Nov. 13, 1956 J. WINKLER 2,770,241

TOBACCO SMOKE FILTER AND METHOD

Filed May 10, 1954

FIG. 1

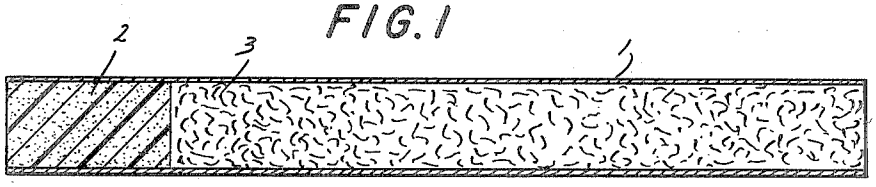


FIG. 2

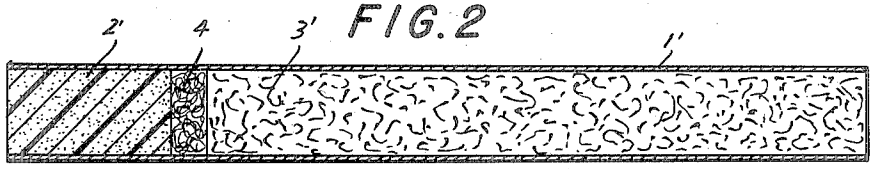


FIG. 3

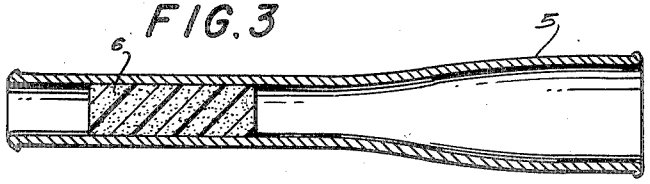


FIG. 5

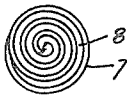


FIG. 4

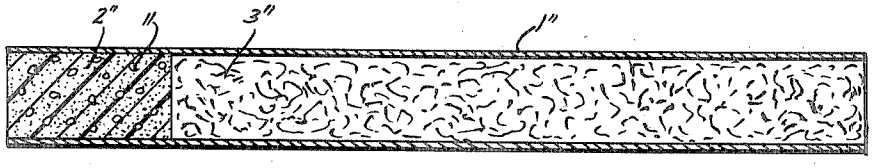


FIG. 6

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TOBACCO SMOKE FILTER AND METHOD

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7 Claims. (Cl. 131—208)

It is known that tobacco smoke contains unhealthy impurities such as nicotine and various tar-like pyrogenic substances. These mostly liquid substances are held suspended in the tobacco smoke in the form of tiny microscopic droplets which during the smoking process deposit and partly become absorbed by the mucosa of the mouth, nose and throat. When inhaled they travel further into the bronchial ducts and into the lungs where they exert a highly irritating action.

Cigarette manufacturers have been searching for means to eliminate from the tobacco smoke as much as possible of the irritating substances. This is done either by selecting less strong tobacco blends or by the increased use of filtering devices built into the cigarette or provided for the cigarette-holder or pipe. These conventional filters are designed to eliminate from the smoke as much as possible the pyrogenous tar-like substances and a great part of the nicotine itself.

Essentially, these filtering devices consist of a short hull filled with loosely packed thin fibers of cotton, alpha-cellulose and cellulosic materials in general. In order to increase the contact surface of the fibers with the smoke, the fiber layers are rolled up with thin ruffled paper leaflets. The length of such a cigarette filter is approximately about 10 millimeters, its diameter is that of the cigarette or about 10 millimeters.

For cigarette holders smoke filters consist of a short container filled with small pellets of silica gel known as having absorbing properties for vapors.

However, cellulosic materials and silica gel are highly hydrophilic substances, being primarily good absorbents for water vapors as well as for water soluble or water miscible substances, like nicotine and some low molecular water soluble resins, present in the tobacco smoke. Cellulosic materials on the other hand are very poor absorbents for water insoluble high molecular tars and polymerized nicotine derivatives. The presence in the tobacco smoke of relatively large amounts of water insoluble, high molecular pyrogenic substances, belonging to the class of polycyclic, polyphenolic substances is a scientifically proven fact, and evidence is accumulating that they are to a great extent responsible for the chronic irritating action in the respiratory organs of smokers.

Therefore, no matter what an ingenious construction a tobacco smoke filter may have, the mere fact that it usually contains only hydrophilic absorbents, incapable of retaining water insoluble hydrophobic impurities, shows clearly that it cannot perform properly the desired job, i. e. to make the smoke completely safe.

I, therefore, have conceived the new idea of using as a tobacco smoke filtering agent a highly surfaced hydrophobic material instead of or together with the conventional hydrophilic filtering materials, like cellulose and derivatives and silica gel. After having tested a number of artificial highly surfaced fibers which have a low moisture retention, such like nylon, Orlon, Dacron, acrilan etc., none, however, was found as sufficiently absorbent

for water insoluble tar-like constituents of the tobacco smoke. Evidently, besides hydrophobic properties, such material must also possess absorbent properties for the water insoluble high molecular tars of the tobacco smoke.

I finally have found, and this is the main feature of this invention, that highly surfaced polymeric materials belonging to the class of linear or reticulated polyurethanes, such substances which contain in their molecule the basic urethane group —CO.O.NH—, and which are chiefly synthesized by reacting polyols or polyesters with organic isocyanathes, are not only highly hydrophobic but also have a great affinity to tar-like polycyclic, oxygen and nitrogen containing matters, occurring in the tobacco smoke.

Highly surfaced polyurethane plastics which prove themselves to be the best for the purpose of filtering the tobacco smoke and of removing from it the most undesirable tars, must be open cell light foams, made from organic diisocyanates and polyesters, preferably in the presence of water. Such open cell polyurethane cellular plastic materials, having a volume density from 25 to 100 kilograms per cubic meter, have an excellent wettability with almost the majority of fluid organic compounds, especially such which contain in the molecule oxygen, nitrogen and sulphur. They not only exhibit great absorption upon their surface but also have the unusual ability to swell and increase their volume more than twice when brought into contact with large amounts of high molecular organic liquid compounds, in particular with polycyclic polyphenols and polycyclic nitrogen containing compounds.

In order to make a relatively short and small tobacco smoke filter sufficiently effective, the open cell polyurethane cellular plastic material must contain cells as small as possible and the membranes between the cells must be as thin as possible and interconnected with each other by numerous openings.

Thus for the first time this invention discloses a new method of purifying by the use of open cell polyurethane cellular plastics for the purpose of filtering the tobacco smoke and of absorbing therefrom, to a high degree and most efficiently, the water insoluble tars and polymeric nicotine derivatives which, so far, could not be efficiently eliminated by conventional cellulosic or silica gel filters.

For most smoking purposes, filters containing only open cell polyurethane cellular plastic are sufficient. The not absorbed, water soluble low molecular resins and the nicotine impart to the smoke the by many smokers desired strong flavor, while the smoke is being filtered substantially free of unhealthy impurities. If, however, a very mild smoke is preferred with a simultaneous elimination of the most of the nicotine and of the strong flavoring resins, this invention provides a method and a tobacco smoke filter which is a not hitherto known combination of an open cell polyurethane foam with the conventional cellulosic fibers or silica gel pellets.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

Fig. 1 is a longitudinal cross sectional view of a cigarette and filter in accordance with the present invention;

Fig. 2 is a longitudinal cross sectional view of a cigarette and filter according to another embodiment of the present invention;

Fig. 3 is a longitudinal cross sectional view of a cig-

arette holder including a filter according to the present invention;

Fig. 4 is a longitudinal cross sectional view of a pipe including a filter in accordance with the present invention;

Fig. 5 is an end view of another embodiment of a cigarette filter according to the present invention; and

Fig. 6 is a longitudinal cross sectional view of a cigarette with a filter according to still another embodiment of the present invention.

Referring more particularly to the drawings, and specifically to Fig. 1, a cigarette 1 is provided with tobacco 3 and at the end of the cigarette with a filter consisting of an open cell polyurethane cellular plastic material.

In Fig. 2 a cigarette 1' is provided with tobacco 3' and with a filter 2' consisting of an open cell polyurethane cellular material, and between the tobacco 3' and the filter 2' is a layer of cotton fibers 4.

In Fig. 3 there is illustrated a cigarette holder 5 provided with a filter 6 consisting of open cell cellular polyurethane plastic material, and in Fig. 4 a pipe 9 is provided with a filter 10 consisting of an open cell cellular polyurethane plastic material.

The embodiment of Fig. 5 consists of alternate layers of open cell polyurethane cellular plastic material 7 and cotton felt 8 rolled into the form of a cylinder. The embodiment of Fig. 6 consists of a cigarette 1'' provided with tobacco 3'' and with a filter 2'' consisting of an open cell polyurethane cellular plastic material having embedded therein particles of silica gel 11.

The following examples illustrate the invention:

100 parts by weight of a polyester resin having an acid number of 35 and which was made from 3 mols of adipic acid, 3½ mols of 1,4-butylene glycol and ½ mol of glycerine, are copolymerized with 48 parts of a mixture of 2,4 and 2,6-m-toluene-diisocyanate in the presence of one part of a 10% aqueous solution of a nonionic emulsifier such as Aerosol OT of the American Cyanamid Corporation; and ½ part of an activator such as N-methyl morpholine. After the mixed mass has reached a creamy stage resembling whipped cream, it is poured into a preheated to about 150° F. aluminum mold, which was previously coated with a silicone mold-release compound. This mold has preferably the following dimensions: 1000 millimeters wide, 2000 millimeters long and 180 millimeters high. The mold is covered and cured for one hour at about 240° F. After cooling, an elastic, naturally white slab is produced, which after cutting off the upper and bottom thin skins, gives a fine dense but very light and elastic open cell foam having the following physico-chemical properties:

Volume weight	kg./m.^{3}	40
Tensile strength	kg./m.^{2}	1½
Resistance to compression	kg./m.^{2}	2
Average diameter of the open cells	millimeter	0.1

Average absorbing surface in one cubic centimeter, about 450 cm.^{2}.

This material is colorless, odorless and tasteless, non toxic, insoluble in solvents, does not promote growth of microorganisms, and has a sparkling look. It is highly elastic but at the same time soft in touch. More firm foams can be easily produced by the same method, and they are also very useful for filtering of the tobacco smoke, but they are less economical as a foam of a density of 100 kg./m.^{3} will give a filter of the same volume 2½ times heavier, and consequently 2½ times more expensive.

The resulting skinless, about 140 millimeters thick plate is now sliced into 10 millimeters and 1½ millimeter sheets.

Example 1

From the 10 millimeters sheet, cylinders are cut out having a diameter of 8 millimeters. Such a cylinder having a slightly larger diameter than the average diameter of a cigarette, fits because of its elastic compressibility perfectly into one end of the cigarette and thus provides a tight fitting filter for the smoke.

Example 2

Another method of manufacturing of a tobacco smoke filter under this invention is to place between the tobacco and the polyurethane filter a thin, 2 millimeters thick layer of loose cotton fibers. This will insure the removal from the smoke not only of the undersired polycyclic water insoluble pyrogenic tars as in Example 1, but also the rest of the water soluble low molecular resinous ingredients of the smoke and most of the nicotine.

Example 3

Another method of manufacturing of a tobacco smoke filter is to cut the 10 millimeters thick sheet into 10 millimeters wide strips and 2000 millimeters long and further to cut these long strips into pieces about 10 millimeters long. Because of the elastic compressibility of the foam, such a square piece when inserted into a cylindrical opening of the cigarette hull, fills it tightly and completely without channels.

Example 4

As in the Example 2, a thin 2 millimeters layer of loose viscose fibers is placed between the tobacco and the rectangular filtering piece of the polyurethane foam from the Example 3. It serves the same purpose as described in Example 3.

Example 5

Another method of manufacturing of a tobacco smoke filter is to use the 1½ millimeter thick sheet, and cut it into 10 millimeters wide and 2000 millimeters long strips. Said strips are cut into about 60 millimeters long pieces. Each piece is now 1½ millimeter thick, 10 millimeters wide and 60 millimeters long. The strip is then rolled up tightly to a 10 millimeters long cylinder having a diameter of about 8 millimeters. Such a cylinder through gentle squeezing is tightly inserted into the mouthpiece of a cigarette holder or pipe, or into one end of a cigarette.

Example 6

Another method of manufacturing of a tobacco smoke filter embodying the invented combination of cellulosic fibers with an open cell polyurethane foam, is to proceed as follows:

The 1½ millimeter thick sheet is again cut into 10 millimeters wide and 2000 millimeters long strips. Said strips are cut into about 40 millimeters long pieces. Upon each strip a one millimeter thick cotton felt is now placed, having the same dimensions, and all this is rolled up to a cylinder 10 millimeters long and of a diameter of about 8 millimeters. This cylinder is now, by gentle squeezing, inserted into one end of the cigarette, or placed into the mouthpiece of a cigarette holder or pipe.

Example 7

Another method of manufacturing of a tobacco smoke filter is to shred the 1½ millimeter thick sheet into shreds 4–5 millimeters long and 1–1½ millimeters wide and to fill with those shreds small separate hulls 10 millimeters long which are tightly fitted into one end of a cigarette.

Example 8

Another method of manufacturing of a tobacco smoke filter embodying the invented combination of cellulosic fibers with polyurethane foam is to mix the shredded polyurethane foam as was done in Example 7, with fine fibers of alpha-cellulose in a ratio of 1:1 and to fill with it small separate hulls as described in Example 7.

Example 9

Another method of manufacturing of a tobacco smoke filter embodying the invented combination of cellulosic

fibers with an open cell polyurethane foam, is to place at a distance of about 10 millimeters from the end of the cigarette hull an about 2 millimeters thick layer of loosely felted cotton fibers, after this an about 6 millimeters tightly packed layer of the shredded open cell polyurethane foam, made as described in the Example 7, and finally at the end of the cigarette again a 2 millimeters thick layer of cotton fibers.

Example 10

Another method of manufacturing of a tobacco smoke filter embodying the invented combination of open cell polyurethane cellular plastic material with silica gel pellets is to mix shredded polyurethane foam as described in Example 7 with silica gel pellets in a ratio of 1:1 and to fill with it a small separate hull as described in the Example 7.

Of course all those methods and applications as described in the Examples 1 to 10 to provide a tobacco smoke filter for cigarettes, in mass production can be accomplished by machines, similarly built as the ones which are producing cigarette filters consisting of conventional cellulosic fibers.

Finally it is worthwhile to mention the additional valuable properties of filtering devices for tobacco smoke embodying open cell polyurethane foams:

(1) The elastic resiliency of a tobacco smoke filter, containing an open cell polyurethane foam, imparts to the end of a cigarette a round feel, while held in the lips, and prevents squeezing or biting flat the end of the cigarette, thus unobstructing smooth smoking.

(2) While smoking, the water repellency of the open cell polyurethane foam prevents saliva from soaking into the cigarette and obstructing smoking.

(3) No ticklish cellulosic fibers protrude from the end of the cigarette while the cigarette is being held in the mouth, which sometimes happens with cigarettes containing conventional cellulosic fibers.

(4) Polyurethane cellular filters are hygienic.

(5) A polyurethane cellular filter because of its great absorption ability for organic fluids, can be easily flavored or medicated. This enables for the first time the manufacture of special cigarettes which during smoking give up an additional taste, flavor or medication for inhalation.

(6) Many smokers dislike filter cigarettes as the conventional cellulosic filters absorb the moisture from the smoke, thus making it dry and much more irritating for the respiratory tract. The polyurethane plastic foam being hydrophobic does not deprive the smoke of its natural moisture.

I wish to be understood that I do not claim any method of manufacturing of the open cell polyurethane cellular material in any form whatsoever. I do not claim here either the usefulness of open cell polyurethane cellular plastics as filtering media for general purifying purposes.

This invention is a result of a tedious and long research for a highly surfaced material which would have the property of a high absorbency for high molecular water insoluble tars occurring in the tobacco smoke and the ensuing discovery that open cell polyurethane cellular plastics because of their typical chemical composition and their unique polymeric and reticulated physical structure are specific and highly efficient for that purpose.

I claim:

1. A tobacco smoke filter containing as a tar absorbent an open cell polyurethane cellular plastic material.

2. A tobacco smoke filter containing as a tar absorbent an open cell polyurethane cellular plastic material, said material being the products of copolymerization of polyesters with organic isocyanates.

3. A tobacco smoke filtering device containing as a tar absorbent open cell polyurethane cellular plastic material, said material being made by copolymerization of polyesters with organic isocyanates, whereby its volume weight is not higher than 100 kilograms per cubic meter.

4. A tobacco smoke filter consisting of open cell polyurethane cellular plastic material combined with fibers of a cellulosic material.

5. A tobacco smoke filter consisting of open cell polyurethane cellular plastic material combined with silica gel pellets.

6. A cigarette fiter containing a combination of an open cell polyurethane cellular plastic material with alpha-cellulose fibers.

7. A cigarette filter consisting of a combination of an open cell polyurethane cellular plastic material with viscose rayon fibers.

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