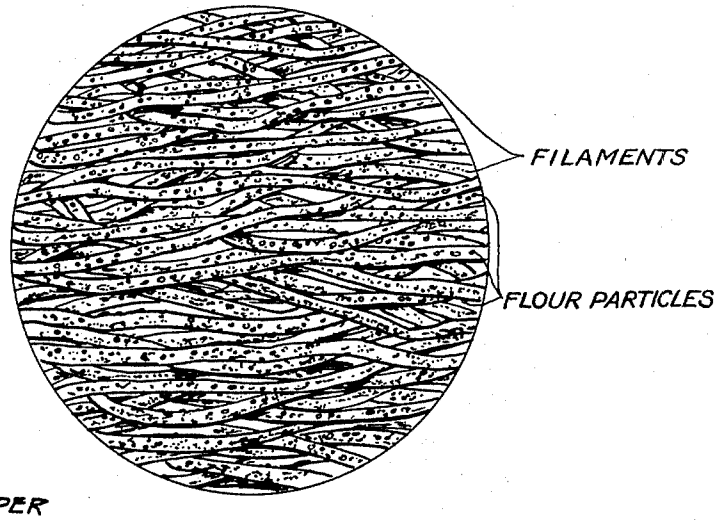
Dec. 15, 1959 G. P. TOUEY 2,917,054

FIBROUS TOBACCO SMOKE FILTER CONTAINING SOLID ADDITIVE

Filed April 22, 1955

FIG. 1.



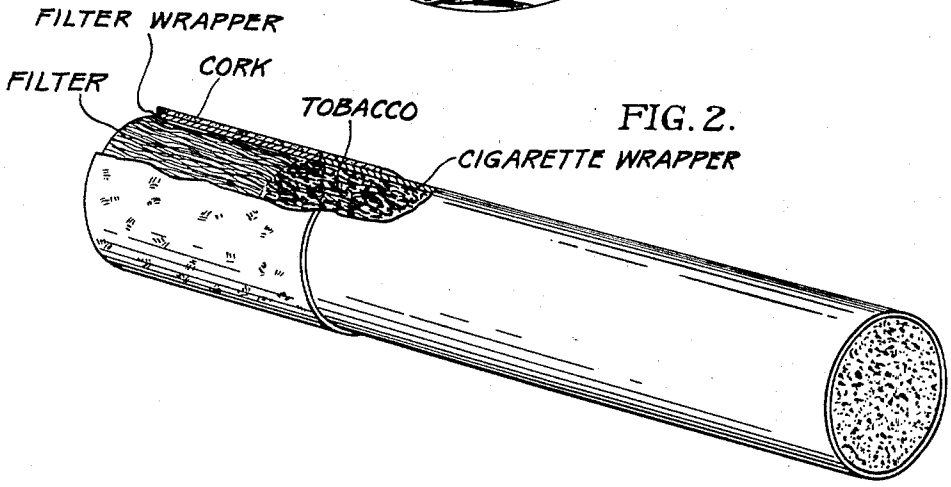


FIG. 2.

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FIBROUS TOBACCO SMOKE FILTER CONTAINING SOLID ADDITIVE

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Application April 22, 1955, Serial No. 503,188

4 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 filter therein described 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, such as a unitary nature, rigidity, and resiliency, which are 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 generally parallel to each other, some channeling of the smoke through the filter may be possible.

In other words, while a desirable amount of interference with the smooth flow of combustion products through the channels is provided by the random bonds between adjacent fibers, by the 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 limited amount of the smoke passing through the filter apparently travels through channels in a smooth, non-turbulent and undisturbed manner and thereby may be exposed to somewhat less than a theoretically maximum amount of impingement upon and contact with the solid surfaces of the filter. Experimental investigations have shown that any attempt to reduce the size or change the shape of the detrimentally smooth smoke channels through the filters by an increase in filter density either through greater compaction of the fiber mass or through the use of finer fibers generally also results in an intolerable increase in pressure drop through the filter. It is also unsatisfactory to substantially increase the amount of fiber crimp in order to obtain an increase in the amount of smoke

impingement by increasing the number of divergent and convergent fiber portions.

In my copending U.S. patent application Ser. No. 413,950, filed March 3, 1954, I have disclosed and claimed an improvement based on my discovery that the efficiency of filters of the type described above may be substantially increased without the expected equivalent increase in pressure drop through the filters by preparing the filters with deposits of finely divided solid vegetable starch particles in the smoke channels provided by the spacing of adjacent fibers. The starch particles are carried by and supported on the surfaces of the fibers. Among the powdered, relatively pure starches specifically enumerated in the said copending application are those derived from wheat, potatoes, rice and tapioca.

I have now discovered that an impure, i.e., nonconcentrated starchy material (namely, ordinary wheat flour) provides a filtration efficiency equally as high as the relatively pure starches and exhibits an unexpected and advantageous distinction in that it adheres to the tow fibers more firmly than most of the starch powders. Thus, during the fabrication, packaging, and use of the filters and cigarettes produced therefrom, those filters containing wheat flour are completely resistant to being sifted out of the tow.

This invention, therefore, has as one object the production of an efficient cigarette smoke filter consisting of a fibrous filtering material, particularly a material comprising a bundle of substantially longitudinally oriented textile fibers infused with finely divided wheat flour 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 applications without creating a high pressure drop. Still another object is to provide a firmly adhering particulate additive for fibrous tobacco smoke filters, particularly those fibrous filters prepared with fibers bonded through a coalescence obtained by means of the application of a spray of a liquid, solvent-type plasticizer. Other objects will be obvious from the present specification and claims.

Accordingly, the present invention consists, in general, in a fibrous tobacco smoke filtering medium, for example, one 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 wheat flour particles in an amount of 1 to 60% by weight of the mass (the concentration not being critical so long as there is sufficient wheat flour present to improve the filtration efficiency of the filter without creating excessive pressure drop), said particles being supported along the surfaces of and by the fibers and occupying positions along the walls of and partially blocking said passages whereby a substantial portion of the smoke is impinged on the particles.

A more specific and very advantageous 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 sub-

stantially 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 wheat flour in the amount of about 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 wheat flour particles in the amount of about 5 to 30% by weight of the filter.

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 wheat flour 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 flour to the fibers electrostatically, i.e. to induce a charge on the fibers by friction or other suitable means and then to run the fibers through a chamber containing a highly concentrated cloud of flour dust. Preferably this is done with the fibers in the form of a tow and in a banded, i.e. spread-out condition. Still another method for applying the flour particles is to wet the surface of the fibers with an adhesive or a plasticizer before exposing them to a flour spraying device. Preferably, the flour is continuously applied to an opened and banded moving tow formed as described in the Crawford and Stevens patents. 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., 10 times its original width, thereby exposing substantially all of the filaments to material, i.e. plasticizer, issuing from a dispenser adiacent which the tow passes. The flour 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, and

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

The invention is further illustrated in the following examples:

EXAMPLE 1.—FILTRATION EFFICIENCY

A partially opened tow of a crimped, regular cross-section cellulose acetate yarn (39.2% acetyl) having about eight crimps per inch and containing approximately 12,000 filaments of five denier per filament was slowly pulled over a corresponding air banding device as disclosed in the aforementioned Crawford and Stevens patent applications and in Jackson U.S. patent application Serial No. 356,983, filed May 25, 1953, now U.S. Patent No. 2,737,688 which spread out the fibers to a width of about twelve inches. While the tow was in this spread condition it was sprayed uniformly with finely divided droplets of di-(methoxyethyl) phthalate plasticizer in order to make numerous portions of the surfaces of the fibers adhesive. The spread tow was then passed through a dusting chamber which dusted the fibers with a finely divided (325 mesh) wheat flour of a type commercially available and designated as bleached, enriched hard wheat flour and said to contain 14.0% protein, 67% starch and 13% moisture, the remainder consisting of fats, sugars, and inert fibrous material. After this spreading, spraying, and dusting, the tow was pulled back to its original shape of a cord and fed into a conventional cigarette make-up machine which formed it cylindrically, wrapped it with paper, and cut it into rods 78 mm. in length and 8 mm. in diameter. The rods had the approximate composition of 25% flour, 14% plasticizer and 61% cellulose acetate by weight. The filter rods were then given a heat treatment for one hour at 80° C. to cause partial solvation of the acetate fibers by the plasticizer and thereby bond the flour particles to the fibers and the fibers to each other; imparting firmness to the rods. Thereupon the rods were readily cut into 13 mm. filter tip lengths and attached to king-size cigarettes of a standard brand available on the retail market in the U.S. The cigarettes were first shortened by 13 mm. and the rods affixed to the remainder by means of an adhesive tape. These filter cigarettes were smoked to a total butt length of 35 mm. 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 smoke which passed through the cigarettes was collected and analyzed for nicotine and tar content.

Control filters without a powdered additive were also prepared from the same cellulose acetate yarn containing the same amount of plasticizer. These filters were attached to the same brand of standard king size cigarettes shortened by 13 mm. These cigarettes were also smoked to a total butt length of 35 mm. by means of the smoking machine. The smoke which passed through the cigarettes was collected and analyzed for nicotine and tar content.

Ten unfiltered king size cigarettes which were not shortened by 13 mm. were smoked to a butt length of 35 mm. by means of the smoking machine. The smoke which passed through the cigarettes was collected and analyzed for nicotine and tar content.

The results obtained from the three sets of cigarettes are listed in Table I.

Table I

	Average Pressure Drop [1]	mg. Tars Found in the Smoke	mg. Nicotine Found in the Smoke
Cigarettes without filters	3.5	163	25
Cigarettes with cellulose acetate filters	4.0	148	23
Cigarettes with cellulose acetate—wheat flour filters	4.2	100	15

[1] Pressure drop in inches of water at an air flow rate of 17.5 cc./sec.

From the results listed above it can be seen that the filter containing the combination of acetate fibers and wheat flour reduced the amount of tar collected by 38.5% and the amount of nicotine collected by 40%. The control filter reduced the amount of tars collected by 9.2% and the amount of nicotine collected by 8%. The increase in pressure drop of the filtered cigarette due to the addition of the flour to the filter was only about 5%.

EXAMPLE 2.—LOSS OF ADDITIVE BY SIFTING OUT

In order to determine how firmly the wheat flour adheres to the fibers in the finished filter plug, a series of crimped cellulose acetate tow fibers containing various powders was prepared according to the procedure described in Example 1. The cellulose acetate tow employed was identical to that described in Example 1 and contained the same kind and amount of plasticizer sprayed on its surface. The types and amounts of powders incorporated into the filter plugs are listed in the table below. The degree to which the powders adhered to the 78-mm. filter plugs was determined by dropping a plug in a vertical position a distance of 12 inches onto a smooth glass surface. The plug was considered to resist sifting out of the powder if no visible amount of

powder appeared on the glass surface after the plug was dropped six times in succession. The results of this "drop test" are also listed on the table below.

Type and Amount of Powdered Additive in the Plug	Results of the 12" Drop Test
Activated silica gel, 325 mesh, 22%	Trace of powder after 1st drop.
Activated aluminum oxide, 325 mesh, 20%	Do.
Activated charcoal, 250 mesh, 18%	Do.
Talc, 325 mesh, 20%	Do.
Calcium carbonate, 325 mesh, 21%	Do.
Titanium oxide, 325 mesh, 15%	Do.
Wood flour, 250 mesh, 23%	Trace of powder after 2nd drop.
Cellulose powder, 200 mesh, 25%	Trace of powder after 3rd drop.
Dextrin, 250 mesh, 20%	Do.
Potato starch, 200 mesh, 21%	Do.
Rice starch, 325 mesh, 18%	Trace of powder after 4th drop.
Wheat starch, 300 mesh, 20%	Do.
Wheat flour, 325 mesh, 25%	Trace of powder after 10th drop.

In carrying out the operation of this invention, the type of wheat flour employed is not a critical factor. Rather, the form of the flour is more important. The flour should be in a finely powdered form so that it can be readily slurried in a liquid or passed through a spraying nozzle. While the exact size of the particles does not appear to be critical, it is indicated that the flour additive should be capable of passing through a 200 mesh screen and probably should be no finer than 500 mesh. Advantageously, a flour is used which has at least 80% of its particles of a diameter less than the diameter of the fibers of the filter. No substantial number of particles should be as large as twice the filament diameter or as small as one-tenth the filament diameter. Any source of flour which passes this requirement can be employed. Such commercial types of wheat flour as bleached, unbleached, whole-wheat, whole bran, self-rising and the like may be employed.

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. di-(methoxyethyl)phthalate 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 such fibers for example, of viscose, cotton, nylon, polyamides, polyesters, particularly where the fibers are in substantial longitudinal alignment and are coextensive with the body of the filter. It is preferred to use for filter preparation in accordance with the present invention a continuous strand, e.g. tow, of 4,000 to 35,000 filaments, the filaments being of 16 to 3 denier and having about 4 to 10 crimps per inch.

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. Surface solvation bonds between fibers are sometimes also referred to as "fused" or "welded" bonds.

It is to be noted that while the filters of the present invention seem to derive special benefits from the properties and behavior of wheat flour itself, yet the invention, in essence, appears to be dependent upon the structural character of the filter. In this regard, the more important structural factors found in the most advantageous form of the invention seem to be:

(1) That the aligned filaments be randomly bonded at

randomly spaced intervals. This may be achieved by spraying a solvent type of plasticizer onto a spread tow of synthetic thermoplastic filaments as described above. It also may be accomplished by use of a filament strand in which at least some of the filaments contain sufficient plasticizer to be softened at slightly elevated temperatures.

(2) That the filament bonds be formed by coalescence of the surface solvation type. In other words, no material should be employed for adhering the filaments which would coat, destroy or otherwise substantially interfere with the integrity of the wheat flour particles. Obviously no plasticizer should be employed which has a solvent or softening action on the flour particles. Bonds formed by coalescence of the surface solvation type also may be attained through the use of filaments spun with a suitable plasticizer content.

(3) That substantially all the flour particles be carried on the surfaces of the filaments, supported by the filaments, and substantially immobile with respect thereto. This structure is best accomplished by softening of portions of the filament surfaces whereby the particles may be slightly embedded therein without being coated or covered. It is also most easily accomplished when the diameters of the particles are not too different from the diameters of the filaments, the major portion of the particles being, for instance, less than twice the filament diameter, but more than one-tenth of the filament diameter.

I claim:

1. A tobacco smoke filtering element made up of a bundle of co-extensive filaments in which all of the filaments are generally longitudinally oriented in said bundle, the filaments making up the bundle being characterized in that said filaments:

a. Comprise approximately 12,000 filaments of cellulose acetate having an acetyl content of 39.2% and a denier of 5 per filament;

b. Are continuous filaments having about 8 crimps per inch;

c. Carry a content of plasticizer from the group consisting of di(methoxyethyl)phthalate or methylphthalylethylglycolate and also a content of wheat flour of 325 mesh bound to said filaments by means of said plasticizer so as to resist sifting out;

said bundle being characterized in that certain of the coextensive filaments by means of the plasticizer are coalesced to other co-extensive filaments within the bundle at randomly spaced intervals to give a filter element having the approximate composition by weight of 61% cellulose acetate, 25% flour and 14% plasticizer, said filter being pervious along its longitudinal axis.

2. A tobacco smoke filtering element made up of a bundle of co-extensive filaments in which all of the filaments are generally longitudinally oriented in said bundle, the filaments making up the bundle being characterized in that said filaments:

a. Are of cellulose acetate;

b. Are of crimped continuous filaments;

c. Carry a content of plasticizer and finely-divided wheat flour particles in which at least 80% of the particles are of a diameter less than the diameter of the filaments, said flour being bound to said plasticizer so as to resist sifting out;

said bundle being characterized in that certain of the coextensive filaments within the bundle are coalesced to other coextensive filaments at randomly spaced intervals, said filter being pervious along its longitudinal axis.

3. A tobacco smoke filtering element made up of a bundle of co-extensive filaments in which all of the filaments are generally longitudinally oriented in said bundle,

the filaments making up the bundle being characterized in that said filaments:

a. Are of cellulose acetate;

b. Are of crimped continuous filaments;

c. Carry a plasticizer and 5–30% by weight of finely-divided wheat flour of particle size within the range of 200–500 mesh;

said bundle being characterized in that certain of the coextensive filaments by means of the plasticizer are coalesced to other coextensive filaments within the bundle at randomly spaced intervals, said filter being pervious along its longitudinal axis.

4. A tobacco smoke filtering element made up of a bundle of co-extensive filaments in which all of the filaments are generally longitudinally oriented in said bundle, the filaments making up the bundle being characterized in that said filaments:

a. Are of thermoplastic filaments which are continuous and crimped;

b. Carry a content of plasticizer and of finely-divided wheat flour attached to said filaments in a manner whereby the flour resists sifting out;

said bundle being characterized in that certain of the coextensive filaments within the bundle coalesced to other

coextensive filaments at randomly spaced intervals, said filter being pervious along its longitudinal axis.

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CERTIFICATE OF CORRECTION

Patent No. 2,917,054 December 15, 1959

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 59, for "corresponding" read -- compressed--; column 7, line 27, for "bundle coalesced" read -- bundle are coalesced --.

Signed and sealed this 21st day of June 1960.

(SEAL)
Attest:
KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents