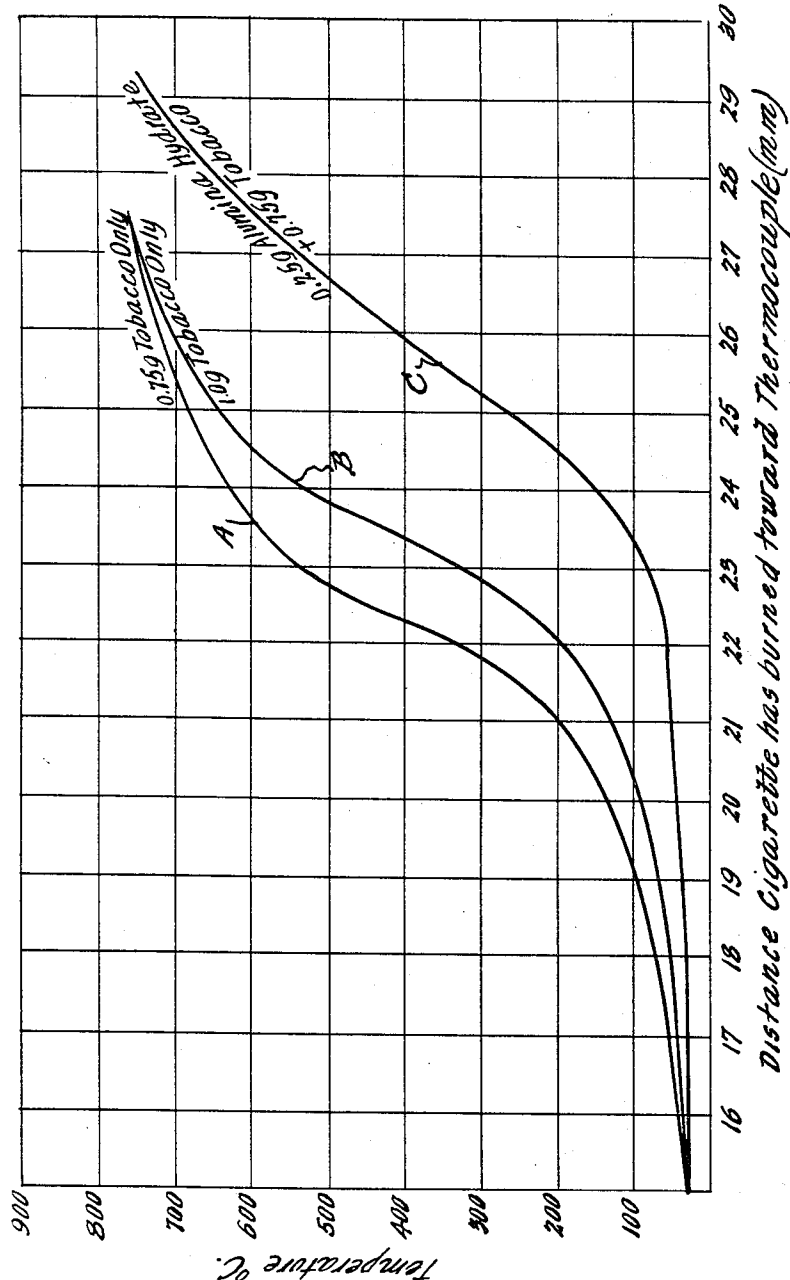
Nov. 12, 1968 B. F. ARMBRUST, JR., ET AL 3,410,276

TOBACCO COMPOSITION

Filed July 28, 1965



INVENTORS

Bernard F. Armbrust, Jr.
Val G. Carithers,

BY Glenn, Palmer & Matthews
ATTORNEYS

United States Patent Office 3,410,276
Patented Nov. 12, 1968

3,410,276

TOBACCO COMPOSITION

Bernard F. Armbrust, Jr., Benton, and Val G. Carithers, Little Rock, Ark., assignors to Reynolds Metals Company, Richmond, Va., a corporation of Delaware

Continuation-in-part of abandoned application Ser. No. 372,305, June 3, 1964. This application July 28, 1965, Ser. No. 475,331
9 Claims. (Cl. 131—9)

ABSTRACT OF THE DISCLOSURE

Tobacco is mixed with about 5 to 35 percent by weight of a shredded sheet material made of a temperature control substance (such as alumina hydrate), a fibrous matrix material such as asbestos, and a vegetable gum binder (such as guar gum). The additive has a lowering influence on peak temperature and firms the ash when the tobacco is smoked. The shredded sheet may have rough exposed surfaces providing internal filtration of the smoke.

This application is a continuation-in-part of copending application Ser. No. 372,305, filed June 3, 1964, now abandoned.

This invention relates to novel cigarette and smoking tobacco having incorporated therein a combustion temperature control material in the form of a shredded sheet. More particularly, the invention concerns cigarettes and tobacco products incorporating said novel tobacco, which upon smoking, reduces the formation of harmful substances while improving the smoking flavor thereof.

During the past several years, there has been extensive discussion in medical and public health circles concerning the alleged carcinogenic and other harmful effects of cigaretees and other smokers' articles. This discussion has recently been supplemented by the report of the Surgeon General of the United States, confirming that statistical evidence tends to show a higher incidence of throat cancer and lung cancer in the case of smokers, and especially cigarette smokers, than is true of non-smokers. These carcinogenic effects are usually ascribed to the presence in cigarette smoke of certain polycyclic aromatic hydrocarbon compounds containing fused ring structures. Experimental studies have indicated that the carcincogenic compounds resulting from tobacco pyrolysis are formed chiefly at temperatures above about 800° C. Below about 700° C., relatively small amounts are formed, and at about 600° C. and below, no aromatic polycyclic compounds are found in the pyrolysis products.

It is known that the smoking process is a complicated one and includes both pyrolysis and combustion, and that in every material pyrolyzed, whether tobacco or paper, there is a temperature at which the maximum amount of polycyclic compound is formed, so that as temperature increases, the formation of polycyclic compounds increases up to a certain point, after which the formation decreases. Some of the pyrolytic products which formed during the combustion process are subsequently burned in situ after being formed, a result which is influenced to some extent by the peak temperatures reached, but the net presence of harmful substances in the smoke is the result of the total smoking process and not the result of peak temperatures alone. Thus there is presented the possibility of incorporating in the tobacco a substance by means of which the rate of combustion of the tobacco can be controlled with concomitant lowering of distillation temperature and perhaps some catalytic response

from the nature of the substance. There also might be produced simultaneously polycyclic aromatic compounds which are known to exert an anticarcinogentic action on known carcinogenic polycyclic compounds of similar chemical structure. Thus, the tendency toward formation of harmful products in the smoke can be favorably influenced.

Methods have been proposed in the prior art, whereby there are added to tobacco in order to influence its combustion temperature characteristics, the oxides, hydroxides, and carbonates of alkaline earth metals, or of magnesium, or of aluminum. Of these additives, the most efficient appears to be aluminum oxide, particularly in the form of its various hydrates. The hydrates of aluminum oxide, such as, for example, alumina trihydrate and bauxites which contain up to 75% or more alumina hydrates, are capable of releasing their united water at temperatures starting at about 150° C., and it has been proposed to utilize this characteristic by incorporating in tobacco such alumina hydrates and activated aluminas containing adsorbed water, as disclosed, for example in Patents 3,106,-210 and 3,106,211. These aluminas are all nontoxic and relatively stable under ordinary conditions of temperature and humidity. They all contain definite amounts of sorbed or combined water which are readily releasable when the aluminas are exposed to heat. In Patent 3,106,210 there is further disclosed a fluffy form of alumina or bauxite wherein the finely divided material is admixed with a vegetable or synthetic gum binder to promote adhesion of the alumina particles to each other.

Among the requirements for a material of this temperature control type is that the alumina and/or other substance be distributed among the tobacco particles so intimately and uniformly that the temperature of the mixture is uniformly and effectively controlled during smoking and that it will produce a strong ash from which the alumina and/or other additive will not seperate to an objectionable degree during the smoking process. Finely divided alumina has the tendency to segregate from its admixture with the tobacco, settling to the bottom of the cigarette, causing uneven burning. In addition, the powdery aditives tend to sift out of the cigarette when it is handled an especially when it is tapped. Most importantly, a coherent ash is not formed, but instead the ash tends to flow off. This can, of course, largely nullify the effectiveness and the acceptability of a finely divided additive.

In accordance with the present invention, the aforementioned disadvantages of segregation of the additive from the tobacco and the undesirable flow of ash, are avoided by incorporating a novel combustion control additive with the tobacco in a wholly novel manner.

In accordance with the invention, there is employed for incorporation with the tobacco a shredded sheet which may be processed like the leaf tobacco in most steps in tobacco and cigarette manufacture. The shredded sheet additive of the invention comprises a temperature control substance, a fibrous matrix, and a small amount of organic binder. This sheet and its preparation are described in copending application Ser. No. 372,369, filed June 3, 1964.

The temperature control substance employed as a component of the shredded sheet additive of the invention is selected so as to be more or less effective in cooling to enhance taste and other desired characteristics of the burning cigarette. Among the more effective cooling agents are those compounds which have large proportions of hydration or of volatile nontoxic anions, such as carbonates or which possess large heat demand for phase transformations. These compounds must, of course, not be inimical to flavor nor must they generate obnoxious or undesirable fumes when exposed to temperatures up to 800° C. The greatest heat demand should be preferably

in the range 200° to 600° C. in order to cool the critical destructive distillation zone of the cigarette most effectively.

The temperature control substance selected in accordance with the invention may thus include an oxide, hydroxide, or carbonate, or a hydrated form thereof, of an alkaline earth metal, or of magnesium, or of aluminum or other cation which is nonvolatile under the burning conditions. There may also be employed hydrated minerals capable of giving off their contained water upon heating, such as various clays.

These temperature control substances are prepared in sheet form by admixing a major proportion of a temperature control substance of the character described with a minor proportion of a fibrous matrix material, and a small amount of a binder. The dry mixture is made into a viscous slurry with water, and the slurry is placed on an impervious, chemically inert and nonadherent surface provided with a retaining edge, dried, and the resulting sheet is stripped off.

The preferred temperature control substance, in accordance with the invention, is a hydrate of alumina which is capable of releasing its sorbed or combined water upon heating. Thus, there may be employed the crystalline hydrates of alumina represented by the formulas $Al_2O_3.3H_2O$ or $Al(OH)_3$. These are dry, free-flowing white crystalline products available in abundance from the Bayer, or Bayer-sinter process. The combined water is releasable on heating starting at about 150° C. Instead of hydrated alumina, there may be employed activated alumina, which is defined as essentially a mixture of various transition phases of aluminum oxide, such as gamma, eta, and the like, usually with boehmite ($Al_2O_3.H_2O$). Activated alumina is a material having a large surface area per unit of weight, and a highly porous structure. It is produced by heating alumina hydrate to a temperature sufficient to drive off the great preponderance of combined water. It is capable of adsorbing from about 16% to about 20% of additional moisture, depending upon the relative humidity of the atmosphere to which it is exposed. The adsorbed moisture is readily and rapidly releasable at the elevated temperature which occurs in the burning of a cigarette. As an alternative to activated alumina, there can also be employed activated bauxite, which is prepared from bauxite aluminum ore in a manner similar to that by which activated alumina is prepared from alumina hydrate, and it has similar properties.

Activated alumina has the additional advantage of being an adsorbent like carbon for volatile compounds other than water. It can thus selectively trap components of smoke capable of entering its pores. Its use as a catalyst or catalyst base is well known, thereby providing yet another modifier of the components of cigarette smoke. It should be further noted that the alumina trihydrates convert to activated alumina in the course of exposure to heat, thus combining the greater cooling power of the trihydrate with many of the benefits of activated alumina.

In addition to the foregoing advantages, alumina and alumina hydrates possess another outstanding advantage as additives to smoking tobacco, which is wholly surprising and unexpected. This is the ability of these substances to reduce to a very low level in the gaseous combustion products of the tobacco, radioactive elements of the type which emit alpha radiation, such as polonium. It has been known for some time that tobacco leaves contain minute amounts of the element polonium-210, an alpha-emitting radioactive element, which vaporizes at about 500° C., or substantially below the combustion temperature of a cigarette, which is in the range 800° to 900° C. The element polonium (Po) possesses 24 isotopes, ranging in mass from 197 to 218, all of which are radioactive. The most common form is Po^{210} which has a half-life of 138.4 days. Polonium is capable of being adsorbed strongly and rapidly on smoke particles, leading to the current belief that polonium in cigarette smoke may act as an important initiator in the development of lung cancer. Polonium as an alpha radiation emitter is considered very hazardous, presenting a definite inhalation danger as a potential lung carcinogen in an insoluble form of appropriate particle size, approximately 1 micron. Published data (Science, vol. 143, page 247), have shown that a forty cigarette a day smoker may develop localized polonium-210 concentration of up to 1000 rem in various regions of the bronchial tree over a 25 year period. Dosages of 1300 rem over a 25 year period can cause lung carcinoma. A rem is a measure of the radiation damage done to living tissue and is dependent on the concentration and disintegration rate of the radioactive element as well as the energy of the emitted particles. Thus, the literature indicates that for polonium-210, 0.033 picocuries per square centimeter dosage would be equivalent to 165 rem over a 25 year period.

As shown in the test data of Table 4, below, the inclusion of alumina as an additive in cigarettes reduced the polonium in the smoke from cigarettes that would be taken into the lungs by about 40%. Thus, localized concentrations of the polonium due to smoke from cigarettes containing the alumina additive of the invention would be reduced to a value well below the 1300 rem considered to be dangerous for persons smoking two packs of cigarettes a day.

The fibrous matrix material is composed of inorganic fibers, examples of which include asbestos, or a ceramic fiber made from alumina and silica sold under the designation "Fiberfrax" (Carborundum Co., Niagara Falls, N.Y.), or glass wool. The fiber must be "opened up" and dispersed before use. Asbestos, for example, comprises fibers closely stacked together, and these must be separated, for example, by dry or wet hammermill separation. For maximum effectiveness, the fibers must be treated so that they are reasonably separate with sufficiently rough or fibrilated surfaces to make a satisfactory bond (aided by a binder) with each other and with the temperature control substance to give good sheet strength.

The fibers should also not be so long as to be difficult to control with a doctor blade in feeding the slurry into which they are subsequently formed onto the drying belt or other device. The fibers should not be so short as to be incapable of effective bonding. In general, a length of about ¼" to about ½" is satisfactory.

Where asbestos is employed, it is preferably a hydrous magnesium silicate of the tubular fiber type, an example of which is chrysotile asbestos, having the approximate formula $3MgO.2SiO_2$. This material has a fibrous crystal structure and a silky luster, is white in color, and exhibits very good tensile strength. There may also be employed crocidolite type asbestos, which is a complex sodium-iron silicate, also possessing high tensile strength, and a lavender color.

The organic binder may be a natural or synthetic gum, the term as employed herein including, for example, vegetable gums, such as gum arabic, gum tragacanth, and other water soluble gums, which consist largely of carbohydrates and are hydrophilic colloids. There may also be employed synthetic gums, such as dextrin, and various cellulose ethers, such as, for example, methylcellulose or hydroxypropylcellulose. These are obtainable in aqueous solution, the methylcellulose solution having a viscosity of about 4000 centipoises, while the solution of the hydroxypropylcellulose has a viscosity of about 15,000 centipoises.

Where a vegetable gum is employed as a binder for the temperature control substance in the sheet of the invention, it is preferably a polysaccharide type, such as, for example, guar gum, derived from the seeds of *Cyamopsis tetragonobolus,* which exhibits a high degree of water dispersibility and thickening power. Thus, there can be

employed the product sold under the designation Burtonite No. 78 (The Burtonite Company, Nutley, N.J.).

A small amount of a plasticizer, namely from about 1% to about 5% by weight, is advantageously incorporated in the temperature control substance sheet mixture to improve sheet flexibility. The plasticizer is advantageously a polyhydric alcohol, such as, for example, glycerol, or a glycol, such as ethylene glycol or propylene glycol.

The foregoing ingredients are preferably employed in the following proportions:

	Percent by weight
Temperature control substance, e.g., alumina trihydrate	75–95
Fibrous matrix material	3–15
Vegetable gum binder	1–5
Plasticizer	1–5

These ingredients are admixed with water in an amount from about 5 to about 20 times by weight of total solids, made into a viscous slurry in any suitable type of mixer and dried at a temperature below that at which the temperature control substance begins to release its own water. Some fibrous materials are improved in effectiveness by vigorous shearing action to fibrillate them, as in a blender, Jordan, etc. Some gums require heat and agitation to dissolve, but heat degradation should be avoided.

A preferred composition for the sheet of the invention is, by weight:

	Percent
Alumina trihydrate	85.0
Asbestos	8.5
Guar gum	4.2
Plasticizer	2.3

The particle size of the temperature control substance is not critical, but particles should preferably be finer than 325 mesh to avoid rough surfaces that tend to powder and that make the sheet less strong. Thus, where alumina trihydrate is employed, the average particle size may be about 25 microns.

Some of the combustion control substances disclosed are normally white or nearly white in color, and thus may present some difficulty with respect to inconspicuous blending into the tobacco. It has been found that this difficulty may be overcome by incorporating in the control substance an inorganic or organic dye compound which will stain the sheet product any desired yellow to brown tint. Thus, ferric hydroxide obtainable, for example, by reacting ferric ammonium oxalate with ammonium hydroxide may be added to the alumina-asbestos-binder-plasticizer slurry in the amount desired to produce the required color in the dried sheet made therefrom.

The finished alumina fibrous matrix thin sheet containing a binder is quite flexible, but the small amounts of glycerine or other plasticizing materials serve to increase the flexibility.

There are two types of sheet useful in this invention.

The first type sheet, which contains asbestos fiber, evidences reduction in tar of smoke plus temperature control of the critical distillation zone. The surface of the sheet is rough with asbestos fibers exposed and these provide internal filtration. Sheet with asbestos fiber also makes a stronger ash than sheet with other fibers.

The first type sheet is somewhat weak so that it can be broken up in regular tobacco cutters and handling apparatus to a satisfactory length for a good ash. It, therefore, can be fed in 2–3" strips directly to the tobacco leaves any place before the cutters.

The second type sheet reduces the temperature without tar reduction (no internal filtration). This sheet is produced from the same raw materials and in a similar manner to the first type sheet but generally using more concentrated and viscous slurry and removing the sheet without scraping from the drying surface. The sheet therefore is smooth on both surfaces and exposes very little asbestos fiber.

The second type sheet is generally stronger and, before mixing with tobacco, should be broken into shreds and pieces not exceeding ¾" in length to avoid a rough-looking ash from long shreds.

The second type sheet with asbestos fiber can be converted to provide internal filtration and tar reduction like the first type sheet by beating the second type sheet sufficiently to expose the asbestos fibers in the sheet. The shreds and pieces, of course, will be somewhat smaller than the broken pieces of the second type sheet that would not have internal filtration.

The temperature control substance sheet is admixed with the tobacco in a proportion ranging from about 5% to about 35% by weight of the tobacco, preferably about 10% to 25%.

The sheet may be mixed with either regular tobacco or with reconstituted tobacco. For the purposes of this invention the term reconstituted tobacco refers to tobacco particles or sheet prepared either from regular tobacco or from waste fines, field scrap (farm damaged leaves), stems and dust, which are customarily cut or comminuted and formed into sheets and afterward converted to filaments by shredding, or into strips, for the preparation of cigars, cigarettes, and the like.

Suitable flavoring materials, humectants, and the like, may be admixed with the control substance as well as with the tobacco itself.

The following examples illustrate the practice of the invention, but are not to be regarded as limiting.

Example 1.—Internal filtering sheet

20 grams of alumina trihydrate having a fineness such that approximately 90% is minus 325 mesh, and averaging about 25 microns in diameter, is admixed with 2 grams of chrysotile asbestos fibers, 1 ml. of glycerol and 1 gram of guar gum binder (Burtonite No. 78). The mixture is made into a viscous slurry with 300 ml. water. The slurry is spread on a sheet of polytetrafluoroethylene (Teflon) plastic provided with retaining edges, and placed in an oven at 100° C. until dry. The sheet is stripped off and cut into shreds like cigarette tobacco.

The shredded particles are admixed in a blender with tobacco in the proportion of 0.25 grams of sheet per 0.75 grams of tobacco, to yield a mixture which is combustible, and this mixture was made into cigarettes.

Example 2

Proceeding as in Example 1, a sheet was prepared from the following ingredients:

Alumina trihydrate	grams	20
Glass wool	do	2
Burtonite–78	do	1
Glycerol	do	0.5
Water	ml	100

This sheet was shredded and admixed with tobacco in the proportion of 0.25 gram sheet to 0.75 gram tobacco.

Example 3

2000 lbs. of an aqueous slurry of alumina hydrate, asbestos and guar gum containing about 10% solids were prepared from:

	Parts by weight
Water	89
Alumina trihydrate	10
Asbestos	1
Guar gum	0.5
Glycerol	0.25

31% formaldehyde preservative, 6 cc. per gallon of slurry.

All dry components, alumina, asbestos and guar gum, vere dry ground in a hammer mill prior to mixing with hot water to improve the casting and sheet forming characteristics of the slurry. The slurry was made into a sheet by feeding evenly onto a polished steel conveyor belt with a steam chest on the underside for drying; or by passage through a hot air furnace for drying.

Example 4

These are examples of common fillers that may be used with the asbestos matrix.

(1) A stock matrix slurry was prepared by blending two minutes in an Oster blender (a) 6 grams chrysotile asbestos, (b) 3 grams Burtonite No. 78 Guar gum, (c) 1.8 grams glycerol, (d) 1000 milliliters distilled water.

(2) To 250 milliliters of above matrix slurry were added respectively: (a) talc, 15 grams (b) kaolin clay, 15 grams, and (c) ferric hydroxide, 15 grams (d) silicic acid in the amount of 15 grams. Each slurry was then blended in the Oster blender. The four slurries were then cast on Teflon sheets and dried at 105° C. in an electric oven until dry. The sheets were removed after drying and examined; the sheets were typical, pliable and acceptable.

The novel tobacco additive temperature control sheet of the invention produces many unexpected and advantageous effects. In the following discussion, cigarettes made with a tobacco filler containing 23% by weight of the preferred alumina trihydrate-asbestos-guar gum sheet of the invention will serve for purposes of illustration.

The most important advantage obtained in incorporating the shredded sheet in the tobacco lies in a reduction of between 100° and 200° C. in the average prevailing temperature in the critical distillation zone of cigarettes containing the sheet as compared with those which do not. This reduction effect is observed both in filter and nonfilter types of cigarettes. The following table shows these average smoking temperatures for various types of cigarettes made in factory machines and the temperature differences obtained with and without the sheet additive. The sheet additive has little apparent effect on the peak burning temperatures, which were about 850° C. for all the cigarettes.

TABLE 1

Type of Cigarette	Average Active Zone Temperature, ° C.	Temperature Difference, ° C.
Control, no filter	595	
Sheet, no filter	480	115
Control filter	625	
Sheet filter	425	200

This temperature reduction effect is attributable to the high heat demand of the alumina trihydrate, which is about 900 B.t.u. per pound. Liberation of the water of hydration occurs at 250°–600° C., within the critical pyrolytic range.

Another favorable effect arising from the use of the sheet additive of the invention lies in an improvement in the chemical composition of the smoke. The following table indicates that the chemical composition of the smoke has been appreciably altered, particularly in the important basic and neutral fractions.

TABLE 2.—ANALYSIS OF FRACTIONS IN SMOKE

[Percent of Fraction in Tar]

Type of Cigarette	Insoluble	Basic	Strong Acid	Weak Acid	Neutral
Control, no filter	5.1	39.4	9.6	14.0	31.9
Sheet, no filter	5.7	48.4	8.2	13.9	23.8
Control filter	5.8	36.0	8.6	18.0	31.7
Sheet filter	8.3	49.5	7.2	12.4	22.7

With reference to Table 2, the polycyclic hydrocarbons, which would include the carcinogens, are mainly in the neutral fraction which showed a 26% decrease in the smoke from the alumina sheet cigarettes.

The change in chemical character of the smoke may be partly attributed to the fact that the alumina dehydrates to a highly porous and activated form (gamma and eta phases) during the heating, thus providing a possible catalytic action on the chemical reactions taking place during pyrolysis, and partly to chilling, condensing, adsorption and internal filtration effects that profoundly alter conditions in the critical distillation zones of the cigarette, and also permit the more rapidly condensed fractions to be re-exposed more times to the peak burning temperature.

Thus the presence of increased moisture and cooler average temperature during pyrolysis, coupled with the possible adsorptive and catalytic action of the activated alumina is conducive to the formation of different pyrolytic products. Such changes are evident in Table 2. Despite these changes there is still a satisfying taste.

Another important advantage of the alumina sheet lies in the fact that the rough-surface shredded sheet in admixture with the tobacco acts as an internal filter in the cigarette. Thus it provides not only thermal control and improvement of chemical composition of the smoke from the standpoint of carcinogens, but by acting as a filter, the rough-surface shredded sheet provides a measure of control of tar passing through. As explained previously, the internal filtration is obtained by a rough surface on the sheet which may be produced as such, or the surface may be made rough by hammer milling or breaking in a double cone mixer with intensifier bar. The rougher the sheet surface the more effective is the filtering action. The presence of fines in addition to the twisted shreds, to get into the interstices and exert a blocking action on the flow, increases internal filtration. This is accomplished, for example by longer conditioning of the sheet as formed by treatment in the hammer mill or double cone mixer with intensifier bar.

These internal filtration effects are illustrated in the following table, which shows test results per cigarette made in factory machines in terms of changes in tar, nicotine, ash, and air flow rates, with and without the additive.

TABLE 3.—TAR AND NICOTINE CONTENT OF SMOKE

Type of Cigarette	Wt. in gms.	Wt. of ash, mgs.	No. puffs	Tar, mg.	Nicotine, mgs.	Air flow rate, cc./sec.
Control, no filter	1.18	119	10.1	25.8	2.4	22.5
Sheet, no filter	1.26	266	11.9	13.1	1.1	12.6
Control filter	1.07	99	8.9	18.8	1.5	12.7
Sheet filter	1.11	211	10.2	10.9	0.8	10.1

In the foregoing table, the measurements of number of puffs, tar and nicotine were made at a standard smoking rate of 35 cc./2 sec., once a minute, to a butt of 26 mm. for filter cigarettes, and of 24 mm. for plain ends. Air flow was measured in cc./sec. under 2% inch water draw.

The internal filtration effect of the shredded sheet is indicated by the average reduction of about 45% in tar and 50% in nicotine as compared with cigarettes using plain tobacco.

In terms of comparative mildness, the mildest was the cigarette employing both sheet and filter, while the next mildest was the cigarette employing sheet and no filter. The standard filter and non-filter cigarettes were respectively, next harshest. Thus the additive of the invention can be employed in an amount sufficient to produce the necessary thermal control, while producing a mild satisfying flavor and a reduction in tar and nicotine as great as that of an ordinary filter. Of course, a conventional filter could also be employed to further decrease tar and nicotine to new low levels, but it alone cannot provide

the complex internal filtration effect of the present invention.

Another advantage in the use of the additive of the invention lies in the fact that the combined water in the alumina, about 10% of dry tobacco weight, cannot be lost in storage. It is present to increase the moisture in the smoke, thereby reducing the effect of any loss of free moisture of the tobacco prior to use. Normally there is a drying out of the tobacco in the cigarettes on prolonged storage, regardless of type of packaging. This greatly increases the tar and nicotine developed in the smoke. The shredded sheet provides excess water in a combined storage-stable form which is available for thermal control and humidification when the dried out cigarette is burned. The water of hydration helps compensate, during smoking, for any moisture previously lost from the tobacco. The additive permits a net reduction of the amount of tobacco present, but without detriment to smoking satisfaction.

As indicated previously, the alumina present in the tobacco additive of the invention acts to reduce by some 35% to 40% the polonium contaminants in the mainstream smoke. This is demonstrated by comparative tests conducted on cigarettes with and without the alumina additive, the latter serving as controls, the cigarettes being both with and without filters. Tobacco and smoke samples were analyzed for polonium-210, smoking two samples of each of the mentioned types of cigarettes. The results are set forth in the following table.

TABLE 4.—POLONIUM-210 IN CIGARETTE SMOKE

[Unit: Picocuries per cigarette]

Type of Cigarette	Mainstream	Side Stream	Butt	Ash	Tobacco
Control, no filter	0.130	0.140	0.10	0.051	0.49
Sheet, no filter	0.076	0.110	0.14	0.043	0.37
Control filter	0.067	0.130	0.096	0.041	0.38
Sheet filter	0.043	0.089	0.072	0.045	0.28

The results indicate that the Po^{210} content of mainstream (inhaled) smoke from cigarettes with alumina sheet was about 40% less than that from control cigarettes.

In order to determine the burning characteristics of the tobacco mixtures with the additive sheet shreds of the invention, tests were carried out on a conventional smoking machine of a type designed to simulate cigarette puffs at spaced time intervals.

Several series of the cigarettes each were prepared, and tested in the smoking machine employing a thin thermocouple drawn through the center of the cigarette at a distance of 30 mm. from the burning end of the cigarette. The machinery was adjusted for standard smoking conditions to take one 35 cc. puff per minute for a period of two seconds duration for each puff.

The tested series were as follows:

A. Per cigarette: 0.75 gram tobacco; no additive;
B. Per cigarette: 1.0 gram tobacco; no additive;
C. Per cigarette: 0.75 gram tobacco plus 0.25 gram of alumina hydrate-asbestos sheet.

The accompanying drawing shows a set of curves comparing temperature in degrees centigrade with the distance the cigarette has burned from the original lit end to the point at which the thermocouple was inserted, 30 mm. from the original end. The curves indicate that, for a given distance burned, the temperature at the point where the thermocouple is placed, averages considerably lower for the cigarette made with alumina-hydrate-asbestos sheet material of the invention. The ash, moreover, remains firm. Thus, the cigarette of the invention provides a good ash, a much lower temperature in the distillation and destructive distillation zone, and a greatly lengthened time of burning or smoking, as compared with an untreated cigarette. This greatly lengthened burning rate may be seen from the curves of the accompanying drawing. Thus, the cigarette containing 1 gram of tobacco with no additive burned at the rate of 4.37 mm. per minute, while the cigarette containing 0.75 gram tobacco burned at the rate of 6.55 mm. per minute. In contrast thereto, the cigarette containing 0.75 gram of tobacco and 0.25 gram of temperature control substance of the invention burned at the rate of only 3.55 mm. per. minute.

As indicated previously, there can be employed, in accordance with the invention, a non-filtering type of shredded sheet, which gives the same temperature reduction and mildness of smoke as the internal filtering sheet, but no substantial reduction in tar and nicotine content of the smoke. Nevertheless, the non-filtering sheet effects an equal reduction in distillation zone temperatures, provides a mellowed smoke and prolongs smoking time. It is also possible, in accordance with the invention, to convert the non-filtering type of sheet to the internal filtering type of sheet, if desired, as explained previously, so that there is present the advantage of having to produce initially only one type of base sheet. In both cases, however, asbestos is the material of choice, since it provides a stronger sheet and ash.

The following example shows the preparation of the nonfiltering type of sheet, using asbestos.

Example 5.—Non-filtering type sheet

2.75 lbs. of grade 3K700 chrysotile asbestos and 2.75 lbs. grade 4A700 chrysotile asbestos were placed in a 3 cu. ft. Patterson-Kelley twin shell blender and blended for 15 minutes with intensifier bar at 2510 r.p.m. and shell speed 25 r.p.m. There were then added to the blender contents 3 lbs. Burtonite No. 78 guar gum and 50 lbs. of alumina hydrate of minus 325 mesh particle size, and the entire mixture blended for 5 minutes. The dry discharge from the blender was fed to a high speed, multi-hammer, hammer mill, equipped with a ½ inch screen. Nine batches of the discharged dry mix was slurried in 4100 lbs. water at 180° F. containing 15 lbs. glycerine. The slurry was vigorously agitated 30–60 minutes. If desired, the dry mix may be slurried in water at ambient temperature and allowed to remain at ambient temperature. Mixing time varied, up to 5 hours, according to which temperature is used. The slurry properties were: viscosity about 4,000 cps. (Brookfield No. 4 spindle at 12 r.p.m.) at 160° F. or about 6,500 cps. at 100° F., density 1.0–1.2 grams per cc., solids content 10.8%.

The slurry was spread on a continuous stainless steel conveyor belt 48 inches wide by a suitable feeder doctor blade arrangement to give a film of the slurry 37–40 mils thick and 44–45 inches wide. The belt was then heated on the underside with steam until the slurry was evaporated to dryness. Drying required about 2.5–3.0 minutes at 230° F. and gave a dry product 5–8 mils thick. As the dry product came out of the drying oven, a cool shower of water was sprayed on the underside of the drying surface, the water being at 60–75° F. The cooled product and belt were then subjected to a very small amount of live steam (10–20 lbs. steam per 350 lbs. dry product) which impinged on the surface. This steam penetrated the product and condensed on the cold metal surface below to form a very thin film of water between the drying surface and the product. Although the condensed steam was rapidly absorbed by the product, the product was loosened from the drying surface and could be lifted therefrom without scraping using a doctor blade for lifting. The stripped sheet was then redried to remove residual moisture from the steaming operation.

The dried sheet was further processed by placing 25 lbs. in a Patterson-Kelley blender for 1.5 minutes to produce shreds of the sheet approximately 0.5–0.75 inch in diameter. This shredded product was then screened on a Tyler 18 mesh screen to remove any fines and the plus 18 mesh material was ready for incorporation with tobacco. This shredded sheet was of the non-filtering type, reducing average active temperatures, but giving no significant reduction in tar or nicotine.

Example 6.—Conversion of non-filtering to filtering sheet

Two parts by weight of the dried product from Example 5, was admixed with 1 part by weight of product prepared similarly, but processed in the Patterson-Kelley blender for 5 minutes, instead of 1.5 minutes. The mixture of 25 lbs. of 5-minute treated material and 50 lbs. of 1.5 minute treated material was thoroughly blended and then screened on a Tyler 18 mesh screen to remove fines produced during the shredding process. The plus 18 mesh mixture when incorporated into tobacco will not only reduce temperatures, but will produce a significant reduction in tar and nicotine.

The internal filtering type of sheet exerts an effect in tar reduction far greater than that attributable to the reduction of the tobacco content of the cigarette alone. Table 5 and the curves of the accompanying drawing were developed by determining the mg. of dry tar per cigarette in comparison to the percentage of sheet additive. The theoretical tar reduction curve was calculated by multiplying the dry tar from the control cigarette by the percent of tobacco that would be left after the designated percent addition of sheet. All cigarettes tested had the same initial weight, and were hand-made on a laboratory machine.

It will be seen from Table 5 that for a level of 16% sheet additive, the theoretical control cigarette would give 13.9 mg. of tar. But only 9.7 mg. of tar was evolved from

TABLE 5

Kind of Cigarette	Percent Sheet Additive	Tobacco Content Factor	Dry Tar, mg./cigarette
Control	0	1.00	16.5
Tar calculated from percent sheet loadings	8	.92	15.2
	16	.84	13.9
	24	.76	12.6
	32	.68	11.2
Non-Filtering Sheet	8	----------	13.9
	16	----------	12.1
	24	----------	11.6
	32	----------	11.2
Internal Filtering Sheet	8	----------	12.2
	16	----------	9.7
	24	----------	7.8
	32	----------	7.0

a cigarette with 16% of the internal filtering type sheet additive, representing a reduction from the theoretical of 4.2 mg. tar, or about 30%. At 24% or 32% sheet loadings, the reduction was about 4.5 mg. tar, or 36% and 40% reduction, respectively, below the theoretical evolution. The non-filtering type of sheet gave little or no reduction of tar below the theoretical value. The foregoing figures are for dry tar (105° C.), thus having greater significance as being undiluted with volatile smoke fractions which do not contain carcinogens.

What is claimed is:

1. Smoking tobacco having incorporated therein from about 5% to about 35% by weight of the tobacco of a shredded sheet consisting essentially of (a) from about 75% to about 95% by weight of a temperature control substance selected from the group consisting of an oxide, hydroxide, and carbonate of magnesium, and an oxide and hydroxide of aluminum, and the hydrated forms thereof; and in addition (b) from about 3% to about 15% by weight of a siliceous inorganic fibrous matrix material; and in addition (c) from about 1% to about 5% by weight of an organic gum binder selected from the group consisting of natural vegetable gums and synthetic cellulose ether gums; the fibers of said matrix material having been treated to produce a roughened fibrilated surface thereon.

2. The tobacco of claim 1 in which the fibrous matrix material is asbestos.

3. Smoking tobacco having incorporated therein from about 5% to about 35% by weight of the tobacco of a shredded sheet consisting essentially of (a) from about 75% to about 95% by weight of an aluminous temperature control substance united with water; and in addition (b) from about 3% to about 15% by weight of a siliceous inorganic fibrous matrix material; and in addition (c) from about 1% to about 5% by weight of an organic gum binder selected from the group consisting of natural vegetable gums and synthetic cellulose ether gums; the fibers of said matrix material having been treated to produce a roughened fibrilated surface thereon.

4. The tobacco of claim 3 in which the fibrous matrix material is asbestos.

5. The tobacco of claim 3 in which the binder is guar gum.

6. Smoking tobacco having incorporated therein from about 10% to about 25% by weight of the tobacco of fibrous shreds consisting essentially of (a) from about 80% to about 90% by weight of alumina trihydrate; and in addition (b) from about 5% to about 15% by weight of asbestos; the balance being at least 1% by weight of a natural vegetable gum binder; said fibrous shreds having been treated to produce a roughened fibrilated surface thereon.

7. The tobacco of claim 6 in which the gum binder is guar gum.

8. A cigarette comprising a filler of smoking tobacco having incorporated therein from about 5% to about 35% by weight of the tobacco of a shredded sheet consisting essentially of (a) from about 75% to about 95% by weight of a temperature control substance selected from the group consisting of an oxide, hydroxide, and carbonate of magnesium, and an oxide and hydroxide of aluminum, and the hydrated forms thereof; and in addition (b) from about 3% to about 15% by weight of a siliceous inorganic fibrous matrix material; and in addition (c) from about 1% to about 5% by weight of an organic gum binder selected from the group consisting of natural vegetable gums and synthetic cellulose ether gums; the fibers of said matrix material having been treated to produce a roughened fibrilated surface thereon, and a cigarette paper wrapper.

9. A cigarette comprising a filler of smoking tobacco having incorporated therein from about 10% to about 25% by weight of the tobacco of fibrous shreds consisting essentially of (a) from about 80% to about 90% by weight of alumina trihydrate; and in addition (b) from about 5% to about 15% by weight of asbestos; the balance being at least 1% by weight of a natural vegetable gum binder; said fibrous shreds having been treated to produce a roughened fibrilated surface thereon, and a cigarette paper wrapper.

References Cited

UNITED STATES PATENTS

3,005,732	10/1961	Specht	131—17
3,061,479	10/1962	Merritt	131—17
3,106,210	10/1963	Reynolds et al.	131—17
3,255,760	6/1966	Selke	131—17

MELVIN D. REIN, *Primary Examiner.*