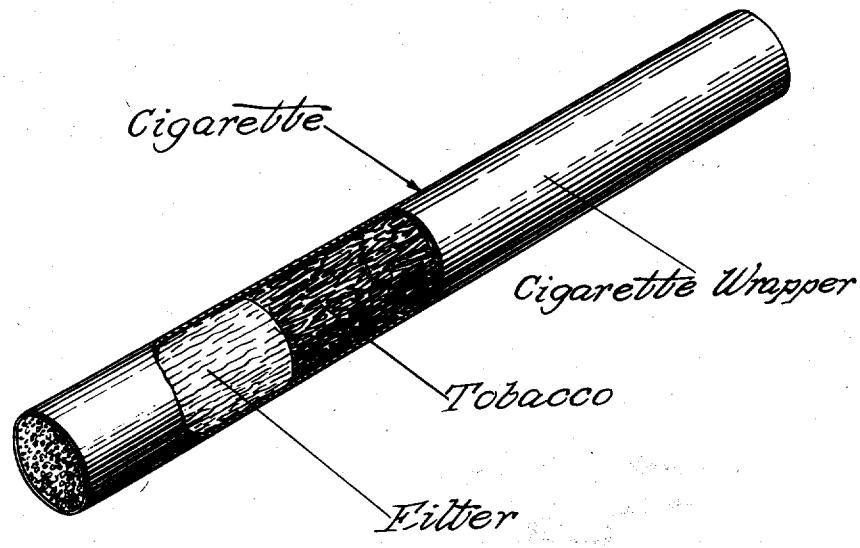
Jan. 12, 1960 J. W. KINNAVY 2,920,630

TOBACCO SMOKE FILTER

Filed July 23, 1958



Inventor:
James W. Kinnavy,
By Merriam, Lorck, Smith, Attys.

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2,920,630

TOBACCO SMOKE FILTER

James W. Kinnavy, Chicago, Ill., assignor to Wallace A. Erickson & Co., Chicago, Ill., a corporation of Illinois

Application July 23, 1958, Serial No. 750,524

23 Claims. (Cl. 131—10)

This invention relates to the treatment of tobacco smoke for the purpose of reducing the presence of undesired constituents therein and means to accomplish this result.

This application is a continuation-in-part of my application Serial No. 726,273, filed April 3, 1958.

The harmful physiological effects of volatile constituents contained in tobacco smoke have long been recognized. It is well known, for example, that tobacco smoke contains various alkaloids and health-affecting volatile materials such as nicotine and also tarry and other constituents which tend to physiologically irritate the smoker. Attempts have been made to obviate the harmful effects induced or aggravated by these materials by using filters. However, the various filtering devices and processes of the prior art have not been entirely satisfactory, although in many cases they remove, to some degree, toxic materials. For example, some of the methods and devices used for filtering tobacco smoke fail to satisfy completely the needs of the smoker or tobacco industry because they only remove a small portion of the toxic materials, are inconvenient to use, unfavorably influence the taste of the tobacco smoke, or adversely affect the burning characteristics of the tobacco.

I have found that it is possible, by use of a simple filtering operation and device, to remove substantial quantities of the harmful constituents of tobacco smoke evolved from burning tobacco. This is accomplished by contacting tobacco smoke with quaternary ammonium compounds having the general formula:



wherein:

R, R^1, R^2 and R^3 are the same or different members of the group consisting of alkyl and aryl (includes nuclear substituted aryl groups) radicals;

A is a member of the class consisting of Cl— and



groups

x is 1 when A is Cl— and either 1 or 2 when A is



groups

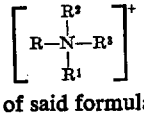
R^4 is an alkyl radical having up to 17 carbon atoms when x is 1 and an alkylene radical having up to 16 carbon atoms when x is 2;

y is 1 when A is



groups

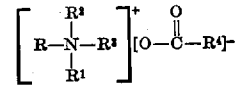
and 2 when A is Cl—; and



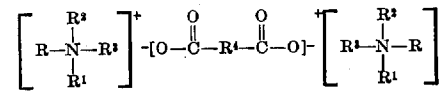
is the cationic moiety of said formula.

When y is 2 (see Formula 3, infra), there is no R^4 radical because the subscript becomes zero (i.e., 2—2=0); however, when y is 1, the subscript becomes one and the R^4 radical remains as a moiety of the formula (see Formulae 1 and 2, infra). The following three classes of compounds are embraced by this formula:

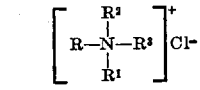
(1)



(2)



(3)



The cationic moieties in Formula 2, supra, may or may not be the same; therefore, R in these moieties need not be the same alkyl group (e.g., in length of chain), and the same is true of R^1, R^2 and R^3. The nicotine and tars of tobacco smoke become bound to these quaternary compounds. Although the quaternary ammonium compounds embraced by the above-mentioned general formula serve to retain alkaloids such as nicotine and tars present in tobacco smoke without requiring the use of other filter materials or a porous carrier, these quaternary ammonium compounds may be retained by materials which serve as a filter as well as carrier for these compounds. For example, the quaternary ammonium products or compounds may be adsorbed on porous materials such as exemplified by cellulosic products (e.g., cellulose acetate, paper, cotton, and wood), asbestos wool, particles of pumice stone, silica gel, cork, glass, wool, earth and plastic materials. These porous or carrier materials may be formed in the shape of cylindrical cartridges or inserts, or packed in cylindrical capsules or envelopes. Whatever form or shape filter is used, it may be retained within smoking articles such as cigarettes, cigars, cigarette or cigar holders, or pipes in conventional manner, thereby permitting tobacco smoke to be drawn into contact with the filter before entering the mouth of the smoker.

The invention is illustrated in the accompanying drawing which shows a partially broken away perspective view of a cigarette having disposed therein tobacco and a tobacco smoke filter adapted to permit the passage of smoke therethrough. The filter comprises a cylindrical insert of asbestos wool having the above-mentioned quaternary ammonium compounds retained therein. The drawing shows the same cigarette wrapper circumscribing the tobacco and filter insert.

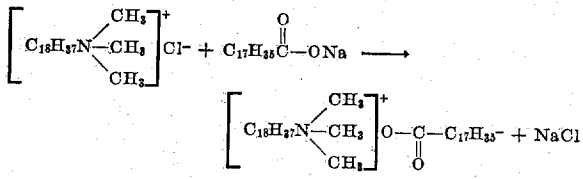
The following examples illustrate satisfactory procedures for distributing the quaternary ammonium on cotton fibers to form a filter.

EXAMPLE I

About 1390 parts by weight of about a 25% isopropyl alcohol solution of trimethyloctadecylammonium chloride may be added to a vessel containing about 2 grams of cotton. About 1224 parts by weight of about a 25% mixture of sodium stearate dispersion containing about 10% water and about 65% isopropyl alcohol should then be added at room temperatures, with agitation, to the vessel. Commercially available, triple-pressed stearic acid may be used in making the sodium stearate.

An immediate reaction occurs whereby the resulting trimethyloctadecylammonium stearate is formed directly

on the cotton fibers. This reaction may be shown as follows:



In this process, the trimethyloctadecylammonium chloride is first adsorbed by the cotton, and trimethyloctadecylammonium stearate is afterwards formed directly on the cotton fibers upon the addition of sodium stearate to the vessel.

The deposition of about one gram of trimethyloctadecylammonium stearate on 2 grams of cotton produces an excellent filter, although satisfactory results may be obtained with less than this amount.

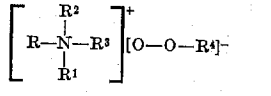
The impregnated cotton should be removed from the vessel, dried in a conventional manner and formed into a cylindrical filter for use in a cigarette. The resulting filter will have the cationic, water-insoluble trimethyloctadecylammonium stearate affixed to its fibers. Nicotine and tars become readily bound to the stearate retained by the cotton carrier.

The concentration of the reactants in this example is not critical because a high proportion of the trimethyloctadecylammonium stearate reaction product formed in the liquid media will be deposited on and/or adsorbed by the carrier irrespective of its concentration in the solution. However, a sufficient amount of stearate reaction product should be formed so as to assure the deposition or formation of an effective amount of the cationic stearate reaction product on the carrier. As illustrated in the above equation, one mole of trimethyloctadecylammonium chloride and one mole of sodium stearate react to form one mole of trimethyloctadecylammonium stearate.

By using an anionic carrier, the ionic attraction of the cationic stearate reaction product to the anionic carrier will be sufficiently great so as to tend to assure the deposition of high levels of stearate reaction product on the carrier. Therefore, it is advantageous to add, first, the chloride to the carrier and then add sodium stearate to the vessel so that the resulting reaction product is formed directly on the carrier. On the other hand, if desired, trimethyloctadecylammonium stearate may be first formed, then substantially dissolved in hot chloroform, and finally applied as a solution to the carrier.

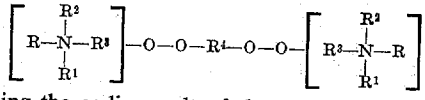
The carrier may likewise be treated with other quaternary ammonium compounds having the formulae:

(1)



or

(2)

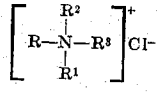


by adding the sodium salt of the anionic moiety to the cationic moiety in the presence of the supporting mass in the manner shown above with respect to the trimethyloctadecylammonium stearate reaction product.

EXAMPLE II

When quaternary ammonium chloride compounds having the formula

(3)



are used to treat the filter mass, the water-soluble chlorides may be applied to the filter mass as an aqueous solution whereas the water-insoluble chlorides may be solubilized with a suitable solvent such as isopropyl alcohol and applied to the filter mass in a similar manner. In either case, the chloride is adsorbed by the filter mass.

For example, 1390 parts by weight of trimethyloctadecylammonium chloride may be added to a vessel containing about 2 grams of cotton. The impregnated cotton should be dried. The filter mass should adsorb about one gram of the chloride.

EXAMPLE III

In order to determine the comparative levels of alkaloids, such as nicotine and tars, that are removed from tobacco smoke when the quaternary ammonium compounds are used in conjunction with a carrier mass such as cotton, cotton carriers were treated with the above referred to three classes of quaternary ammonium compounds and the resulting treated carriers were tested under normal smoking conditions. More specifically, members of groups 1 and 2 were applied to 3 grams of cotton by saturating the cotton with 0.01 molar quantities of chloride and sodium salt reactants, whereas in the case of the group 3 compounds a 0.01 molar solution of the chloride was used, in accordance with the procedures set forth in Examples I and II, above. The impregnated cotton samples were dried in a vacuum desiccator and the weight of the "add-on" quaternary ammonium compound retained by each sample was determined. Then 0.25 gram each of the treated cotton samples that contained about 0.09–0.16 gram of the ammonium compound were used as a filter bed for a burning cigarette. Each cigarette was mechanically smoked at a substantially constant burning rate, designed to simulate normal smoking conditions, over a six minute period.

The results of these tests are shown in Table I, below.

Table I

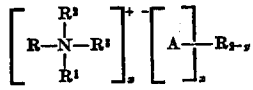
Quaternary Ammonium Compound	Grams of Ammonium Compound Retained by 0.25 Gram of Cotton Filter	Milligrams of Nicotine and Tars Filtered-Out by Treated Cotton Filter
None	None	8
Trimethyloctadecylammonium Stearate	0.13	25
Dimethylbenzyldodecylammonium Stearate	0.13	26
Trimethyloctadecylammonium Acetate	0.13	44
Trimethyllaurylammonium Stearate	0.13	33
Trimethyllaurylammonium Acetate	0.16	29
Dimethyldioctadecylammonium Stearate	0.14	19
Dimethyldioctadecylammonium Acetate	0.12	49
Trimethyloctadecylammonium Chloride	0.11	29
Dimethyldioctadecylammonium Chloride	0.11	32
Trimethyldodecylammonium Chloride	0.09	35
Trimethyloctadecylammonium Adipate	0.13	25
Di-(trimethyloctadecylammonium) Adipate	0.12	45
Dimethylethylbenzylammonium Stearate	0.11	34
Dimethylethylbenzylammonium Acetate	0.09	26
Trimethyloctadecylammonium Hexanoate	0.10	23
Trimethyloctadecylammonium Oleate	0.13	22
Tetramethylammonium Chloride	0.035	12
Tetramethylammonium Acetate	0.13	36
Tetramethylammonium Stearate	0.25	26

The above tabulated results show that the quaternary ammonium compounds that were treated materially increased the level of alkaloids retained by untreated cotton.

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom, as modifications will be obvious to those skilled in the art.

I claim:

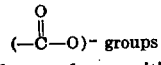
1. A tobacco smoke filter comprising a supporting mass adapted to afford passage of tobacco smoke therethrough, said mass including a quaternary ammonium compound having the generic formula



wherein:

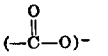
R, R^1, R^2 and R^3 are selected from the class consisting of alkyl and aryl groups,

A is a member of the class consisting of Cl— and



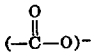
groups

x is 1 when A is Cl— and a positive whole integer of not more than 2 when A is

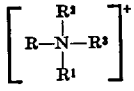


R^4 is an alkyl radical having up to 17 carbon atoms when x is 1 and an alkylene radical having up to 16 carbon atoms when x is 2,

y is 1 when A is

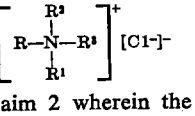


and 2 when A is Cl—, and

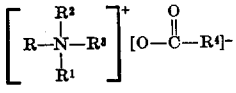


is the cationic moiety of said compound.

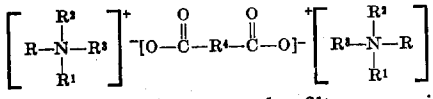
2. The filter of claim 1 wherein the quaternary ammonium compound has the formula



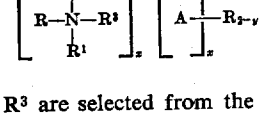
3. The filter of claim 2 wherein the quaternary ammonium compound has the formula



4. The filter of claim 2 wherein the quaternary ammonium compound has the formula



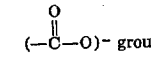
5. An improved tobacco smoke filter comprising a cylindrical tobacco smoke filter having an effective amount of a quaternary ammonium compound as a filtering aid, said quaternary ammonium compound having the generic formula



wherein:

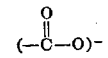
R, R^1, R^2 and R^3 are selected from the class consisting of alkyl and aryl groups,

A is a member of the class consisting of Cl— and



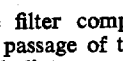
groups

x is 1 when A is Cl— and a positive whole integer of not more than 2 when A is



R^4 is an alkyl radical having up to 17 carbon atoms when x is 1 and an alkylene radical having up to 16 carbon atoms when x is 2,

y is 1 when A is



and 2 when A is Cl—, and

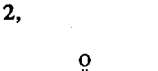
is the cationic moiety of said compound.

6. A tobacco smoke filter comprising a supporting mass of anionic material adapted to afford passage of tobacco smoke therethrough, said mass containing a cationic quaternary ammonium compound having the generic formula

wherein:

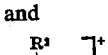
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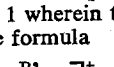
groups

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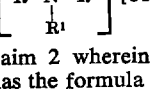


R^4 is an alkyl radical having up to 17 carbon atoms when x is 1 and an alkylene radical having up to 16 carbon atoms when x is 2,

y is 1 when A is



and 2 when A is Cl—, and



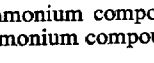
is the cationic moiety of said compound.

7. The method of treating tobacco smoke to reduce irritating constituents therein, which comprises contacting the smoke with a quaternary ammonium compound having the generic formula

wherein:

R, R^1, R^2 and R^3 are selected from the class consisting of alkyl and aryl groups,

A is a member of the class consisting of Cl— and



groups

x is 1 when A is Cl— and a positive whole integer of not more than 2 when A is

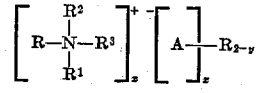
R^4 is an alkyl radical having up to 17 carbon atoms when x is 1 and an alkylene radical having up to 16 carbon atoms when x is 2,

y is 1 when A is

and 2 when A is Cl—, and

is the cationic moiety of said compound.

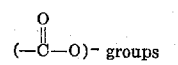
8. The method of treating tobacco smoke to reduce irritating constituents therein, which comprises contacting the smoke with a quaternary ammonium compound which is retained by a carrier, said quaternary ammonium compound having the generic formula



wherein:

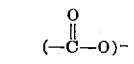
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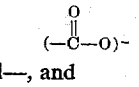
groups

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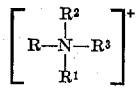


R^4 is an alkyl radical having up to 17 carbon atoms when x is 1 and an alkylene radical having up to 16 carbon atoms when x is 2,

y is 1 when A is



and 2 when A is Cl—, and



is the cationic moiety of said compound.

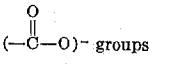
9. A tobacco smoking article having disposed therein tobacco and a tobacco smoke filter adapted to permit the passage of the smoke therethrough, said filter comprising a supporting mass which includes a quaternary ammonium compound, whereby irritating constituents in tobacco smoke are retained by said filter when smoke from the burning tobacco is drawn through said filter, said quaternary ammonium compound having the generic formula



wherein:

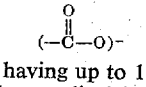
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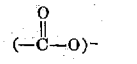
groups

x is 1 when A is Cl— and a positive whole integer of not more than 2 when A is

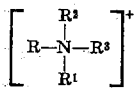


R^4 is an alkyl radical having up to 17 carbon atoms when x is 1 and an alkylene radical having up to 16 carbon atoms when x is 2,

y is 1 when A is

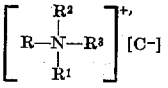


and 2 when A is Cl—, and

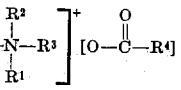


is the cationic moiety of said compound.

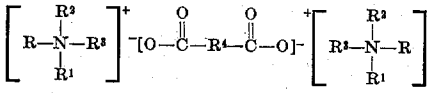
10. The tobacco smoking article of claim 9 wherein the quaternary ammonium compound has the formula



11. The tobacco smoking article of claim 9 wherein the quaternary ammonium compound has the formula



12. The tobacco smoking article of claim 9 wherein the quaternary ammonium compound has the formula



13. The filter of claim 1 wherein the quaternary ammonium compound is dimethylbenzyldodecylammonium stearate.

14. The filter of claim 1 wherein the quaternary ammonium compound is trimethyllaurylammonium stearate.

15. The filter of claim 1 wherein the quaternary ammonium compound is dimethyldioctadecylammonium stearate.

16. The filter of claim 1 wherein the quaternary ammonium compound is trimethyloctadecylammonium chloride.

17. The filter of claim 1 wherein the quaternary ammonium compound is dimethyldioctadecylammonium chloride.

18. The filter of claim 1 wherein the quaternary ammonium compound is trimethyldodecylammonium chloride.

19. The filter of claim 1 wherein the quaternary ammonium compound is di-(trimethyloctadecylammonium) adipate.

20. The filter of claim 1 wherein the quaternary ammonium compound is dimethylethylbenzylammonium stearate.

21. The filter of claim 1 wherein the quaternary ammonium compound is trimethyloctadecylammonium oleate.

22. The filter of claim 1 wherein the quaternary ammonium compound is tetramethylammonium chloride.

23. The filter of claim 1 wherein the quaternary ammonium compound is tetramethylammonium stearate.

References Cited in the file of this patent

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