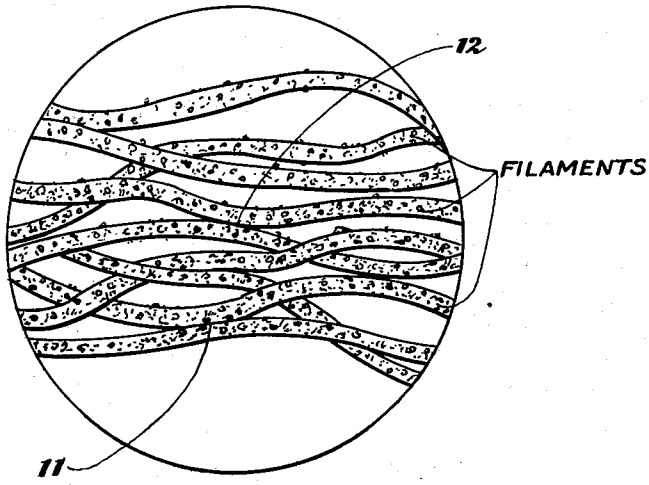
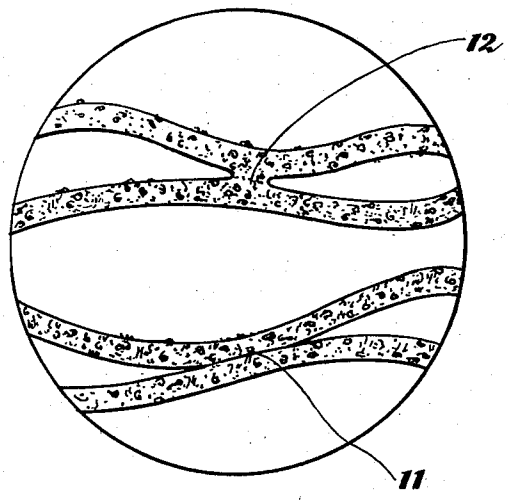


FIG. 4



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United States Patent Office 2,928,399
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2,928,399

FIBROUS TOBACCO SMOKE FILTER

George P. Touey, Kingsport, Tenn., assignor to Eastman Kodak Company, Rochester, N.Y., a corporation of New Jersey

Application May 27, 1954, Serial No. 432,932

6 Claims. (Cl. 131—208)

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, the invention is concerned with an improvement in filters of the general type disclosed in Crawford and Stevens U.S. Patents Nos. 2,794,239 and 2,794,480 of June 4, 1957.

In the aforementioned patents, newly discovered advantages of a certain type of fibrous tobacco smoke filter are discussed. The proposed type of filter is prepared from a specially conditioned tow of synthetically spun continuous filaments and comprises a structurally unitary rod-like mass of fibers and a wrapper encircling the mass, each fiber of the mass being substantially coextensive therewith, the fibers as a whole being in substantial alignment longitudinally of the mass but substantially each of the individual fibers having a plurality of short portions thereof crimped into diverging and converging relationship to the main fiber axis, a plurality of the fibers having surface solvation bonds to contiguous fibers at random points of contact. Very good results have been obtained in the use of such filters for the removal of nicotine and tars from tobacco smoke, especially in view of the fact that the filters supply other requirements equally as necessary to the success of a tobacco smoke filter.

These filters also have a marked processing advantage over other filters known in the art. However, since the fibers in such filters are substantially parallel to each other, some channeling of the smoke through the filter may be possible, resulting in a decreased filtering action.

In other words, while interference with the smooth flow of combustion products through the channels is provided by the random bonds between adjacent fibers, by incompleteness of fiber orientation, and by the short fiber portions which are crimped into diverging and converging relationship to the main fiber axis, yet a certain amount of the smoke in the core of any minute column of smoke passing through the filter apparently may be exposed to somewhat less than a theoretically maximum amount of contact with the fiber surfaces. Experimental investigations have shown that any attempt to reduce the size of smoke channels through the filters by an increase in filter density either through greater compaction or through the use of finer fibers generally also results in an intolerable increase in pressure drop through the filter. Unfavorable conditions also generally result when an increased amount of fiber crimp is employed in order to increase the relative number of divergent and convergent fiber portions.

I now have found that the efficiency of the filters described may be substantially increased without equivalent increase in pressure drop through the filter by depositing certain finely divided solids in the smoke channels provided by the spacing of adjacent fibers. I further have discovered that when protein powders are employed as the finely divided deposit, unusual efficiency is obtained.

This invention, therefore, has as one object the production of a more efficient cigarette smoke filter consisting of a bundle of substantially longitudinally oriented textile fibers infused with finely divided protein particles. Another object is to provide means for increasing the efficiency of a cigarette filter prepared from a textile fiber. A still further object is provision of a filter which is capable of removing nicotine, tars, and other deleterious components of cigarette smoke without causing the smoke to be dry or distasteful. Another object is to increase the efficiency of tobacco smoke filters of the Crawford and Stevens application without creating a high pressure drop. Other objects will be obvious from the present specification and claims.

Accordingly, the present invention consists, in general, in a tobacco smoke filtering medium comprising a mass of substantially longitudinally aligned fibers, the spacing of substantially all groups of adjacent fibers providing minute passages for smoke therethrough, said mass carrying therein finely divided protein particles in an amount of 1 to 60% by weight of the mass, said particles occupying positions in and partially blocking said passages whereby a substantial portion of the smoke is impinged either on the fibers or on the protein particles.

A more specific embodiment of the invention comprises a new tobacco smoke filtering material of synthetically spun continuous filaments and an element made therefrom, the element comprising a structurally unitary rod-like mass of fibers and a wrapper encircling the mass, each fiber of the mass being substantially co-extensive therewith, the fibers as a whole being in substantial alignment longitudinally of the mass but substantially each of the individual fibers having a plurality of short portions thereof crimped into diverging and converging relationship to the main fiber axis, a plurality of the fibers having surface solvation bonds to contiguous fibers at random points of contact, the mass carrying substantially uniformly dispersed therein a solid finely divided protein powder in the amount of 1 to 60% by weight of the mass.

Most advantageously, the invention comprises a filter of cellulose acetate fibers having surface solvation bonds achieved through the application of a plasticizer spray, the filter carrying uniformly dispersed protein particles in the amount of about 10 to 40% by weight of the filter. By the term "surface solvation" of the fibers as used herein is meant the creation, by the action of a solvent or plasticizer and/or heat, of an adhesive, tacky or readily bonding condition of the fibers by solution or incipient solution of surface portions of the filament material whereby there is produced a welding and adhesion between adjacent filaments contacting at such portions, and by "coalescence" I mean the situation caused by partial or incipient solvation of surface portions of the filaments and resulting in a condition within those portions under which the portions will flow into or unite with similar portions of dissolved or plastic material in contiguous filaments.

Any suitable means known to the art for spreading a powder onto a fibrous surface or through a fibrous mass may be employed in preparing filters of the invention. Thus, for example, the protein powder can be blown onto the fibers or it can be applied as a slurry in cold water or in a volatile organic vehicle or a plasticizer for the fiber. Another method is to apply the protein powder to the fibers electrostatically, i.e. to induce a charge on the fibers by friction or other suitable means and then

to run the tow in a banded, i.e. spread out condition through a dusting chamber containing a concentrated cloud of protein dust. Still another method for applying the protein is to wet the surface of the fibers with an adhesive or a plasticizer before exposing them to a powder spraying device. Preferably, the protein is continuously applied to an opened and banded moving tow formed as described in the Crawford and Stevens applications. That is to say, tow from a supply roll is opened to debundlize the filaments and provide a larger and more uniform tow cross section, and the opened tow is spread uniformly to a much larger width of e.g., 8 times its original width, thereby exposing substantially all of the filaments to material, i.e. plasticizer, issuing from a dispenser adjacent which the two passes. The protein may be added before, simultaneously with, or after the plasticizer, preferably with or after.

The invention is illustrated in the accompanying drawings in which

Fig. 1 represents a magnified view of the interior of a mass of filtering material prepared in accordance with the invention,

Fig. 2 is a view of a cigarette having attached thereto a tip prepared from a filtering material of the invention,

Fig. 3 is a more highly magnified view of a portion of the mass of Fig. 1 particularly showing surface solvation bonds between adjacent filaments, and

Fig. 4 is a further enlargment of the bonds shown in Fig. 3.

With particular reference to Figs. 3 and 4, the reference numerals **11** and **12** designate surface solvation bonds achieved at random points by the application of a plasticizer spray. The numeral **11** represents a bonding condition or welding as described above which has resulted from the plasticizer rendering the fiber tacky and adhesive by means of solution or incipient solution. As will be seen from the drawing, no foreign material enters into the bonding and the two contacting filaments are more or less held together as one homogeneous body (composition-wise) as the term coalesce implies. The tacky condition of surface portions of the filament material has provided sufficient cohesiveness to form a bond. The bond **12**, on the other hand, has resulted where the solution of surface portions of the filament material has resulted in a condition within these portions, under which the portions have flowed together and united as described above.

The invention is further illustrated in the following examples:

Example 1

A crimped continuous filament tow of yarn type cellulose acetate of 5 denier per filament with a total denier of 100,000, and 9 crimps per inch was used to prepare filters in accordance with the preliminary conditioning procedure of Crawford and Stevens. The tow was pulled from a ball warp over stationary tensioning fingers and into a tensioning device functioning to provide tow opening as the first phase of filament separation. The device employed was of the type employing a pair of driven rolls to place under tension tow positioned in the ratch between the driven rolls and a pair of retarded rolls upstream of the driven rolls. The device was equipped with the improved reciprocating striker as disclosed and claimed in Smith pending U.S. patent application Serial No. 416,010, filed March 15, 1954, now U.S. Patent No. 2,790,208. Upon being released from the nip of the positively driven tension rolls into a zone of relative relaxation, i.e. relatively little tension, the tow bloomed through inherent forces manifested upon the return of the tow to its original position.

The partially opened tow of cellulose acetate yarn was slowly pulled over a compressed air banding device as disclosed in the aforementioned Crawford and Stevens patent applications and in pending U.S. patent application Serial No. 356,983, filed May 25, 1953, by Wallace T. Jackson, now U.S. Patent No. 2,737,688. The banding device momentarily spread out the fibers to a width of six inches. While the tow was in this spread condition it was sprayed with a highly agitated slurry of one part of a commercial brand of powdered casein, in five parts dimethoxyethylphthalate plasticizer.

After this spreading and spraying treatment the two was uniformly collected and fed to a garniture, i.e. a cigarette-making machine. The tow was fed into the garniture through a shaping horn which served to condense the conditioned tow back into its original shape of a cord. The cigarette making machine wrapped the tow with paper and cut it into rods similar in size to a standard size cigarette. The rods contained 1 part casein powder, 5 parts plasticizer, and 25 parts cellulose acetate by weight. After the filter rods were given a short heat treatment to cause partial solvation of the acetate fibers by the plasticizer they were readily cut into 12 mm. filter tip lengths. These tips were attached to a standard brand of cigarettes available on the retail market in the U.S. by means of an adhesive tape. 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 collected smoke was analyzed for nicotine and tars. The results of the smoking experiment were compared with those obtained from smoking the same brand of cigarettes containing 12 mm. filter tips made from the same tow of cellulose acetate fibers plasticizel with dimethoxyethylphthalate without the addition of casein.

Type of Cigarette Filter Tip (12 mm.)	mg. of tars [1]	mg. of nicotine [1]
Plasticized cellulose acetate tow	139	18
Plasticized cellulose acetate tow containing 3.2% powdered casein	109	13

[1] Obtained from the collected smoke of ten filtered cigarettes. Moisture of the tobacco in each of the cigarettes=12.1%.

The cigarettes containing the acetate tow filter had an average pressure drop of 27%; the cigarettes containing the filter of acetate tow and casein powder had an average pressure drop of 29%, where pressure drop is measured as the percent additional time required for a standard tube of water to drain when the cigarette to be measured is inserted into the vent of this tube, compared to the draining time of the same apparatus when this vent is unobstructed with any cigarette to be measured.

Example 2

A loose, i.e. partially opened crimped continuous filament tow of cellulose acetate containing approximately 10,000 fibers of 8 denier per filament was pulled through a bath containing a highly agitated slurry of 15 parts commercially available finely powdered gelatin, 42 parts water, and 42 parts ethanol. After leaving this bath, the tow was drawn through squeegee rolls and dried. When dry, the tow contained approximately 6% by weight of gelatin uniformly dispersed throughout, and strongly adhered to the fibers, giving them a rough, irregular surface. The tow was processed into filter rods in a garniture as described in Example 1 and the resulting rods were cut into 12 mm. lengths. The filter tips so produced were attached to standard brand cigarettes and ten of these filter tipped cigarettes were smoked on the smoking machine. The collected smoke was analyzed for nicotine and tars. A control, consisting of the same brand of cigarettes tipped with filters made from the 8 denier per filament tow containing no gelatin was also smoked on the smoking machine and the collected smoke was analyzed in the same manner for nicotine and tars.

	mg. of tars [1]	mg. of nicotine [1]
Acetate tow filter	150	20
Acetate tow filter containing 6% gelatin	114	13

[1] Obtained from the collected smoke of ten filtered cigarettes.

Moisture of the tobacco in each of the cigarettes=11.9%.

The cigarettes containing the acetate tow filter had an average pressure drop of 22%; the cigarettes containing the filter of acetate tow and gelatin powder had an average pressure drop of 26%, where pressure drop is measured as explained in Example 1 above.

Example 3

A tow of cellulose acetate yarn containing approximately 40,000 fibers of 3 denier per filament was spread out to a width of six inches and sprayed with a 10% solution of a water-base adhesive. While the tow was still spread out and wet with the adhesive it was sprayed with a commercially available finely divided dry wheat gluten powder and then rolled back into its original form. The impregnated tow was processed into filter rods and the rods were cut into 12 mm. lengths. The filter tips, containing 7% wheat gluten based on the weight of the acetate fibers, were attached to standard brand cigarettes and ten of these cigarettes were smoked on the smoking machine. The collected smoke was analyzed for nicotine and tars. A control consisting of the same brand of cigarettes tipped with a filter of the 3 denier per filament tow containing the adhesive but no protein powder was also smoked on the smoking machine and the collected smoke was analyzed in the same manner for nicotine and tars.

	mg. of tars	mg. of nicotine
Acetate tow filter	135	19
Acetate tow filter containing 7% wheat gluten	100	12

Moisture of the tobacco in each of the cigarettes=12.5%.

The cigarettes containing the acetate tow filter had an average pressure drop of 33%; the cigarettes containing the filter of acetate tow and gluten powder had an average pressure drop of 35%, where pressure drop is measured as explained in Example 1 above.

In carrying out the operation of this invention the type of protein employed is not a critical factor. Rather, the form of the protein is more important. The protein should be in a powdered form so that it can be readily slurried in a liquid or passed through a spraying nozzle. Any source of protein particles which passes this requirement can, therefore, be employed. Thus the protein powders that can be employed in carrying out the operation of this invention can be any of the commonly known animal or vegetable proteins. The choice of protein, therefore, is simply governed by the ease with which the protein can be obtained from its animal or vegetable source in a dry powdered form, i.e. 100 to 200 mesh which can be readily slurried in a liquid or passed through a spraying nozzle. Among the animal proteins which are useful are dried casein powder (milk), and powdered gelatin. The useful vegetable proteins include zein powder (corn), soybean protein powder, and gluten powder (wheat).

While unusually good results have been obtained with filters prepared from a crimped continuous filament tow of cellulose acetate fibers sprayed with a plasticizer, e.g. dimethoxyethylphthalate or methylphthalylethylglycolate, it will be recognized by those skilled in the art that the usefulness of the invention extends to other fibrous filters, including those prepared from fibers of viscose, cotton, nylon, polyamides, polyesters, etc., particularly where the fibers are in substantial longitudinal alignment and are coextensive with the body of the filter.

I claim:

1. A tobacco smoke filter element consisting essentially of a rod-like member of crimped, continuous filaments of a yarn-type cellulose acetate of not greater than 5 denier per filament and of a total denier not greater than approximately 100,000, said member containing plasticizer for the cellulose acetate and the filaments having a content of casein powder on their surface, and a wrapper around the periphery of the filter element and the filter element by weight of said components being about 25 parts of cellulose acetate, 5 parts of plasticizer and 1 part of casein.

2. A tobacco smoke filter element consisting essentially of a rod-like member of crimped, synthetic thermoplastic filament yarn which yarn extends longitudinally of the rod-like member and in which substantially all of said crimped filaments of the yarn are completely coextensive in length with the filter element, a content of plasticizer in the filter element amounting to at least ⅛ of the total weight of the filter element, said filaments in the filter element being further characterized in that they are joined to contiguous filaments at random points of contact and the filaments have on their surface a powdered additive consisting substantially entirely of protein powder, the amount of the additive by total weight of the filter element being at least 3% and not more than 60% and a wrapper covering the periphery of the rod-like member.

3. A tobacco smoke filter element consisting essentially of substantially longitudinally positioned crimped, continuous filaments of cellulose acetate, substantially all of said crimped filaments being coextensive in length with said filter element, a content of plasticizer contained by the filaments and this plasticizer content amounting to at least ⅛ of the total weight of the filter element, said filaments also having on their surface a content of protein powder in an amount by weight of the filter element of at least 3% and not greater than 60%, said content of protein powder being substantially uniformly positioned on the surface of the filaments, the filter element being pervious along the axis to which the filaments as a whole are aligned and a wrapper encircling the periphery of the filter element.

4. A tobacco smoke filter element composed essentially of a rod-like member consisting of a bundle of at least 10,000 continuous crimped cellulose acetate filaments, the diameter of the bundle being approximately the diameter of a cigarette, and a wrapper encircling the periphery of the bundle, the continuous cellulose acetate filaments of the bundle being characterized in that they contain plasticizer and the filaments on their surface carry a powdered additive consisting essentially of a powdered protein in the amount by weight of the filter of at least 3% and not greater than 60%, the aforementioned plasticizer serving to assist in the bonding of said protein powder to the filaments and a wrapper encircling the periphery of the filter element.

5. A tobacco smoke filter element in accordance with claim 4 wherein the powdered protein is from the groups consisting of casein, gelatin, zein, soybean and gluten powders.

6. A filter element in accordance with claim 4 wherein the plasticizer is an ester.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,928,399 March 15, 1960

George P. Touey

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 15, and column 4, line 9, for "two", each occurrence, read -- tow --; same column 4, line 32, for "plasticizel" read -- plasticized --.

Signed and sealed this 13th day of September 1960.

(SEAL)

Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents