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FILTER FOR TOBACCO SMOKE

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2 Claims. (Cl. 131—10)

This invention concerns filter means for treating or conditioning tobacco smoke to the end of rendering it less irritating or toxic.

Although there has been much debate on the subject, it seems generally agreed that tobacco smoke, particularly when inhaled, is at least potentially harmful, especially in the instance of individuals suffering from cardio-vascular and similar disorders. In the treatment of such cases, it has been found that substantial reduction or complete cessation of smoking frequently produces even more harmful effects because of shock, both physical and psychological, to the individual's system. A definite dilemma is thus presented, the resolution of which in an individual case is never a true solution. The problem is one which is of increasing magnitude due to the increasing popularity of cigarette smoking.

Even apparently physically sound individuals may show minor blood pressure changes due to smoking, but as to these individuals, nose and throat irritation is of the greatest concern.

My invention enables the removal of any desired proportion of the tars and nicotine present in tobacco smoke which account for its irritating properties and potential toxicity. Actually, of course, complete removal of these substances is not desirable due to considerations of taste and flavor. Moreover, in the event all of the tars and nicotine are removed no "smoke" is produced, i. e., the smoker draws into his mouth only colorless and highly unpalatable combustion gases. It is nevertheless significant as illustrating the remarkable nature of my invention that I can in fact achieve almost complete removal of the stated substances and even within the limits imposed by practical factors such as the necessity for maintaining a free "draw" and the relatively short length of filter-type cigar and cigarette holders.

My invention, as previously indicated, takes the form of a screening medium or filter disposed in the path of the tobacco smoke. The filter is distinguished in that it comprises a substantial proportion of asbestos or other small diameter fibers having a diameter corresponding to the diameter of the smoke particles to be removed and being of the order of 0.1 to 0.6 micron, these fibers being substantially uniformly distributed in a loose, uncompacted fashion in carrier fibers of substantially greater diameter, the latter being present in predominant proportion. While mineral fibers, such as asbestos or glass fibers, of the specified diameters have been found to be particularly satisfactory, fibers of a variety of other materials, such as nylon, cellulose acetate, viscose rayon, and polyester fibers such as Orlon and Dacron, are satisfactory provided their diameters are within the specified range.

As a practical matter it is difficult and expensive to obtain a supply of small diameter fibers all of which have a diameter within the range 0.1 to 0.6 micron unmixed with any fibers of somewhat larger diameter, and the objects of the present invention can be attained by employing, as the source of small diameter fibers, a

fibrous material in which some of the fibers have diameters outside of the 0.1 to 0.6 micron range, say in the range of 0.1 to 2.0 microns, provided a substantial proportion of fibers of the specified diameter are present.

In the case of asbestos, it has been found that fibers of the specified small diameter exist only in the form of very short lengths, most of them of the order of 0.004 to 0.012 inch in length, although a few may be as much as 0.12 inch in length. Asbestos which has been incompletely opened may contain "sticks" or bundles which appear fibrous and which are considerably longer than ¼ inch, but these will have diameters greater than 2.0 microns. While other fibers, particularly synthetic fibers, having the specified small diameter may exist in longer lengths, substantially all of the small diameter (0.1 to 0.6 micron) fibers in the filter of the present invention have a length less than ¼ inch.

The carrier fibers may be conventional textile fibers, cotton, rayon, or other cellulosic fibers being preferred, although wool and nylon fibers as well as fibers of other synthetic materials may also be employed. These fibers normally have diameters of the order of cotton fibers, i. e., 10 to 25 microns. The length of the carrier fibers may vary upwardly from 1/16 inch or even less, although they are preferably at least ¼ inch long and may be as much as several inches long, although normally, of course, their length will be no greater than the over-all dimensions of the filter.

I have found that most smokers do not consider the flavor of the tobacco as objectionally impaired when from 35%–60% by weight of the tars and nicotine are removed from the tobacco smoke. Accordingly, my invention is represented in its preferred embodiment by a filter manufactured to specifications which provide for the removal of from 35%–60% by weight of the smoke particles, usually 40%–50%. Generally and preferably such filter comprises about 2%–20% small diameter fibers (0.1–0.6 micron) based on the total weight of all the fibers in the filter.

It will, of course, be understood that the quantity of the tobacco smoke particles removed is not entirely a function of the concentration of the small diameter fibers since the density of the fiber mixture and the diameter and length of the filter must also be considered. As to cigarettes, I customarily prepare the filter (combining 2%–20% small diameter fibers) so that it has a diameter of about 0.81 to 0.83 centimeter, a length of about 1.0 to 1.5 centimeters and an apparent specific gravity (weight per unit volume) in grams per cubic centimeter of from 0.1 to 0.23.

The density of the filter is obviously a most important factor since there can be no substantial interference with "draw." It is this limitation on density or compactness particularly which has prevented the development of a really satisfactory tobacco smoke filter heretofore. Interestingly, conventional crepe paper filters and filters of the type comprising spun viscose are capable at best of removing not more than 5%–30% of the particles making up tobacco smoke before unreasonable interference with draw.

In the manufacture of my filter, it is important that the blending of the two classes of fibers be as uniform as possible. Using asbestos fibers as the small diameter fibers and cotton fibers as the carrier fibers, I customarily effect the blending on conventional textile machinery. Thus, I feed together to a picker-lapper two laps, one comprising the cotton fibers, the other the asbestos fibers. The picker-lapper delivers the laps to the cylinder of a cotton carding machine, the product of which is a substantially uniform web of the mixed fibers having a predetermined thickness. Alternatively, a mixing picker such as is used in the wool industry may be employed in

the preliminary blending and the blend may be delivered to the hopper of a wool carding machine. In any case, the working in the carding machine not only brings about the desired blending but also operates to open up the asbestos fibers as is manifestly necessary. A rod-shaped roving is formed from the web and cut into lengths as determined by the length of the particular filter. Where encasement of the roving is necessary or considered desirable, the roving may be drawn through a tubular member, normally of paper, which is cut simultaneously with the roving. Better, the encasing material may be formed into a U-shape, as by the use of a suitable mandrel, the roving deposited thereon and the whole passed through a tubular die member wherein the edges of the material are brought together, overlapped and secured, the roving being simultaneously compressed to provide the specified apparent specific gravity. In any case, additional mechanical strength may be imparted to the roving, when indicated, by braiding the same with cotton thread or the like, or by applying a binder or bonding material to the fibrous mixture to bind together the individual fibers or a substantial proportion of them at their intersections to render the filter firm and resilient while retaining its loose uncompacted nature without impairment of draw. Thermoplastic or thermosensitive materials such as synthetic resinous binders preferably having a softening or activation point of 150°–300° F. may be applied to the fiber mixture in the form of dry solid particles or liquid droplets or a solution or dispersion in a liquid medium. If desired, the binder material may itself take the form of a fibrous material and may replace part or all of either the small diameter or the carrier fibers. When a thermoplastic or thermosensitive binder is employed, either in the form of fibers or otherwise, a subsequent heating step is required to activate it and bond the fibers together at their intersections to stabilize the fibrous mass in its loose uncompacted form having the required apparent density. When the binder material is applied to the fiber mixture, care should be exercised to avoid coating the small diameter fibers so as to increase their diameters above the specified size. The proportion of binder material to the total fiber mixture is usually about 10%–25% by weight, preferably about 15% by weight.

It is to be clearly understood that the previously stated range on small diameter fiber concentration is not critical, for I may include either a substantially higher or a substantially lower proportion of such fibers. Even with amounts as low as 1%, I can effect a distinct improvement over crepe paper or all-cotton filters for example. However, for best results the content of small diameter fibers (0.1–0.6 micron) should not be much less than about 2% by weight of the total fiber mixture, preferably at least 5%. Depending upon the demand, the concentration of small diameter fibers in some cases may be as high as or higher than 30%, despite the fact that at this point there is definite impairment of tobacco taste and flavor. In the case of filter masses including from 5% to 30% by weight of small diameter fibers there will be present from 70% to 95% by weight of carrier fibers having a diameter on the order of cotton fibers. Such a filter mass preferably has substantially no greater resistance to draw than an equal volume of the cigarette tobacco.

The importance of using small diameter fibers of the diameter indicated cannot be overly emphasized. Fibers of greater diameter are relatively ineffective, while smaller diameter fibers have the disadvantage of contributing disproportionately to the air resistance and so are practically inoperable.

Tobacco smoke, as well understood, represents a dispersion of solid and liquid particles in air, the dispersion being extremely stable by reason of the small size of the particles, which makes the effect of gravity negligible compared with the effect of convection currents and Brownian movement.

The manner in which my invention works is perhaps best explained with the aid of diagrams. It has been determined that the diameter of the particles constituting tobacco smoke is about 0.1–0.6 micron. Since the diameter of paper fibers of the type heretofore employed in tobacco filters is of the order of 10–25 microns, there is presented a situation such as portrayed in Fig. 1, where A is a smoke particle, B is a cross-section of the paper fiber, C is a slip line representing the flow of the air stream, and D is a similar slip line with the Brownian movement of the particle (denoted by the wavy line F) superimposed thereon. It is clear that if the smoke particle is to be removed from the air stream, it must impinge or collide with the fiber. In the situation represented, the possibility of collisions are obviously remote. One solution to the problem would be to accelerate the particle to such an extent that it would be thrown from the air stream due to its greater inertia into a straight line path E toward the surface of the fiber. However, such a high linear speed manifestly could never be realized under the conditions involved in the problem to which the invention herein is addressed.

Another angle of attack would be to increase the number of fibers in the path of the particle by closer packing of the fibers and to pass the particle through this tight maze so slowly that it would be bound to collide with one of the fibers due to a diffusion effect. Obviously, this approach is also out of the question because of the limiting conditions here involved.

The invention will be described with reference to certain embodiments shown in the appended drawings in which:

Fig. 1 is a schematic representation of the path of a smoke particle past a fiber of large diameter;

Fig. 1*a* is a similar representation of a path of a smoke particle past a fiber of small diameter;

Fig. 2 is an elevation, partly broken away and in section, showing the filter of the present invention embodied in a cigarette;

Fig. 3 is an end elevation of another embodiment of my invention;

Fig. 4 is a view in elevation, partly broken away and in section, of a smoking pipe embodying the present invention; and

Fig. 5 is a view in elevation, partly broken away and in section, of a cigarette holder embodying the present invention.

Fig. 1*a* is representative of the mechanism of the filtration as effected according to the invention. Here, A' is the smoke particle, B' is a cross-section of a small diameter fiber, preferably an asbestos fiber, having a diameter approaching that of the smoke particle, and C' and D' are slip lines as in Fig. 1, wavy line F' denoting the Brownian movement of the particle as in that figure. In this instance, the displacement of the slip lines around the fiber is very slight indeed, and, as a consequence, the particle is almost certain to collide with the fiber and be removed from the air stream—especially when one considers the deviation resulting from the Brownian movement.

Moreover, it should be pointed out that the particle in Fig. 1*a* would not need to be accelerated to nearly as high a linear speed as the particle in Fig. 1 before the inertia of the particle would cause it to deviate sufficiently from the path represented by the slip lines to bring about its collision with the fiber.

The carrier fibers combined in my filter serve to maintain the structure sufficiently open to allow for easy passage of air. In the absence thereof, the density of the filter would be such that it would be virtually impossible to draw any smoke through it. As most preferably manufactured, the resistance of the filter is substantially no greater than the volume of tobacco as contained in a cigar, cigarette or pipe. Even under these conditions, upwards of 35%–50% of the tars and nicotine are effectively removed.

Forms which my invention may take are illustrated in Figs. 2 to 5, in which the filter material is indicated by the numerals **10**, **10'**, **10''** and **10'''** respectively, and may be assumed as combining cotton fibers or other fibers as the carrier fibers and Bolivian blue asbestos as the small diameter fiber component, such asbestos being particularly preferred for use according to the invention. In Fig. 2 the material is shown encased within a cigarette tip **12** which may simulate ivory or cork, for example, the tip having a slightly greater diameter (exaggerated in the drawing) than the body **14** of the cigarette and being secured thereto by means of a suitable adhesive. In this embodiment the fibrous mass **10** is in the form of a roving having the carrier fibers generally oriented in the direction of travel of the tobacco smoke. Fig. 3 affords an enlarged tip-end view of a cigarette construction in which the filter material in the form of a loose fibrous web **10'** is distributed in the folds of a conventional crepe paper filter **16**, relatively loosely formed. As shown in Fig. 3, the crimps of the crepe paper extend generally in the direction of travel of the tobacco smoke. This increases the efficiency of such a paper filter not less than 500%, assuming a weight ratio as between the fibrous filter material (comprising 2%–20% small diameter fibers) and the crepe paper of approximately 1:2.

The filter construction in the pipe represented by Fig. 4 is shown as including a paper casing **18**. A cloth casing, for example either finely woven or open mesh, may be substituted.

The filter disposed in the cigarette holder of Fig. 5 is also shown as including a casing **20** of paper or equivalent material. Because of the greater efficiency of the filter, it becomes loaded with tars and nicotone much sooner than conventional filters and accordingly should be changed more often. But the filter, even after the smoking of say ten cigarettes is still upwards of 200%

more efficient than a conventional filter freshly inserted in the holder.

This application is a continuation in part of my parent application Serial No. 260,187 filed December 6, 1951, now abandoned, and of my copending application Serial No. 384,673 filed October 7, 1953.

Although I have herein described specific embodiments of my invention, I do not intend to limit myself solely thereto, but to include all of the obvious variations and modifications within the spirit and scope of the appended claims.

I claim:

1. A tobacco smoke filter comprising a loose mass of intermingled fibrous material having an apparent density from 0.1 to 0.23 gram per cubic centimeter, said mass including a predominant proportion of carrier fibers and a lesser proportion of small diameter fibers, said carrier fibers having a diameter on the order of cotton fibers and said small diameter fibers having a diameter corresponding to the diameter of the smoke particles to be removed and being of the order of 0.1 to 0.6 micron.

2. A cigarette having a filter member for removing a substantial amount of the tars and nicotine from the smoke from said cigarette, said filter member comprising a loose mass of intermingled fibrous material having an apparent density from 0.1 to 0.23 gram per cubic centimeter and having substantially no greater resistance to draw than an equal volume of the cigarette tobacco, and said mass including from 70% to 95% by weight of carrier fibers having a diameter on the order of cotton fibers and from 5% to 30% by weight of small diameter fibers having a diameter corresponding to the diameter of the smoke particles to be removed and being of the order of 0.1 to 0.6 micron.

No references cited.

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Fig. 1.

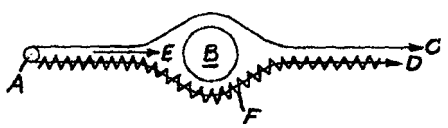

Fig. 1a.

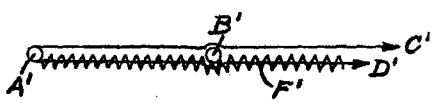

Fig. 2.

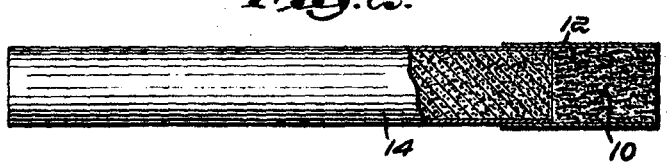

Fig. 3.

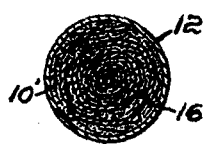

Fig. 4.

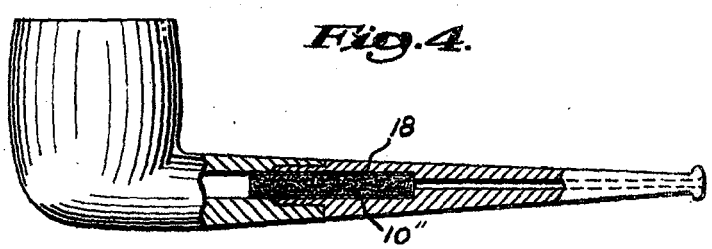

Fig. 5.

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