

SPECIFICATION

Improvements in cigarette filters

- 5 This invention relates to cigarette filters and, more particularly, to improvements in the filter to be used as combined with a cigarette or cigarette holder to trap and remove toxic substances contained in smoke at the time of smoking. 5

It is generally known that various substances detrimental to the human body such as, generally, (1) nicotine, (2) tar, (3) carbon monoxide, (4) imperfect combustion products containing carcinogenic matters, and the like are contained in cigarette smoke. For nicotine, for example, it is said that 20 to 25 mg. of nicotine are contained usually in one cigarette and that about 3 mg. of nicotine are absorbed into the lung of a smoker in one smoking. Therefore, in order to trap such toxic substances in smoking, measures have been taken in which a filter made of fibrous material of cotton, synthetic resin or glass, or made of a continuous cellular foamed plastics or the like is provided at an end of a cigarette, alone or combined with granular or powdery activated carbon or within a cigarette holder combined with water with which the filter is impregnated. However, such a filter used alone or combined as above is preferably of such a density that it does not appreciably obstruct the flow of smoke. Therefore, toxic substances can still be carried into the body of the smoker without contacting the filter-forming member and any material combined with it. Further, in such conventional measures, the trapping of toxic substances depends solely on such physical actions as the deposition of those substances on the filter-forming member or the like and the dissolving in the impregnating water and, therefore, the toxic substances having passed through the filter are carried as they are into the human body. In particular, it has not been possible to trap carbon monoxide which is gaseous by means of such physical action only and, with conventional filters, no counter-measures can be taken against the carcinogenic matters carried into the human body through the filter mostly together with tar. The present invention aims to eliminate such defects of the conventional cigarette filters. 10 15 20 25

According to the present invention, there is provided a cigarette filter comprising dry and active green algae in particulate form and a columnar carrier carrying said algae, said carrier being capable of trapping toxic substances in cigarette smoke, which are deposited on said carrier and which react with said green algae, while allowing the smoke to pass through the filter. By means of the cigarette filter according to the invention, the toxic substances will contact the green algae to be physically absorbed and trapped in pores in the algae and to biologically react with the green algae so as to be denatured into harmless substances. 30 35

The algae may be granular or powdery chlorella.

A granular inorganic porous adsorbent may be mixed with the algae in the columnar carrier and said adsorbent may be selected from zeolite, silica gel, iron oxide and/or activated charcoal.

The invention will now be further described, by way of example, with reference to the drawings, in which:- 40

Figure 1 is a vertically sectioned view of a combination of a generally used cigarette holder and a cigarette filter according to one embodiment of the present invention;

Figure 2 is a vertically sectioned view of an embodiment of a cigarette filter according to the invention directly associated with a cigarette;

Figure 3 is a vertically sectioned view of another embodiment of a cigarette filter according to the invention also directly associated with a cigarette; and 45

Figure 4 is a vertically sectioned view of yet another embodiment of a cigarette filter according to the invention also directly associated with a cigarette.

While the present invention will be described in detail with reference to the illustrated embodiments, it should be understood that the intention is not to limit the invention to these embodiments but is to include all modifications and equivalent arrangements possible within the scope of the appended claims. 50

Chlorella which has been recently extensively used to maintain or improve human health is a single cellular alga and typical of green algae or, in other words, chlorophyceae, and chlorella pyrenoidosa, chlorella ellipsoidea and chlorella vulgaris are known as species of the same genus. Particularly, about half of the alga substances of chlorella are high quality proteins including many kinds of amino acids, enzymes and carbohydrates. On the other hand, nicotine in cigarette smoke is an alkaloid which is a basic vegetable substance belonging to a nitrogenous compound and is, therefore, considered to easily react or co-act with such various substances as proteins of chlorella which is a nitrogenous compound. Further, the main ingredient of tar is also a carbohydrate and can, therefore, be considered to act with such chlorella substances. In the same manner, carbon monoxide which it has not been able to trap or denature at all in the conventional measures by physical depositing or dissolving action is expected to give certain reaction or action particularly when such organic substances as chlorella are heated by cigarette smoke. The so-called carcinogenic matters are contained mostly in tar. Therefore, it is evident 60 65

that the rate of removal of the carcinogenic matters is higher, the higher the capacity of trapping and denaturing tar. The mechanism of the biological action of such algae as *chlorella* expected to have such effects on the cigarette's toxic substances must be found by future investigation.

However, the later described test results prove that such action exists and has a remarkable effect of removing the toxic substances. The dry and active *chlorella* usually available is highly porous having a number of very fine pores whether it is in granular or powdery form so that the rate of contact of it with passing cigarette smoke is as high as that of the conventionally used activated granular charcoal and its capacity of physically trapping the toxic substances is also high. It is evident, therefore, that the multiplied action of the biologically trapping or denaturing capacity and physically trapping capacity is obtained by the green algae represented by *chlorella*. According to the present invention, green algae are utilized to trap and remove the toxic substances in cigarette smoke employing a conventionally used filter means of, for example, a fibrous member or foamed member as a carrier for the algae.

Fig. 1 shows the case in which a cigarette filter according to the present invention is used combined with an ordinary cigarette holder. A cigarette 1 is inserted and held at one end in the cigarette holding end 2' of a holder 2 and an inner chamber 3 communicating respectively with said holding end 2' and a small diameter conduit 2'' at the other end as a mouthpiece is charged with a filter 4 according to the present invention. In this case, granular or powdery green algae 5 is substantially uniformly dispersed and carried within a columnar carrier 6 consisting of a fibrous member of cotton, a synthetic resin such as acetate or glass, or of a continuous cellular foamed plastics.

In Fig. 2, a filter 4 formed in the same manner as the filter in Fig. 1 is directly connected to one end of a cigarette 1, the filter 4 being in contact with a layer 1' of tobacco leaves forming the cigarette and being made integral with the cigarette by a wrapping paper rolled round the cigarette 1 or another paper wound continuously with the wrapping paper.

Fig. 3 shows the case in which the filter 4 is associated directly with the cigarette 1 as in the case of Fig. 2. In this case, however, the filter 4 comprises granular green algae 5 carried as one layer between a pair of columnar carriers 6 of the material explained with reference to Fig. 1. The green algae 5 may be held between the respective carriers 6 of the pair as they are or, alternatively, wrapped columnarly to be of substantially the same diameter as the carrier 6 with a thin paper or the like material having high air-permeability.

In Fig. 4, the filter 4 combined directly with the cigarette 1 consists of the carrier 6 carrying the algae 5 substantially uniformly dispersed as in the case of Fig. 1 or Fig. 2 and arranged in direct contact with the tobacco 1' and another filter layer 6' only of a fibrous or foamed member containing no algae 5. Since the layer 6' is provided at the mouthpiece end of the cigarette, the algae 5 will be prevented from dropping out of the carrier.

In any one of the foregoing embodiments, the algae 5 carried or retained by the carrier 6 may be used independently or, alternatively, together with such inorganic adsorbent as generally used activated charcoal or zeolite having uniform pores and known as an adsorbent. In such a case, the physical trapping capacity of such inorganic adsorbent will be elevated and the effect of the biologically trapping and denaturing actions expected mostly from such algae as *chlorella* will also be increased.

In order to investigate the effects of the thus obtained cigarette filter according to the present invention in removing the toxic substances except carbon monoxide gas, tests have been carried out in the following manner. Plain cigarettes marketed under the trade mark "Peace" produced and sold by Japan Monopoly Corporation were used as cigarettes to be tested. The cigarette was held in a cigarette holder charged with a cigarette filter according to the present invention of the formation shown in Fig. 1. The holder was connected at the mouthpiece end to a Cambridge filter holder having therein a collecting filter which is used extensively for this kind of test. The filter holder was connected in turn to an aspirator utilizing, for example, a water flow. When water was passed through the aspirator and the cigarette was lit, a negative pressure was created within the aspirator, whereby the cigarette burned as if it were being smoked, so that the smoke passed through the cigarette filter of the present invention and was then led to the collecting filter capable of collecting particles of a diameter longer than 0.1μ , and exhausted through an exhaust port of the aspirator. After one "Peace" cigarette had been burnt, the collecting filter was taken out of the Cambridge holder, the collected substances were separated from the collecting filter and compositions of the thus separated substances analysed by a chromatography technique in a known manner.

The cigarette filter of the present invention used in the test comprised a carrier formed of acetate fibres in a columnar shape of 8×20 mm. similar to a conventional cigarette filter, to which was added a mixture of 30 mg. of granular *chlorella* in dry and active form and 20 mg. of adsorbent consisting of powdery iron oxide and granular activated charcoal, the mixture being uniformly dispersed within said carrier. Amounts of nicotine, tar and 3, 4-benzopyrene contained in the cigarette smoke after passing through the cigarette filter according to the present invention and collected by the collecting filter are shown in Table 1, in which Sample 1 shows

the case in which, for comparison, no cigarette filter was used, Sample 2 shows the case in which a cigarette filter according to the present invention containing chlorella was used, and Sample 3 shows the case in which, for comparison, a so-called aquafilter in which the above referred carrier containing no chlorella but impregnated with 0.2 cc of plain water was used.

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Table 1

Sample	Nicotine (mg)	(Tar (mg)	3,4-benzpyren (ng.)
1	2.180	16.5	7.6
2	0.430	4.3	0
3	0.350	13.8	7.6

15 (Test results by Japan Food Hygiene Association, a testing and analysing authority appointed by the Minister of Health and Welfare in Japan.) 15

3,4-benzpyren is known as the most remarkable cause of a lung cancer among some benzpyrens known as carcinogenic matters contained in the tar of cigarettes. In the case of Sample 2, its detected amount is not always absolutely zero but tar is trapped so much by the cigarette filter of the present invention that the amount of 3,4-benzpyren contained in the tar reduced to such a very small amount is considered to be substantially equal to zero. 20

Now, the test results of investigating the carbon monoxide gas removing capacity of the cigarette filter according to the present invention for cigarettes of different brands made by means of a gas chromatography technique are shown in Table 2, in which the numerical values are CO gas concentrations in the cigarette smoke in the case of using no cigarette filter and in the case of passing the smoke through the cigarette filter according to the present invention which is the same as that used in the tests of Table 1. The tests with the cigarette filter according to the present invention were made with respect to a plurality of cigarettes of the respective brands. 25

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Table 2

Cigarette Brand	No cigarette filter (p.p.m.)	Using the cigarette filter according to the present invention (p.p.m.)
PEACE (Japan)	About 1,000	200-400
Marlboro (U.S.A.)	About 1,000	250-400
M.S. (Italy)	About 400	100-200

(Test results by the Japan Food Hygiene Association.)

The concentration of the CO gas remaining in the smoke after passing through the cigarette filter according to the present invention is seen to vary depending on the cigarettes of the respective brands, because it is thought that, even if the tobacco leaves forming the cigarettes of the respective brands are of the same kind and composition, when the origin of the tobacco leaves of each cigarette is different, its composition will be different. Anyhow, it is proved by the tests that about 50 to 80% CO gas is removed by the cigarette filter containing chlorella according to the present invention. 45

In the above described tests, a mixed adsorbent of powdery iron oxide and granular activated charcoal is used mixed with the granular chlorella but, other inorganic porous adsorbents such as zeolite, or silica gel can be used if desired. The dry and active green algae represented by chlorella may be used independently carried by the carrier, without any inorganic adsorbent. However, in view of the effect of the multiplied action of the capacity of biologically denaturing the toxic substances mainly by the algae and the capacity of physically trapping them mainly by the inorganic adsorbent, it is considered preferable to use algae together with any of such adsorbents or with a proper combination of them. 50

While the amount of algae or a mixture of algae with an inorganic adsorbent to be used should vary between the case of repeatedly using the cigarette filter as combined with the cigarette holder and the case of using the filter only once as combined directly with a cigarette, it is preferable to keep the total amount within the range of about 20 to 50 mg. The rate of mixing the adsorbent with the algae is preferably no more than 50% of the adsorbent. 55



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1. A cigarette filter comprising dry and active green algae in particulate form and a columnar carrier carrying said algae, said carrier being capable of trapping toxic substances in cigarette smoke, which are deposited on said carrier and which react with said green algae, while allowing the smoke to pass through the filter.
- 5 2. A cigarette filter according to claim 1, wherein said algae are granular chlorella.
3. A cigarette filter according to claim 1, wherein said algae are powdery chlorella.
4. A cigarette filter according to any preceding claim, wherein said algae are held between a pair of said carriers when viewed in the longitudinal direction of the filter.
5. A cigarette filter according to claim 4, wherein said algae are enclosed by an air-
10 permeable material.
6. A cigarette filter according to any preceding claim, wherein said carrier has dimensions of approximately 8 x 20 mm containing said algae in an amount in the range of about 20 to 50 mg.
7. A cigarette filter according to any one of claims 1 to 5, wherein a granular inorganic
15 porous adsorbent is mixed with said algae in the columnar carrier.
8. A cigarette filter according to claim 7, wherein said adsorbent is selected from zeolite, silical gel, iron oxide and/or activated charcoal.
9. A cigarette filter according to claim 7 or claim 8, wherein said carrier has dimensions of approximately 8 x 20 mm containing said chlorella and adsorbent in a total amount of about 20
20 to 50 mg.
10. A cigarette filter according to any one of claims 7 to 9, wherein said adsorbent is mixed with said algae at a rate of not more than 50% of the adsorbent.
11. A cigarette filter substantially as described herein with reference to the drawings.