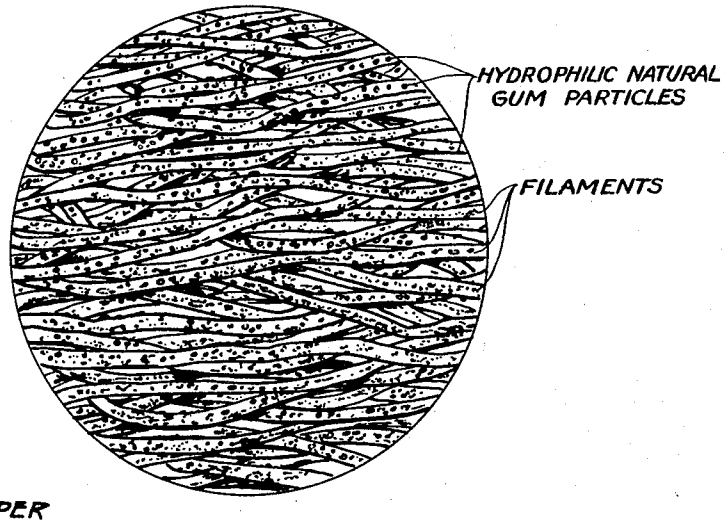
March 15, 1960 G. P. TOUEY 2,928,400

FIBROUS TOBACCO SMOKE FILTERS

Filed June 24, 1954

FIG. 1.



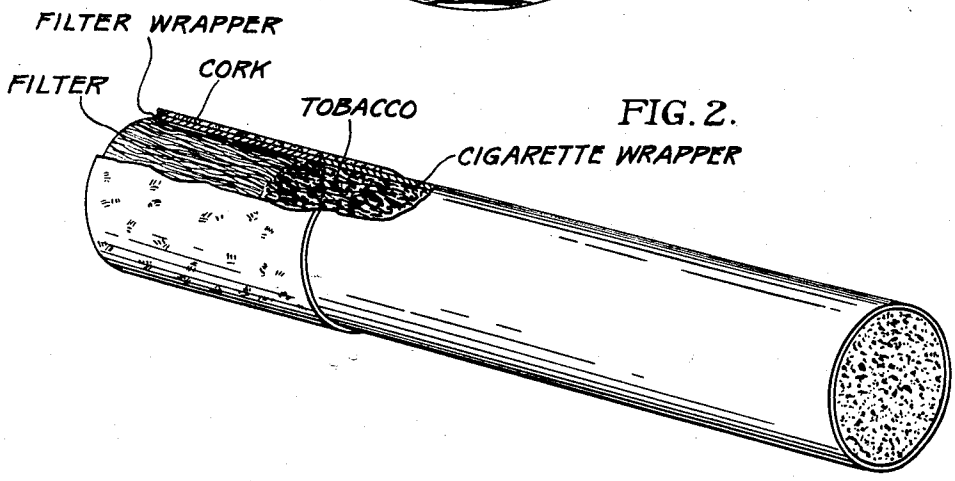


FIG. 2.

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FIBROUS TOBACCO SMOKE FILTERS

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8 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 U.S. Patent No. 2,701,258 to Cobb and Hargrave, and U.S. Patent Nos. 2,794,239 and 2,794,480, to Crawford and Stevens to each of which reference is made.

In the aforementioned applications, 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 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 solid hydrophilic natural gums in the smoke channels provided by the spacing of adjacent fibers.

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 hydrophilic natural gum 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 patent 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 hydrophilic natural gum particles in an amount of 5 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 gum 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 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, the mass carrying substantially uniformly dispersed therein a solid finely divided hydrophilic gum in the amount of 5 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 hydrophilic particles in the amount of about 10 to 40% by weight of the filter. By the expression "surface solvation" 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 filaments 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" is meant 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 gum powder can be blown onto the fibers or it can be applied as a slurry in a liquid that is not a solvent for the powder, or in a volatile organic vehicle or in a plasticizer for the fibers. Another method is to apply the gum powder to the fibers electrostatically, i.e., to induce a charge on the fibers in the tow by friction or other suitable means and then to run the tow in a banded, i.e., spread out condition through a chamber containing a concentrated cloud of gum dust. Although the powders of the natural gum adhere strongly to the fibers without the addition of

a binding agent, the latter may be employed if so desired. Alternatively, the surface of the fibers in the tow can be sprayed with a placticizer or glue prior to their exposure to the powder applying device. In this case the plasticizer plays a dual role—the plasticization of the fibers, and the binding of the powder to the surface of the fibers. Preferably, the gum powder 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 debundleize 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 tow passes. The gum may be added before, simultaneously with, or after the plasticizer, preferably with or after.

The hydrophilic natural gum powders which are suitable in carrying out the operation of this invention may be selected from any of the following sources of natural gums:

I. Natural gums obtained from seaweed. These are represented by alginic acid, by the alginates, agar, and Irish moss.

II. Natural gums obtained from trees and shrubs. These are represented by gum arabic, gum tragacanth, gum karaya, and the like.

III. Natural gums obtained from seed pods and legumes. These are represented by locust bean gum, guar gum, and the like.

The source of the gum is not a critical factor. Rather, the form of the gum is more important. The gum should be in a highly powdered form so that it can be slurried in a liquid or passed through a spraying nozzle. It may be for example, 100 to 200 mesh.

The advantages of employing the natural gums in combination with a tow of a textile fiber to produce a cigarette filter are manifold. The major advantage is the fact that such powders act as an efficient means of preventing channeling of the smoke through the filter. However, the facts that the powders are non-toxic, tasteless, and odorless are also of considerable advantage. Being composed of polysaccharides, they present no danger should traces of the powders be drawn into the smoker's lungs during the normal course of smoking. Another advantage is the fact that the powders are light. Thus, they can be readily blown onto the surface of the fibers or applied as a slurry in a liquid.

The invention is illustrated in the accompanying drawings in which

Fig. 1 is a representation of a photomicrograph showing the interior of a filter element in accordance with the invention, and

Fig. 2 is a view of a cigarette, in part cut away, which embodies a filter element of the invention.

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 positoned 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 U.S. Patent No. 2,790,208 to Smith. 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 was slowly pulled over a compressed air banding device as disclosed in the aforementioned Crawford and Stevens patents and in U.S. Patent No. 2,737,688 to Wallace T. Jackson. The banding device spreads out the fibers to a width of six inches. While the tow was in this spread condition it was sprayed with methyl phthalyl ethyl glycollate plasticizer and passed through a dusting chamber containing a highly pulverized powder of gum arabic. On leaving the dusting chamber the tow of fibers contained 10% plasticizer and 15% gum arabic based on the total weight of the combination.

After this spreading, spraying, and dust application treatments, the tow 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 filter rods were given a heat treatment for one hour at 80° C. to allow the plasticizer to diffuse through the fibers in the filter and impart the desired rigidity to the rods. The rods then were readily cut into 13 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 13 mm. filter tips made from the same tow of cellulose acetate fibers plasticized with about 10% methyl phthalyl ethyl glycollate without the addition of hydrophilic gum.

The ten plasticized cellulose acetate tow filters containing no gum arabic allowed 130 mg. of tars and 20 mg. of nicotine to pass through into the smoke collection flask. The ten plasticized cellulose acetate tow filters containing 15% gum arabic allowed only 100 mg. of tars and 14 mg. of nicotine to pass through into the smoke collection flask.

The cigarettes containing the acetate tow filter had an average pressure drop of 27%; the cigarettes containing the filters of acetate tow and gum arabic had an average pressure drop of 29%, where pressure shop 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

The procedures described in Example 1 were repeated using the same tow of cellulose acetate and the same plasticizer but substituting powdered locust bean gum for the gum arabic in the dusting chamber. The plugs prepared in this case contained 78% cellulose acetate, 11% plasticizer, and 11% powdered locust bean gum. Control plugs containing the same types and amounts of cellulose acetate tow and plasticizer but no locust bean gum powder were also prepared in a similar manner.

Ten 13-mm. filter tips were removed from both sets of filter plugs and attached to standard cigarettes. These cigarettes were smoked on the standard smoking machine and the collected smoke from each set of ten cigarettes was analyzed for nicotine and tar content.

The ten plasticized cellulose acetate tow filters containing no locust bean powder allowed 133 mg. of tars and 19 mg. of nicotine to pass through into the smoke collection flask. The ten plasticized cellulose acetate tow filters containing 11% locust bean gum powder allowed only 95 mg. of tars and 14 mg. of nicotine to pass through into the smoke collection flask.

The cigarettes containing the acetate tow filter had an average pressure drop of 27%; the cigarettes containing the filters of acetate tow and locust bean gum had an average pressure drop of 30%, where pressure drop is measured as explained in Example 1 above.

Example 3

The procedures described in Example 1 were repeated using the same tow of cellulose acetate and the same plasticizer but substituting powdered alginic acid for the gum arabic in the dusting chamber. The plugs prepared in this case contained 75% cellulose acetate, 10% plasticizer, and 15% powdered alginic acid. Ten cigarettes containing 13-mm. filter tips cut from these plugs were smoked on the smoking machine and the collected smoke was analyzed for nicotine and tar content. Only 101 mg. of tars and 11 mg. of nicotine were found in the smoke obtained from ten of these filtered cigarettes.

The cigarettes containing the acetate tow filter had an average pressure drop of 27%; the cigarettes containing the filters of acetate tow and powdered alginic acid had an average pressure drop of 28%, where pressure drop is measured as explained in Example 1 above.

Example 4

The procedures described in Example 1 were repeated using a tow of cellulose acetate yarn containing 5,000 filaments of 16 denier per filament, a plasticizer consisting of 100% triethyl citrate, and a powder consisting of highly pulverized guar gum. The plugs prepared in this case contained 60% cellulose acetate, 10% triethyl citrate plasticizer, and 30% powdered guar gum. Control plugs containing the same types and amounts of cellulose acetate tow and plasticizer but no guar gum powder were also prepared in a similar manner.

Ten 13-mm. filter tips were removed from both sets of filter plugs and attached to standard cigarettes. These cigarettes were smoked on the smoking machine and the collected smoke was analyzed for nicotine and tar content.

The ten plasticized cellulose acetate tow filters containing no powder allowed 155 mg. of tars and 21 mg. of nicotine to pass through into the smoke collection flask. The ten plasticized cellulose acetate tow filters containing 30% powdered guar gum allowed only 105 mg. of tars and 14 mg. of nicotine to pass through into the smoke collection flask.

The cigarettes containing the acetate tow filter had an average pressure drop of 22%; the cigarettes containing the filters of acetate tow and guar gum had an average pressure drop of 24%, where pressure drop is measured as explained in Example 1 above.

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 methylphthalylethylglycollate, 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 comprising an elongated, substantially unitary cylinder of substantially oriented, substantially coextensive, crimped, cellulose acetate filaments generally extending mainly longitudinally of the

cylinder and providing passages for smoke therethrough, a deposit uniformly dispersed throughout the cylinder of about 5%–60% by weight of solid, finely divided hydrophilic natural gum carried on the surfaces of filaments, and a liquid plasticizer which serves the dual purpose of causing adherence between the filaments at random points and for causing adherence of the finely divided gum to the filaments, said filter containing a paper wrapper around the periphery of said cylinder.

2. A tobacco smoke filter comprising an elongated bundle of crimped continuous cellulose acetate filaments wherein the continuous filaments extend mainly longitudinally of the bundle and provide passages for smoke therethrough, a plasticizer content on said filaments, 5 to 40% by weight of a solid 100–200 mesh material from the group consisting of gum arabic, gum tragacanth, gum karaya, locust bean gum, guar gum, alginic acid, alginates, agar and Irish moss carried on the surface of the filaments, the aforesaid plasticizer serving the dual purpose of causing adherence between the filaments at random points and causing the adherence of the aforesaid solid 100–200 mesh material to the filaments, said filter containing a paper wrapper around its periphery.

3. A product in accordance with claim 2 wherein the crimped continuous filaments have at least 9 crimps per inch.

4. A product in accordance with claim 2 wherein the plasticizer is an ester.

5. A product in accordance with claim 2 wherein the plasticizer content is of the order of at least about 10% but not greater than the percentage of the 100–200 mesh material carried on the filaments.

6. A product in accordance with claim 2 wherein the material is gum arabic.

7. A product in accordance with claim 2 wherein the material is locust bean gum.

8. A product in accordance with claim 2 wherein the material is guar gum.

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