Nov. 12, 1957 R. MacHENRY 2,813,051

METHOD OF PRODUCING AN ABSORBENT ELEMENT FOR FILTERS

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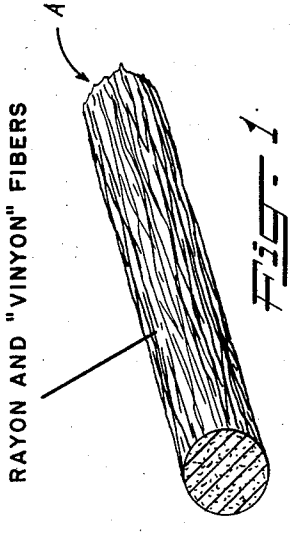


Fig. 1

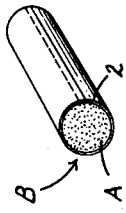


Fig. 2

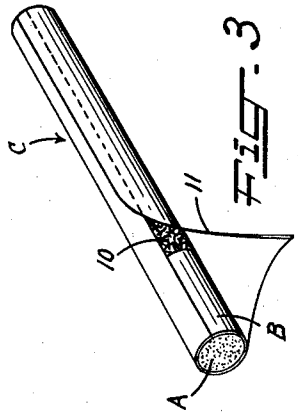


Fig. 3

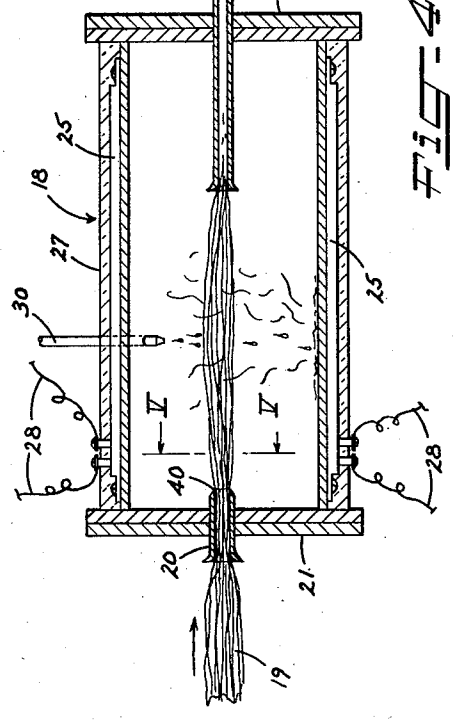


Fig. 4

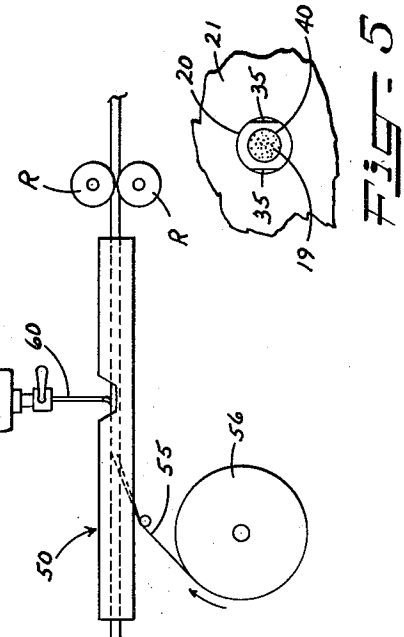


Fig. 5

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METHOD OF PRODUCING AN ABSORBENT ELEMENT FOR FILTERS

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11 Claims. (Cl. 154—90)

The present invention relates to a method of producing a porous, absorbent element of synthetic fibers and particularly such an element suitable as a cigarette filter.

My invention, as herein described, relates principally to tobacco smoke filters; however, the absorbent fibrous elements may be used in dental or surgical pads, dressings, tampons, and the like.

Tobacco smoke is made up of a mixture of gaseous compounds and finely divided solids. The smoke comprises tar, phenol, acetic acid, acrolein, carbon dioxide, water vapor, and solid dust particles. These compounds and elements are formed and derived from the disintegration of the tobacco and, in the case of cigarettes, the cigarette paper wrapper around the tobacco. Most of these substances are contained in tobacco smoke in the vapor state. The major portions of these ingredients are not trapped by the conventional filters so that they pass through the filter into the smoker's mouth and lungs. Therefore, currently known tobacco smoke filters have not proved to be entirely satisfactory and the tobacco companies, especially the cigarette manufacturers, are constantly searching for improved tobacco smoke filters.

The requirements for a satisfactory tobacco smoke filter are, first, that it effectively remove toxic or harmful ingredients from the smoke drawn into the user's mouth. Secondly, the filter must be sufficiently porous so that it does not interfere with free passage of the smoke or what is commonly termed the "draw." In addition, a cigarette filter must be sufficiently firm to support the cigarette without bending or becoming undesirably soft and flabby. It will be appreciated from the above requirements that good "draw" is ordinarily inversely proportional to filtering ability, namely, the denser the filter, the more effective is the filtering, but suction required to draw the smoke through the filter is also higher. Due to the peculiarly beneficial structure resulting from a uniform mixture of a major proportion of crimped staple fibers and a minor proportion of potentially adhesive fibers which serve to bond the mixture together, I have been able to produce a filter which approaches the desired results of maximum filtering combined with easy draw.

It is therefore one object of my invention to provide a novel and improved method for producing a compact, porous and absorbent fibrous element wherein the fibers are autogenously bonded together.

Another object of my invention is to provide a novel and improved method for producing an internally bound, firm bodied, absorbent element for medical and surgical uses.

Another object of my invention is to provide a novel and improved method for producing tobacco smoke filter material from a fibrous element wherein the fibers within the mass are autogenously bonded together.

A still further object of the invention is to provide a novel and improved method for producing an absorbent tobacco smoke filter element having maximum draw and filtering properties.

A further object of the invention is to provide a novel

and improved method for producing an inexpensive filter or sponge element characterized by a firm body, light weight and maximum filtering efficiency.

Further objects and advantages of my invention will become more apparent from a study of the following description and drawing wherein:

Figure 1 is a view of the fibrous element in bundle or sliver form;

Figure 2 is a perspective of my tobacco smoke filter wrapped in suitable wrapping material;

Figure 3 is a perspective of a filter type cigarette with my tobacco smoke filter incorporated therein;

Figure 4 is a section of the apparatus for forming my filter material; and

Figure 5 is an enlarged fragmentary view taken along lines V—V of Figure 4.

Generally, my method for forming the fibrous absorbent element comprises the steps of forming a sliver or bundle of a mixture of non-adhesive fibers and potentially adhesive fibers. The formed sliver is then passed through an activating chamber wherein the potentially adhesive fibers are activated to autogenously bond together the fibers within the sliver. The sliver is compressed as it is discharged from the activating chamber. When the fibrous mass is used for tobacco smoke filters, the compressed sliver is wrapped in a continuous manner with a suitable paper cover.

It will be understood that throughout the following specification and claims, the terms "non-adhesive" and "potentially adhesive" refer to types of fibers, one of which becomes tacky or adhesive under conditions under under which the other fiber is relatively unaffected. Where the tacky or adhesive condition results from elevated temperature, the potentially adhesive fibers will, of course, be of a thermoplastic nature. Ordinarily, the non-adhesive fiber will not be thermoplastic but a thermoplastic fiber could be used provided the temperature at which it became tacky is sufficiently higher than the temperature at which the other potentially adhesive fiber becomes tacky. By way of example, the potentially adhesive fibers are formed from vinyl resins resulting from the polymerization of compounds containing the vinyl group such as polyvinylchloride or copolymers of vinyl chloride and vinyl acetate. Other potentially adhesive fibers, however, may be used successfully in the present invention, for example, certain copolymers of vinyl chloride and acrylonitrile.

Referring now to the drawings wherein preferred embodiments of my invention are shown, Figure 1 shows the fibrous element in bundle or sliver form. As seen therein, the sliver A is a carefully blended mixture of non-adhesive regenerated cellulose fibers, such as rayon staple, and potentially adhesive or thermoplastic fibers such as those formed from the compound sold commercially under the name "Vinyon." The fibers mentioned above are of the "textile fiber" class having diameters of at least 9 microns.

The mixture of the present invention can be satisfactorily formed by uniformly distributing 10–25% of the potentially adhesive fibers into the major proportion, 75–90% by weight, of crimped rayon staple fiber. It has been found that the potentially adhesive fibers should comprise at least 10% by weight of the mixture and preferably should be in the range of 10–15% by weight.

The length of the individual fibers, both potentially adhesive and non-adhesive, may vary from ⅝ to 2½ inches and should be between 1 to 2½ denier, preferably 1 to 1½ denier. Due to the crimp in the non-adhesive fibers and, if desired, in the potentially adhesive fibers, minute traps or voids are formed within the body of the element

which enhance the absorptiveness of the element and also provide for the porosity which in turn permits easy draw.

The fibers specified above range in weight from 100–125 grains and the fine relatively short length fibers provides compact, dense structure in which many of the shorter length fibers will be across the general longitudinal axis of the element.

An important feature of my invention is that the non-adhesive or rayon fibers within the fibrous mass are crimped. In the case of rayon, the fibers may be crimped chemically as distinguished from a mechanical crimp. Such chemical crimping is disclosed and claimed in United States Patent 2,517,694. This crimping remains in the fiber even when it is wet. The filaments, however, may be mechanically crimped according to well known processes and apparatus. Since relatively small denier fibers are used to form the element and since the fibers are crimped, numerous minute traps or voids are formed within the element which render the fibrous element capable of entrapping and retaining liquids, moisture and minute solid particles. The potentially adhesive fibers may or may not be crimped. When converting the fibrous sliver to specific articles of use, the potentially adhesive fibers are activated, as will be explained hereinafter, to autogenously bond together the non-adhesive fibers in the sliver A. The fibers are compressed, as will also be explained, after the potentially adhesive fibers have been activated to provide a compact article of good strength.

A tobacco smoke filter or plug B formed from the fibrous mass or sliver A of Figure 1 is shown in Figure 2 of the drawing. The tobacco smoke filter B, in this instance, is of cylindrical shape. The potentially adhesive fibers have been activated and compressed to autogenously bond together the non-adhesive rayon fibers and the potentially adhesive fibers to provide a compact cylindrical shaped article of good strength. When the completed element is to be used as a cigarette filter, the bonded element is wrapped or stuffed in a paper wrapper 2 and cut into suitable lengths to form the filter plug B.

Figure 3 shows the wrapped filter plug B of Figure 2 incorporated in a cigarette C. The tobacco **10** and the filter plug B are formed into a unitary cigarette having the usual cigarette paper **11**.

The apparatus for forming and converting the mixed sliver to a tow or rod from which filter elements can be cut has been designed to insure a combination of all the desired properties for a cigarette filter Such a filter element must have firmness or body, maximum filtering ability and porosity to permit free and easy draw. As is well known in the filter art, density of the filter is inversely proportional to the draw or pressure required to force the fluid through the filter. In the present filter and apparatus, it has been possible to obtain maximum filtering and absorbing properties without increasing the density to the point where there is an objectional lack of draw. The crimped fibers which are uniformly and homogeneously bound while being compressed in a predetermined manner cooperate to provide this unexpected and desired result.

The apparatus in which the relatively loose sliver is activated and transformed into a comparatively strong, dense but porous rod comprises a chamber or tube **18** into which the sliver **19** is drawn through a funnel shaped die **20** mounted in the forward end wall **21** of the chamber. The tacky sliver is drawn out of the chamber **18** through a relatively longer die **23** mounted in the rear wall **24** of the chamber and in alignment with die **20**. Die **23** has a substantially smaller bore than entrance die **20**. The preferred diameters for the entrance and exit dies are three-quarters and three-eighths of an inch respectively when it is desired to fabricate a cigarette filter. For other articles the dimension of the bores may be changed but substantially the same ratio should be maintained. The inside of the chamber **18** is maintained at an elevated temperature of approximately 110° C. by means of one or more heating elements **25, 25** which surround the walls of the chamber. If desired, the heating elements are covered by suitable insulating material **27** through which electrical connections to the heaters may be made at **28, 28**. At a point approximately midway between the downstream terminus of die **20** and the upstream terminus of die **23**, a liquid-softening or activating agent such as acetone is introduced into the chamber through a nozzle **30**. The acetone may fall directly on the sliver in the chamber or it may be vaporized when it falls onto the heated chamber wall. The 110° C. temperature maintained within the heated chamber is sufficient to maintain the activating agent in a vapor state during the travel of the sliver through the chamber. In either event the potentially adhesive fibers in the sliver are sufficiently softened throughout the sliver so that when the sliver is drawn through die **23** there is a compression or rearrangement of the structure to provide a firm, compact, internally bound but porous rod **31**. The potentially adhesive fibers set up after leaving die **23** when they are cooled and the acetone evaporates or is otherwise removed. Partial setting up may take place in the bore of die **23** and the length and relative axial position of this forming die in the end wall **24** is so controlled to provide the results which may be desired. In order to eliminate sticking or deposition of material in the bore of either of the dies, they are preferably made of polytetrafluoroethylene, sold commercially under the trade name of Teflon.

Depending upon the degree of activation found desirable and the speed with which the sliver is drawn through chamber **18** by means of draw rolls R, R, it may be found necessary or desirable to provide limited venting for the chamber. This can be accomplished by the provision of one or more flats **35, 35** (Figure 5) along the side of the entrance die **20**. These flats extend through the end wall **21** so that limited venting of the interior of chamber **18** is achieved. By providing an annular bevel **40** on the downstream end of die **20**, it is possible to prevent build-up or adherence of fibers to any part of die **20**.

When the activated sliver is to be used for tobacco smoke filters, the rod **31**, after leaving the chamber **18**, passes through a wrapping apparatus **50** wherein a continuous sheet of wrapping paper **55** supplied from a reel **56** is folded around the rod **31**. The wrapper **55** is sealed by applying an adhesive from a liquid adhesive applicator **60** connected with an adhesive supply container **61**. The diameter of the bore of the wrapping apparatus **50** through which the activated sliver passes is somewhat smaller than the diameter of the exit die **23** of the activation chamber or chamber **18** whereby the diameter of the tow is further reduced to correspond with the diameter of a cigarette or tobacco cylinder with which the filter plug B is to be incorporated.

Vaporized acetone as an activating agent for the potentially adhesive fibers is preferred in that it has been found that the fibers within the rod **31** which have been subjected to vaporized acetone are more firmly bonded together and the finished filter plug exhibits greater stiffness and excellent draw properties which features also contribute to the success of the filter. It has also been found that the cleaner cuts may be made with the acetone activated filter plug. In the apparatus described above, the softening of the potentially adhesive fibers is achieved primarily by means of the solvent, namely, acetone, which is applied to the fibers. However, it will be understood that the temperature in chamber **18** may be sufficiently elevated to assist or, if desired, completely provide for the softening of the minor proportion fibers.

Another important feature of my invention is that the filtering efficiency of a tobacco smoke filter improves during use. An inherent property of viscose rayon is that it swells considerably when in contact with water or mois-

ture. When my filter is incorporated with cigarettes, the filtering action improves as the tobacco cylinder burns down since the rayon fibers swell when contacted by the moisture within the smoke. The smoke components or ingredients which have been filtered out by the base portion of the tobacco cylinder will therefore be more effectively filtered out by the swollen fibers as the base portion of the tobacco cylinder burns.

Various colored fibers may be used in the filter to provide a variety of color schemes for the filter. The dye pigment matter may be incorporated with the filament forming spinning solution. Undyed extruded filaments, from which the staple is cut, may be dyed by passing the filaments through suitable dye baths.

If desired, aromatics such as perfume or menthol may be incorporated with the filter material to provide a filter having a pleasing aroma. In addition, other desired or essential oils may be incorporated with the filter.

My tobacco smoke filter plug is porous and has excellent draw properties which permit the smoker to easily pull the smoke through the filter. The filter is economical to produce and has sufficient strength and firmness to permit normal processing of the filter when incorporating it with cigarettes or other tobacco smoking articles. As explained above, the filter plug contains many minute voids or traps because fine denier fibers are used and because the fibers contain a crimp. The traps easily catch and retain the vapor and solid components of the smoke passing therethrough.

As mentioned above, my fibrous mass has numerous uses since it has good liquid and moisture retention properties. Among the uses is that of dental saliva pads which are placed within the patient's mouth to absorb excess saliva. Tampons may also be produced from my fibrous absorptive mass. The fibrous mass may also be used in other fields of medicine and surgery wherein liquid retentive pads are required.

It is to be understood that changes and variations may be made without departing from the spirit and scope of the present invention as defined in the appended claims.

I claim:

1. A method of producing a compact, porous and absorbent article comprising the steps of forming a mixture of non-adhesive and potentially adhesive fibers, passing the fiber mixture through a chamber, activating the potentially adhesive fibers within said chamber with a vaporized activating agent, heating the chamber to a temperature sufficient to maintain the activating agent in a vapor state during the travel of the fiber mixture through the chamber, and subsequently compressing the fiber mixture.

2. A method for producing a compact, porous and absorbent fibrous element from potentially adhesive and non-adhesive fibers comprising the steps of forming a sliver of potentially adhesive and non-adhesive fibers, passing the sliver through a chamber, activating the potentially adhesive fibers within said chamber with a vaporized activating agent, heating the chamber to a temperature sufficient to maintain the activating agent in a vapor state during the travel of the sliver through the chamber, and compressing the sliver as it leaves the chamber to bring the fibers into more intimate relationship.

3. A method for producing a compact, porous and absorbent fibrous element comprising the steps of forming a sliver of non-adhesive fibers and potentially adhesive fibers, passing the sliver through a heated chamber, activating the potentially adhesive fibers within said chamber with a vaporized activating agent, maintaining the temperature of the chamber sufficient to retain the activating agent in a vapor state during the travel of the sliver through the chamber, and compressing the sliver as it emerges from the heated chamber to bring the fibers into intimate relationship.

4. A method for producing a tobacco smoke filter plug material comprising the steps of forming a sliver of potentially adhesive and non-adhesive fibers, passing the sliver through a chamber, activating the potentially adhesive fibers within said chamber with a vaporized activating agent, heating the chamber to a temperature sufficient to maintain the activating agent in a vapor state during the travel of the sliver through the chamber, compressing the sliver to reduce its diameter, and wrapping the sliver in a paper wrapper.

5. A method for producing tobacco smoke filter plug material comprising the steps of forming a sliver of potentially adhesive and non-thermoplastic fibers, passing the sliver through a heated chamber, activating the potentially adhesive fibers within said chamber with a vaporized activating agent, maintaining the temperature of the chamber sufficient to retain the activating agent in a vapor state during the travel of the sliver through the chamber, compressing the sliver to reduce its diameter, and wrapping the sliver in a paper wrapper.

6. The method of producing a firm bodied, porous element for filters and the like, said element being composed of a mixture of crimped non-adhesive and thermoplastic textile fibers, comprising the steps of softening the thermoplastic fibers in the mixture with vaporized acetone under conditions of elevated temperature high enough to maintain the vaporized acetone in a vapor state during the travel of the fiber mixture through the chamber, radially compressing the fiber mixture while the thermoplastic fibers are in a tacky condition, and permitting the fibers to set up while in the compressed condition.

7. A method for producing a compact, porous and absorbent fibrous element from a mixture of non-adhesive and potentially adhesive fibers comprising the steps of forming a sliver of 10 to 25% by weight of the sliver of the potentially adhesive fibers and 75 to 90% of the non-adhesive fibers, passing the sliver through a chamber, heating the chamber, introducing acetone into the chamber, vaporizing the acetone to activate the potentially adhesive fibers within the sliver passing through the chamber, compressing the sliver as it is discharged from the chamber to bring the fibers into more intimate relationship, and volatilizing the acetone from the activated fibers after the sliver is discharged from the chamber.

8. A method for producing a fibrous element according to claim 7 comprising the step of introducing the acetone into the heated chamber in droplet form.

9. A method for producing a compact, porous and absorbent article according to claim 7 wherein the sliver comprises 85% by weight of the article of non-adhesive fibers and 15% of potentially adhesive fibers.

10. A method for producing a cigarette filter plug material comprising the steps of forming a sliver of 75 to 90% by weight of the sliver of non-adhesive fibers and 10 to 25% of potentially adhesive fibers, passing the sliver through a chamber, heating the chamber, introducing acetone into the chamber, vaporizing the acetone to activate the potentially adhesive fibers within the sliver passing through the chamber, compressing the sliver to reduce the sliver diameter, volatilizing the acetone from the activated fibers after the sliver is discharged from the chamber, and wrapping the tow in a paper wrapper.

11. A method for producing a cigarette filter plug material comprising the steps of forming a sliver of 85% by weight of viscose rayon fibers and 15% of thermoplastic fibers formed from a copolymer of vinyl chloride and vinyl acetate, passing the sliver through an activating chamber, heating the chamber to about 110° C., injecting acetone in drop form into the chamber, vaporizing the acetone after it drops into the chamber, activating the thermoplastic fibers with the acetone vapor, confin-

ing the sliver as it passes from the chamber to reduce the sliver diameter and to bring the fibers into intimate relationship, volatilizing the acetone within the activated fibers after the sliver is discharged from the chamber, applying adhesive to one edge of a continuous wrapper for the sliver, wrapping the sliver in a continuous manner with a paper wrapper, sealing the wrapper, and compressing the sliver as it is wrapped to further reduce its diameter.

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