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FILTER FOR TOBACCO SMOKE

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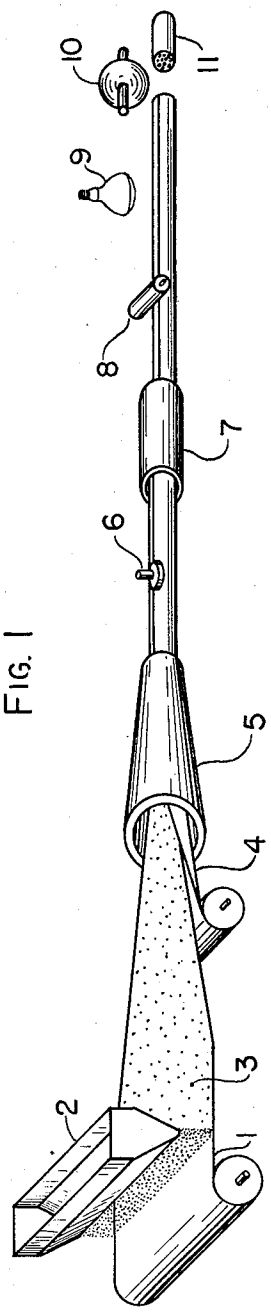


FIG. 1

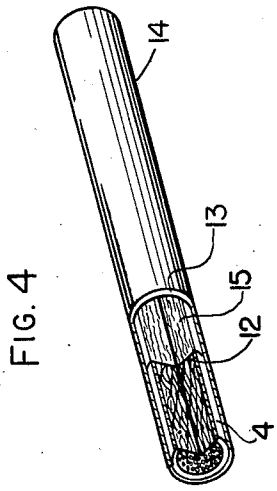


FIG. 4

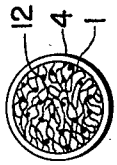


FIG. 3

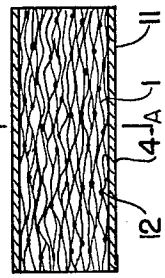


FIG. 2

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FILTER FOR TOBACCO SMOKE

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8 Claims. (Cl. 131—208)

This invention relates generally to tobacco smoking devices and more particularly to a novel filter for tobacco smoke and to a method for making the same.

This invention provides an improvement upon the tobacco smoke filter disclosed in the co-pending application of myself and James C. Rickards, Serial Number 400,072, filed December 23, 1953.

In the aforesaid application, there is disclosed a filter for tobacco smoke made up of a plurality of layers of crumpled paper formed by longitudinally gathering and pressing a continuous web of paper into a rod. As pointed out in that application, the paper utilized for the filtering medium must weigh between about 7 and 25 grams per square meter in order to provide a filter which is effective in removing the undesirable constituents from tobacco smoke. It is also pointed out in the application that optimum results are obtained if paper having a weight near the minimum weight specified is used in preference to the heavier paper. That is, paper weighing from 7 to 16 grams per square meter before the paper has been creped is more effective for removing the particulates from tobacco smoke than heavier paper. It has been found in practice, however, that the filter rods made from the lighter weight paper are very soft because such paper cannot be compressed as tightly as the heavier paper without substantially eliminating the passageways for the tobacco smoke. As a result, the rod is difficult to handle during the manufacture of cigarettes, particularly during that operation in which the rod is sub-divided into lengths suitable for a filter unit. It has also been found that filter paper of the type disclosed in the co-pending application is not stained uniformly during smoking of the cigarette when the basis weight of the paper is higher than about 16 grams per square meter. Although this is relatively unimportant insofar as effectiveness of the filter is concerned, it is definitely disadvantageous from the standpoint of appearance of the partially smoked cigarette.

It is, therefore, an object of this invention to provide a filter containing gathered and compressed layers of filter medium devoid of the foregoing disadvantages. Another object of this invention is to provide a filter for tobacco smoke having optimum filtration characteristics and having a rigidity which facilitates assembly of the filter unit with the tobacco to form a cigarette. Still another object of this invention is to provide a method for stiffening a filter unit formed from layers of light weight, soft paper. A further object of this invention is to provide a method for improving the rigidity and staining properties of a paper filter unit for tobacco smoke. A still further object is to provide a paper filter for tobacco smoke which will be stained uniformly by the tobacco smoke.

Other objects will become apparent from the following description with reference to the accompanying drawing in which

Figure 1 is a diagrammatic perspective view of an

apparatus suitable for forming an embodiment of the invention;

Figure 2 is an enlarged longitudinal sectional view of an embodiment of the invention;

Figure 3 is a cross section taken along the line A—A of Figure 2; and

Figure 4 is a perspective view, partially in section, illustrating an embodiment of the invention as a part of a cigarette.

In accordance with this invention, generally speaking, it has been found that the rigidity of a tobacco smoke filter formed of layers of light weight paper or similar compressible materials can be improved by incorporating an adhesive type stiffening agent in the filter medium prior to its formation into a rod and thereafter activating the adhesive to bind the layers of the medium together at places of contact therebetween. The adhesive may be a thermoplastic or thermosetting synthetic resin, a suitable natural resin, or a suitable starch, dextrin, casein, soya protein, gum or other similar adhesive material. Particles of the resin, either synthetic or natural, may be dusted on the surface of the paper web prior to shaping the web into rod form or the resin may be applied to the web as a suspension or solution thereof in a suitable liquid medium. In the latter process, the suspension or solution may be sprayed or brushed on one surface of the web or it may be applied to the surface by any other suitable means.

A filter medium having a density of from about 0.1 to 0.3 gram per cubic centimeter formed from paper weighing from about 7 to about 16 grams per square meter before it is creped, having the layers thereof spot bonded in accordance with this invention is particularly advantageous because it has the combined advantages of effective filtering, rigidity and optimum staining characteristics.

The paper web or other compressible material, after it has been treated with the adhesive material, is longitudinally gathered and compressed to form a rod having a plurality of layers of paper with tortuous passageways extending longitudinally therebetween. This rod is then treated in such a way as to activate the adhesive contained therein. If the adhesive is a resin the rod may be heated either to melt or set the resin to bring out the required bonding. If a suspension or a solution of an adhesive is utilized the rod may be heated to remove the liquid carrier and thus activate the adhesive.

Suitable resins include the co-polymers of vinyl chloride and vinyl acetate, polyethylene, phenolic and maleic esters, alkyd resins, terpene resins, phenol formaldehyde, ester gum, and any other suitable thermoplastic or thermosetting resin. Excellent results have been obtained with the following materials: Vinylite VYHH (a copolymer of vinyl chloride and vinyl acetate), manufactured by Carbide and Carbon Chemical Company, Polythene Resin D (polyethylene), manufactured by E. I. du Pont de Nemours & Co., Inc., Beckacite B/Elp.—242 (phenolic and maleic ester synthetic resin), manufactured by Reichhold Chemicals, Inc., Neolyn 35 (alkyd resin, rosin derivative), manufactured by Hercules Powder Company, Pentalyn A– and 78 (pentaerythritol ester of rosin), manufactured by Hercules Powder Company, and Piccolyte S–115 (terpene resin), manufactured by Pennsylvania Industrial Chemical Corporation. Such materials may be applied in powder form to the web or may be dissolved in any suitable solvent such as alcohol, acetone and the like.

It is also possible and indeed it is advantageous in some instances to incorporate the resin or some of the other adhesive type stiffening agents in the paper web during the formation of the paper. In such a process the paper fibers and resin particles may be mixed to-

gether in the beater or the head box of the paper machine. The resulting furnish may be sheeted by conventional means on a Fourdrinier or other suitable paper machine.

Adhesive type stiffening agents such as starch, dextrin, casein, soya protein and the like are usually applied to the web by spraying an aqueous solution or paste thereof on the web just prior to its formation into a filter rod.

Although the process provided by this invention is adaptable for making filters from paper of any suitable weight, it is most advantageous for making filters from papers within the weight range preferred for this invention, namely, paper weighing from about 7 to about 16 grams per square meter. As pointed out hereinbefore, filters formed from paper within this weight range are very effective in removing particulates from tobacco smoke but because they are inherently very soft they are very difficult to handle in the operation involved in assembling a filter unit with the other components of a cigarette. By treating the paper in accordance with this invention and thereafter forming the rod, as described above, a filter having sufficient rigidity to overcome this difficulty is obtained. Moreover, because of the exceedingly light weight of the paper, the staining of the filter medium by the tars and other materials in the tobacco smoke is uniform and, consequently, the appearance is improved. It has been found that these improvements can be obtained in accordance with this invention without deleteriously effecting the filtering characteristics of the paper.

In order better to describe and further clarify the invention, the following are specific embodiments thereof:

A continuous web of crepe paper **1** weighing about 16 grams per square meter after creping and about 8.6 grams per square meter before creping was dusted with particles of the co-polymer of vinyl chloride and vinyl acetate **3** sold under the trade name "Vinylite VYHH." The particles of resin **3** were dropped at random on the paper web **1** from a suitable hopper **2**, as illustrated in Figure 1, in such a manner that the resin was fairly well distributed over the sheet. The paper **1** was then longitudinally gathered and compressed by passing it through the forming cone **5** of a cigarette making apparatus. A paper wrapper **4** was placed about the compressed web **1** and the overlapping edges were adhesively bound together by means of a suitable gum adhesive applied to the lap by applicator wheel **6**, thereafter folding the lap over with cone **7** and activating the adhesive by means of a heated roller **8**. The resulting rod was passed under a bank of infra-red lights **9** where it was heated to a temperature of about 125° C. The resin became soft and tacky and as the rod cooled the layers of paper forming the filter medium were adhesively bound together at each point of contact therebetween as illustrated at **12** in Figures 2 and 4. The rod was then cut into lengths of about 66 millimeters by means of a conventional cigarette cutter **10**. This rod **11** weighed about 379 milligrams. The circumference of the rod **11** was about 25.3 millimeters and contained about 11.3% by weight of the resin.

A filter unit was obtained by cutting the rod **11** to 11 millimeters in length and this filter unit and sufficient tobacco **15** were inclosed within a suitable paper wrapper **13** to form a cigarette **14**, as illustrated in Figure 4. The cigarette was smoked on a conventional puffing machine which took a two seconds draw of 35 cubic centimeters volume once each minute. It was found that the tobacco smoke drawn through the filter in this way contained 33% less particulates than tobacco smoke from a similar cigarette not provided with the filter. Moreover, the rod **11** was sufficiently rigid to be cut without trouble into the desired lengths by a cut-off apparatus ordinarily utilized for cutting cigarettes.

A filter rod was made from paper of the same weight and by the same process as described immediately above except that no resin or other adhesive was applied to the surface of the paper before it was formed into the filter. A 66 millimeter length of the rod produced in this way weighed about 371 milligrams. A cigarette was made with a filter unit 11 millimeters long cut from this rod and tobacco like that used in the above described cigarette. The cigarette was smoked in accordance with the procedure described above and it was found that the filter removed about 32% of the particulates from the tobacco smoke. Comparing these results with those obtained with the cigarette having the filter containing the resin, we find that the two filters are substantially equal in effectiveness so the resin does not deleteriously effect the filtering characteristics of the filter. Each of the filter rods, the one containing the resin and the one free from resin, imposed a resistance to the flow of air therethrough equivalent to a column of water 4.8 inches high when the rate of flow of air through the rod was 17.5 cubic centimeters per second. The filter rod formed without the resin was so soft that difficulty was encountered in cutting it to the proper length and assembling it with the tobacco to form the cigarette.

In another embodiment of the invention, a filter rod was prepared in accordance with the foregoing procedure in which a resin was applied to the surface thereof but the paper weight in this instance was about 21 grams per square meter after creping. The stretch (M.O.S.) of the paper was about 37.5% and the basis weight before creping was about 13.3 (M.O.S.) grams per square meter. Granular polyethylene was dusted at random over the surface of the web at a rate such that the resulting paper contined about 17% polyethylene by weight in irregularly spaced areas of the web. The rod was formed by longitudinally gathering and compressing the web into a rod and thereafter heating the rod under infra-red lights to about 120° C. Although the rod was not quite as rigid as the one containing the co-polymer of vinyl chloride and vinyl acetate, it proved more satisfactory during the cutting operation than a filter not containing any adhesive or stiffening agent because of its inherent ability to spring back or recover from any deformation caused by the pressure of the cut-off knife.

In another embodiment a continuously moving paper web weighing about 21 grams per square meter after creping and about 13.3 (M.O.S.) grams before creping was dusted with the co-polymer of vinyl chloride and vinyl acetate at such a rate that the resulting paper contained about 13% by weight of the resin randomly spaced over its surface. The web was then longitudinally gathered and compressed into a filter rod by means of a cigarette machine forming cone and was baked at 120° C. under infra-red lights, as described above. The paper utilized was from the same roll of paper as that used in the above embodiment containing the polyethylene and had a similar weight. The resulting rod was sufficiently firm or rigid to be adapted for cutting to the proper lengths without difficulty and a filter tip about 11 millimeters long removed about 28% of the particulates from the tobacco smoke of a burning cigarette containing the same type of tobacco as the cigarettes of the other embodiments.

A filter rod was prepared from similar paper without any resin having been incorporated therein. This filter tip was sufficiently soft to cause trouble in the cut-off operation. A filter made from this rod was no more effective in removing particulates from tobacco smoke than the more rigid one containing 13% of the co-polymer of vinyl chloride and vinyl acetate described above.

Filter units have also been made from Beckacite B/Elp.–242 (phenolic and maleic ester synthetic resin), Neolyn 35 (alkyd resin, rosin derivative), Pentalyn A– and 78 (pentaerythritol ester of rosin), and Piccolyte S–115 (terpen resin). Each of these resins imparts sufficient rigidity to the rod to facilitate cutting thereof into lengths and the filter units containing these resins are substantially equal to a filter unit devoid of resin in

effectiveness in removing undesirable constituents from tobacco smoke.

In still another embodiment of this invention, paper similar to that utilized in the foregoing embodiment weighing about 21 grams per square meter after creping was sprayed with a solution of about 25 parts by weight potato starch in water. The resulting rod was baked to remove the moisture and was found to be sufficiently stiff to permit cutting without difficulty. The rod contained about 11% (M.O.S.) by weight starch. The density of the treated rod was about 0.13 cubic centimeter. It was found to be as effective in removing undesirable constituents from tobacco smoke as a filter similar thereto in all respects except that the paper did not contain any starch or other stiffening agent.

In an embodiment wherein the adhesive was incorporated in the paper during its formation, about 10 parts powdered copolymer of vinyl chloride and vinyl acetate were mixed with 90 parts by weight paper making fibers in the beater or head box of the paper making machine. The furnish was sheeted by conventional means on a Fourdinier paper machine. The basis weight of the paper was about 16 grams per square meter. A filter rod was then formed from the paper by longitudinally gathering and compressing it into a cylindrical shape by passing it through a forming cone of a conventional cigarette making machine and the rod was heated to about 120° C. to spot weld the paper layers where they were in contact with each other within the rod. The resulting rod was sufficiently rigid to be cut into the desired lengths without difficulty and was equal in effectiveness to a filter similar thereto except the paper contained no resin.

It is to be preferred (M.O.S.) that the adhesive material does (M.O.S.) not completely cover the paper filtering medium in order that the highest (M.O.S.) filtering effectiveness (M.O.S.) will be retained. It is preferred to sprinkle the powder or to apply the solution of the adhesive at random over the surface of the sheet but the areas of adhesive can form any pattern on the surface in so long as the surface is not completely coated with adhesive. In other words, the areas containing the resin or other adhesive material may be irregularly or regularly spaced over the web but, for best results, the adhesive should cover only a minor area of the surface of the sheet. It has been found that from about 4% to about 25% by weight adhesive is sufficient to bring about spot bonding of the layers of the filter at the point of contact and that these amounts will not deleteriously effect the filtering characteristics of the paper. Any means for heating the rod to activate the adhesive can be utilized. For example, the infra-red lights can be replaced with a suitably heated oven.

In order to improve the absorption characteristics of the paper, it may be mechanically worked by crumbling or embossing before it is gathered and compressed to form the rod of filtering medium. The crumpling can be achieved by passing the web through a series of orifices of the type described in the aforesaid copending application. Moreover, materials such as activated charcoal, silica gel, aluminum hydroxide, and the like may be incorporated in the paper to improve the adsorbent properties of the filter. Indeed the combination of mechanically working the paper with the use of paper containing one of the adsorbent materials and with the "spot bonding" provided by this invention produces a most effective and preferred embodiment of this invention. Moreover, the filtering characteristics can be even further enhanced by forming ragged edged rents in the paper before it is formed into a rod.

Although the invention has been described in considerable detail in the foregoing for the purpose of illustration, it is to be understood that such detail is solely for this purpose and that many variations can be made by those skilled in the art without departing from the spirit and scope except as limited by the appended claims.

I claim:

1. A filter for tobacco smoke comprising a wrapper and within the wrapper a plurality of layers of crumpled paper having tortuous longitudinal passageways therebetween, said paper comprising cellulosic fibers and spaced areas containing an adhesive which binds the layers thereof together at spaced points of contact along the passageways.

2. A filter for tobacco smoke comprising a filter medium of a plurality of layers of crumpled paper having tortuous longitudinal passageways therebetween, said layers of paper having irregularly spaced areas containing an adhesive binding them together at points of contact along the passageways.

3. A filter for tobacco smoke having a density of approximately 0.1 to 0.3 gram per cubic centimeter comprising a wrapper and within the wrapper a plurality of layers of paper having tortuous longitudinal passageways therebetween, said layers of paper weighing from about 7 to 16 grams per square meter before being creped and containing intermixed cellulose fibers and particles of an adhesive stiffening agent which spot bond the layers together at spaced points of contact along the passageways.

4. A filter for tobacco smoke comprising a wrapper and within the wrapper a plurality of layers of crumpled paper weighing from about 7 to about 16 grams per square meter before being creped and having tortuous longitudinal passageways therebetween, said paper comprising cellulosic fibers and intermixed therewith randomly spaced particles of an adhesive type stiffening agent, said paper layers being bound together by said adhesive at spaced points along the passageways.

5. The filter of claim 4 wherein said agent is a synthetic resin.

6. The filter of claim 4 wherein said agent is starch.

7. The filter of claim 4 wherein said agent is the copolymer of vinyl chloride and vinyl acetate.

8. The filter of claim 4 wherein said agent is a water activated binder.

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