

United States Patent

Wise et al.

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[54] **FILTER FOR REDUCING THE LEVEL
OF CARBON MONOXIDE IN TOBACCO
SMOKE**

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131/265, 131/266**

[51] Int. Cl. **A24b 15/02, A24d 01/06**

[58] Field of Search **131/10.7, 262 R, 265; 252/455**

[56]

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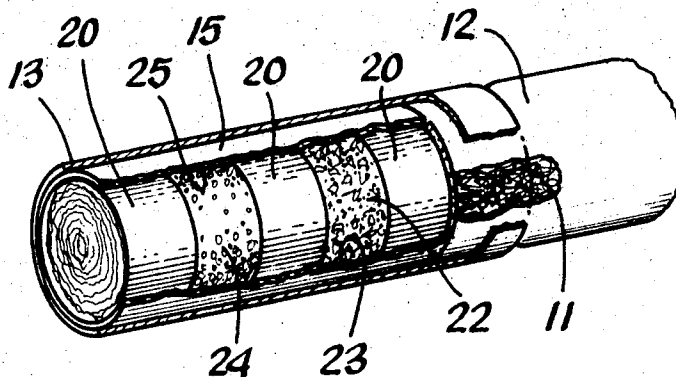
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[57]

ABSTRACT

A large proportion of the carbon monoxide present in tobacco smoke can be removed by use of a composite filter having an activated charcoal component and a molecular sieve component which is positioned downstream from the charcoal.

7 Claims, 6 Drawing Figures



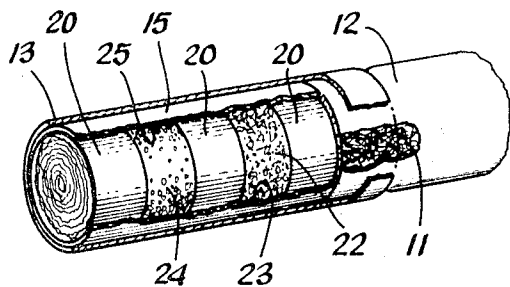


FIG. 1

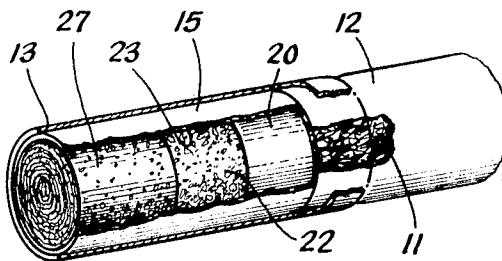


FIG. 4

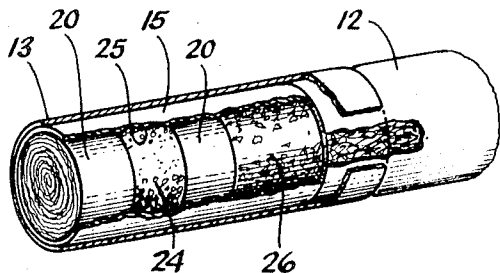


FIG. 2

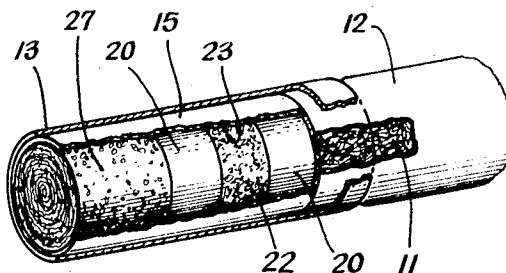


FIG. 5

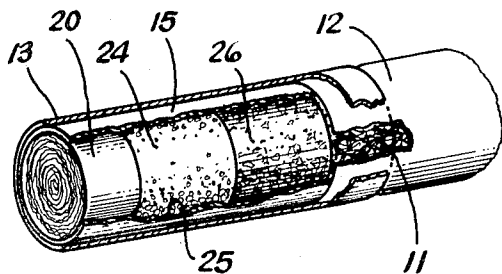


FIG. 3

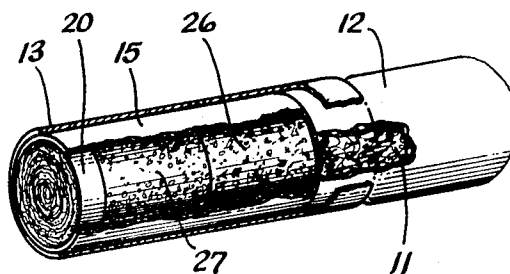


FIG. 6

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FILTER FOR REDUCING THE LEVEL OF CARBON MONOXIDE IN TOBACCO SMOKE

BACKGROUND OF THE INVENTION

It has been found that carbon monoxide is present in significant amounts in the smoke stream of cigarettes (and other tobacco articles) and that the amount thereof increases rapidly as the cigarette length is diminished by combustion. Typical carbon monoxide concentrations, expressed as volume percent of the total gaseous smoke stream, are about 3 to 5 percent at an early stage when approximately one-third of the cigarette has been burned, and 5 to 8 percent when the cigarette is two-thirds consumed. The major factor affecting carbon monoxide concentration in the smoke appears to be dilution of the combustion product gases by air introduced through the porous paper enveloping a tobacco. Thus, more air is admitted at the beginning of the cigarette burning cycle than towards completion thereof when the total surface area of porous paper has been greatly reduced. The use of known filters, while effective in reducing the content of tars, nicotine and various condensable fractions of the smoke, has little if any effect on the carbon monoxide concentration thereof.

Carbon monoxide is a known poisonous gas which combines with hemoglobin in the blood, displacing vital oxygen. It is increasingly suspect as a positive factor in the development of coronary heart disease, for as carbon monoxide enters the blood stream it appears to pave the way for the accumulation of cholesterol in the arteries.

It is an object of the present invention to provide a method for effecting a major reduction in the content of carbon monoxide present in the combustion gases from a cigarette or other tobacco product which the smoker draws into his mouth. A further object is to provide a filter having a compositional makeup which will effect said removal of carbon monoxide from the smoke stream. A still further object is to effect the aforesaid reduction in carbon monoxide without interfering with the taste and drawing characteristics of the cigarette. The nature of still other objects will be apparent from a consideration of the descriptive portion to follow.

SUMMARY OF THE INVENTION

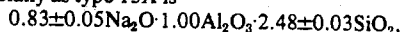
It has been discovered that the foregoing objects can be accomplished by the provision of a filter for tobacco smoke which includes an activated charcoal component and a molecular sieve component which is positioned downstream from the charcoal, i.e., nearer the filter tip end which is inserted between the smoker's lips. By the use of such a filter construction it is possible to remove a relatively large percentage of the carbon monoxide from the smoke stream which would otherwise reach the smoker's mouth. Thus, during the smoking of the first 50 or 60 percent of a cigarette employing a filter of the present invention, the content of carbon monoxide in the effluent smoke stream is reduced by from about 60 to 90 percent from the level which would otherwise prevail. While the degree of carbon monoxide removal from the smoke stream becomes less efficient as the burning process is continued still further, significant amounts of carbon monoxide can be removed from the smoke stream by a practice of this invention even when the cigarette has been burned over 80 percent of its length.

In its overall construction, the filter of this invention, in addition to its activated charcoal and molecular sieve components, may and preferably does contain spaced filter plugs of one type or another comprised of known materials such, for example, as bundles of cellulosic fibers or convoluted crepe papers. The said charcoal and molecular sieve components may be deposited in solid particulate form in separate chambers within the filter defined by said plugs, or one or both thereof may be carried within the interstices of a creped paper or other appropriate plug-forming material adapted for the purpose.

The activated charcoal component of the filter can take any one of a variety of forms. Thus, there may be employed any

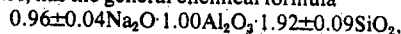
good grade of a gas adsorbent quality activated carbon such, for example, as that having a specific surface area in excess of 500 square meters per gram. It is also possible to employ activated charcoal materials which have been treated with various additives to improve their utility for use as adsorbents in cigarette filters. One such product is described in U.S. Pat. No. 3,251,365, issued May 17, 1966 to Keith et al., wherein the activated charcoal is treated with a small percentage of iron oxide and zinc oxide. However formed, the activated charcoal component can be employed in a finely divided form or as a granular material formed by compressing the fine particles together. When the product is to be employed in the form of a relatively fine powder it can be incorporated by dusting, spraying, tumbling or slurrying into a fibrous material which forms a so-called plug within the body of the filter. Alternatively, activated charcoal particles composited into the form of small granules such, for example, as those having a particle size between about 8 and 50 mesh, can be placed in a chamber within the filter which is defined by spaced filter plugs. In the latter case one such plug typically is placed next to the tobacco, followed by the charcoal granules and then by the other plug. These plugs, as indicated above, can be comprised of a variety of materials, although preferably they are made up of cellulose acetate or other cellulosic fibers, or of a convoluted crepe paper. Alternatively, the forward plug member nearest the tobacco may be as here defined, with the plug positioned downstream of the carbon granules incorporating within its interstices the molecular sieve component of the filter in finely divided form, as discussed more fully below. The weight of activated carbon to be employed in a given filter for a cigarette, cigar, pipe or the like admits of some variance depending on its overall adsorption efficiency. However, good results can be had in most instances by employing from about 50 to 200 mg. of the activated charcoal component in each filter.

The other adsorptive component of the filter represents a material commonly known as a "molecular sieve." Adsorbents of this type are distinguished from other known adsorbents in that they possess uniform adsorption openings of constant dimension in the crystal structure. As a result, they exhibit high selectivity for absorbing particles having a relatively small molecular diameter. Thus, they are not capable of taking up the larger molecules such as those which impart flavor to the smoke. The chemical composition of a molecular sieve consists of a synthetic alkali metal aluminosilicate formulation, quite similar to some natural clays and feldspars. The crystals as synthesized have a three-dimensional crystal structure containing water of hydration. Physically, molecular sieves are white powders, with crystalline particles ranging from 0.1 to 10 microns in diameter. Each particle is a single crystal which contains literally billions of tiny cavities or cages interconnected by channels of unvarying diameter. The size and position of the metal ions in the crystal control the effective diameter of the interconnecting channels. The general chemical formula for a molecular sieve composition known commercially as type 13X is



plus water of hydration. Type 13X has a cubic crystal structure which is characterized by a three-dimensional network with mutually connected intra-crystalline voids accessible through pore openings which will admit molecules with critical dimensions up to 13 angstroms. The void volume is 51 volume percent of the zeolite and thus provides high adsorption capacity.

Another molecular sieve composition, known commercially as Type 4A, has the general chemical formula



plus water of hydration. Type 4A is converted into commercial Type 5A by an ion exchange procedure, in which about 75 percent of the sodium ions are replaced by calcium ions. Types 4A and 5A have a cubic crystal structure characterized by a three-dimensional network consisting of cavities 11.4 angstroms in diameter separate by circular pore openings 4.2 angstroms in diameter.

One or the other of the various 13X, 4A and 5A molecular sieve materials (which contains water of hydration) is that which is preferably employed in a practice of the present invention. These materials are commercially available from Union Carbide Corporation.

The molecular sieve material incorporated in the filter can be employed in the powdered or other finely divided state, though preferably it is used in the form of small granules such, for example, as those of approximately 10 to 40 mesh. In a representative preparation the powdered molecular sieve material is pressed into relatively large pellets which are then mortar-ground and sifted to recover a 16-20 mesh fraction. In whatever physical form employed, the molecular sieve material should have a substantial water content, which usually ranges from about 9 to 20 percent by weight. Preferably the water content of the sieve material is so adjusted as to be at least as high as that of the tobacco employed in the cigarette, thereby avoiding desiccating the tobacco as the cigarette package stands on the shelf.

The amount of molecular sieve material admits of considerable variation and depends upon such known adsorption-modifying factors as particle form, content of water and the precise molecular sieve material employed. However, good results can be obtained by using from about 250 to 1,250 mg. of the molecular sieve material in each filter, with a preferred range being from about 400 to 1,000 mg. thereof.

The emplacement of the molecular sieve material in the filter for the cigarette or other tobacco product can be physically effected in much the same fashion as described above for the activated charcoal, bearing in mind that the smoke must first travel through the activated carbon component before being brought over the molecular sieve adsorbent. Thus, while the molecular sieve component of the filter is preferably contained in granule form in a chamber defined by appropriate plugs, it can be incorporated in the interstices of a convoluted crepe paper or of any other appropriate plug-forming material provided that the drawing characteristics of the cigarette or other tobacco article are not unduly modified.

DESCRIPTION OF PREFERRED EMBODIMENTS

The present invention is represented in various of its embodiments by the figures of the drawing wherein:

FIG. 1 is a perspective view of a cut away cigarette equipped with a filter tip of our invention wherein the activated charcoal and molecular sieve components, both in granular form, are disposed in separate chambers of the filter between cellulosic plugs;

FIG. 2 is a similar view showing another embodiment of the invention wherein the activated charcoal is dispersed in a plug material within the filter and granular molecular sieve material is contained in a chamber defined by cellulosic filter plugs;

FIG. 3 shows a cigarette filter construction similar to that of FIG. 2, but with the molecular sieve granules resting against the charcoal-containing plug;

FIG. 4 is a similar view showing a filter construction wherein activated charcoal granules are present in a filter chamber between a forward cellulosic plug and a rearward plug which contains molecular sieve material dispersed therein;

FIG. 5 shows a filter construction similar to that of FIG. 4, but with the activated charcoal being separated from the molecular sieve-containing plug by an intervening cellulosic plug; and

FIG. 6 is a similar view showing a filter construction wherein the activated charcoal and molecular sieve components are each dispersed in adjacent filter plugs and wherein the tip of the filter carries a cellulosic plug.

Referring to FIG. 1, there is shown a cigarette column of the dimensions ordinarily found in filter cigarettes, which is comprised of a mass of shredded tobacco 11 wrapped in paper 12. Attached to the tobacco column by means of an outer wrapper 13 is a filter assembly having an outer reinforcing

wrapper 15 which serves to contain various components of the filter through which the smoke is drawn by the smoker.

In the several figures of the drawing, cigarette plugs comprising plasticized bundles of cellulose acetate fibers are shown at 20. Such fibers typically have a denier per filament of from about 1.5 to 25, with the total denier per plug ranging from about 30,000 to 90,000.

Shown at 22 in the several figures are masses of discreet carbon particles, or granules, as contained in filter chambers 23, while similar granular masses of the molecular sieve material are shown at 24 as contained in filter chambers 25.

In the embodiments of the invention represented by FIG. 2, 3 and 6, finely divided activated charcoal is shown as being incorporated within the interstices of a filter plug composed of convoluted creped paper, as indicated at 26. Similar plugs of convoluted creped paper provided in the interstices thereof with finely divided molecular sieve material are shown at 27 in FIGS. 4, 5, and 6. If desired, each cellulosic plug 20 and creped paper plug 26, 27 can be wrapped in an additional paper wrapper (not shown) to facilitate handling of the plug portions during the filter making process.

The length of each of the cellulosic plugs 20 (or their equivalent) may be between about 3 and 10 millimeters, while that of the crepe paper plugs 26 and 27 incorporating charcoal of molecular sieve components may be between about 8 and 15 millimeters. The diameter of each of the plugs is such that the finished filter assembly will match the tobacco column.

It will be observed that in each embodiment of the invention shown in the drawing the molecular sieve component is positioned downstream from the activated carbon, i.e., nearer the tip of the filter which is placed between the smoker's lips. This arrangement is critical to a practice of this invention.

In order to show the relative amount of carbon monoxide present in the smoke stream of various commercially available cigarettes, as well as the reduction in the relative carbon monoxide content of the smoke stream therefrom effected by use of a molecular sieve, a number of smoking tests were made. In these tests, the cigarette was attached to a short length of rubber tubing which, in turn, was fitted with a short section of glass tubing. A second section of rubber tubing was then fitted to the outer end of the glass tube. In those tests where a molecular sieve was employed, the said material was incorporated in the glass tubing between a pair of small glass wool plugs which themselves performed no adsorbent function for carbon monoxide and were otherwise inert. In smoking the cigarette the tip of the outer length of rubber tubing was placed by the smoker between his lips as he took intermittent puffs, and during various of the puffs a gas sample was withdrawn for analysis at nearly constant volumetric flow by inserting a gas-tight syringe into this outer length of tubing. Puff samples of this character were taken after different fractions of the cigarette had been consumed in a puffing cycle approaching a sequence of a puff lasting from 2 to 5 seconds, followed by a period of smoldering, and then another puff. The resulting gas samples were analyzed by means of gas-liquid chromatography for separation of carbon monoxide, nitrogen and oxygen from the other gaseous constituents.

In order to show the relative amount of carbon monoxide present in the smoke stream of various commercially available cigarettes at various smoking points along their length, smoking tests as described above were made on (1) a cigarette having a filter made up of a 20 millimeter cellulosic plug, and on (2) a cigarette having a filter made up of activated charcoal granules (100 mg.) deposited in a chamber defined by adjacent cellulosic plugs each approximately 7 millimeters in length. The results of these tests, which reflect the relative carbon monoxide content of the smoke stream at the indicated point in the burning process along the cigarette, are presented in the following table wherein the cigarettes are identified as "1-Cellulose" and "2-Charcoal," respectively. Similar results are also given in the table for these same cigarettes as provided at their filter tip ends with 500 mg. of a type 5A molecular sieve adsorbent of 16-20 mesh size having a water content

of approximately 10-12 percent by weight. This material had been prepared by forming the powdered molecular sieve material into 1/16-inch pellets, then crushing the pellets and recovering the crushed particles having a 16-20 mesh size. These cigarettes are identified in the following table as "1-Cellulose +5A" and "2-Charcoal +5A," respectively.

[Representative values for carbon monoxide levels during intermittent puffing of burning cigarettes]

Cigarette	Cigarette fraction consumed preceding puff	Relative reduction in CO (vol. percent)	CO mole fraction* (CO/CO+N ₂ +O ₂)
1-Cellulose.....	0.3	-----	0.045
	0.5	-----	0.065
2-Charcoal.....	0.3	-----	0.054
	0.5	-----	0.065
1-Cellulose +5A.....	0.7	-----	0.074
	0.3	0	0.055
2-Charcoal +5A.....	0.5	0	0.061
	0.3	83	0.060
	0.5	88	0.068
	0.7	46	0.040

* All values ± 10%.

Results substantially similar to those presented in the foregoing table are obtained when employing either a 4A or a 13X granular molecular sieve material (in amounts ranging from 0.4 to 1.0 gram) in lieu of the 5A product, said 4A and 13X materials having a water content of approximately 8 to 20 percent by weight.

While the present invention has been described in particular detail as it relates to a filter to be used in connection with a cigarette, (whether attached to the tobacco column or as embodied in a separate filter for insertion in a cigarette holder, or the like) it is obvious that the filter can also be used in connection with other tobacco products such, for example, as cigars and pipes.

We claim:

1. A cigarette comprising a column of paper-wrapped tobacco and attached thereto and downstream therefrom a filter element comprising, in axial arrangement, a first section comprising at least about 50 mg. of activated charcoal and downstream from said first section a second section comprising at least about 400 mg. of molecular sieve material having a water content of from about 9 to 20 percent by weight, said sections functioning to substantially reduce the level of carbon monoxide in the smoke stream from the burning tobacco charge.

2. A cigarette as recited in claim 1 wherein the molecular sieve material is selected from the group consisting of those designated as 4A, 5A and 13X molecular sieves.

3. A cigarette as recited in claim 1 wherein the filter element comprises a cellulosic plug positioned adjacent the tobacco, then the activated charcoal, then a second cellulosic plug, then the molecular sieve material, and finally, at the end of the filter element, a third cellulosic plug.

4. A cigarette as recited in claim 1 wherein the filter element comprises a convoluted creped paper plug positioned next to the tobacco column and having the activated charcoal dispersed in its interstices, then the molecular sieve material, and finally, at the end of the filter element, a cellulosic plug.

5. A cigarette as recited in claim 4 wherein a cellulosic plug is interposed between the creped paper plug and the body of molecular sieve material.

6. A cigarette as recited in claim 1 wherein the filter element comprises a convoluted creped paper plug positioned next to the tobacco column and having the activated charcoal dispersed in its interstices, and then a second convoluted creped paper plug having the molecular sieve material dispersed in its interstices.

7. A cigarette as recited in claim 6 wherein the second creped paper plug is followed by a cellulosic plug at the end of the filter element.

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