

1,121,474



PATENT SPECIFICATION

DRAWINGS ATTACHED

1,121,474

Date of Application and filing Complete Specification: 1 September, 1965.

No. 37281/65

Application made in United States of America (No. 394982) on 8 September, 1964.

Complete Specification Published: 31 July, 1968.

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Index at Acceptance:—C3 P (7A, 7C8C, 7C9, 7C12B, 7D1A, 7D1C, 7D1X, 7K7); A2 C (1E2, 1E3); D1 R3.

Int. Cl.:—C 08 f 29/02.

COMPLETE SPECIFICATION

Tobacco Smoke Filters

We, EASTMAN KODAK COMPANY, a Company organized under the Laws of the State of New Jersey, United States of America of 343 State Street, Rochester, New York 14650, United States of America (Assignees of BOBBY JONBS SUBLETT and GEORGE PATRICK TOUEY) do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to the production of tobacco smoke filters from crimped filaments.

In accordance with the present invention a method of making tobacco smoke filters from crimped filaments comprises applying to the filaments, either separately or in admixture, a solid particulate filter additive having a particle size in the range of 12 to 200 mesh and a solid particulate thermoplastic polyolefin having a particle size in the range of 10 to 300 mesh and having a softening point below the softening or charring point of the filaments, the amount of filter additive representing from 50 to 95 percent by weight of the combined weights of additive and polyolefin, and heating the filaments, either before or after conversion into filters, to the softening temperature of the polyolefin so that upon cooling the polyolefin particles bond the additive particles to the filaments.

The invention further provides a tobacco smoke filter made of crimped filaments wherein filter additive particles having a particle size in the range of 12 to 200 mesh are bonded to the filaments by means of a thermoplastic polyolefin.

When the solid additive particles and the particles of polyolefin bonding agents are intimately mixed or commingled with the filaments of the opened filter tow they are

preferably subjected to a heat treatment 45 which softens but does not melt or cause the bonding agent to flow. The softening bonding agent particle acts to grip both the filament and the particle of solid additive in a manner which firmly attaches one to 50 the other. This phenomenon repeats itself innumerable times at random points over the upper surface of the filter tow.

It should be noted that the polyolefin bonding agent need only be heated to its 55 softening point to be given its unique gripping capacity and, therefore, a properly heated bonding agent softens only to the extent necessary to firmly attach the additive particles to the filaments. Furthermore, 60 the softened bonding agent adheres to only a small portion of the total surface area of the additive to leave the major portion of its porous surface exposed to adsorb and remove the gaseous components from 65 tobacco smoke.

The bonding agent thus forms bonds which bind the additive particles to the filaments with sufficient tenacity to prevent them from being shaken loose from the filaments to which they are attached, either during the filter rod shaping operation or in use as a filter element. This type of adhesion is more akin to a cementing action wherein a matrix is formed than to the type 75 of adhesion resulting from the application of a tacky adhesive.

Typical of polyolefin and copolymers having properties and softening temperature ranges which give them particular value in practicing our invention are the following:

Polymer	Softening Point °C	
Polyethylene	70-160°	
Polypropylene	90-180°	85
Ethylene-propylene copolymer	80-170°	
Propylene-butylene copolymer	50-110°	

In producing cigarette filters in accordance

[Price 4s. 6d.]

with our invention, one may employ any suitable filamentary material such as a tow composed of crimped filaments of regenerated cellulose, cellulose acetate, polyolefins (polyethylene, polypropylene, polybutylene and copolymers thereof), polyamides, polyesters, polyacrylonitriles and the like. One of the most satisfactory materials for this purpose is a tow made of 6,000 to 10,000 crimped continuous filaments of 3 to 8 denier per filament having 8 to 16 crimps per inch of filament length. In preparing the tow in preparation for bonding solid particulate additives, such as activated carbon to the filamentary mass, the tow will be removed from a bale or other package thereof and subjected to a "blooming" operation which is a mechanical treatment well-known in the art of cigarette filter manufacture in which the individual filaments of the tow are opened or fluffed in such manner as partially to deparallelize the individual filaments and give the tow increased bulk. The first step in this operation is to pass the tow, as it comes off the bale or other package, through a device known as a banding jet which causes the rope or bundle of crimped filamentary material to become flattened out into the form of a band or ribbon as it is conveyed through the device by a blast of air. The band of filaments thus produced may then be passed through a set of pre-tensioning rolls which serve to debundle the filamentary material, that is, to separate the individual filaments one from another, partially deparallelize them and give the band increased bulk.

Alternatively, one may start with a previously bloomed, that is debundled, opened or fluffed tow and deposit both the solid particulate additive and the solid particulate bonding agent on it. The solid particulate additive may be any suitable material which is capable of removing gaseous and/or particulate components from tobacco smoke, such as activated carbon, rice starch, cellulose acetate floc, calcium carbonate or other suitable material. If activated carbon is employed, it may be derived from a number of different materials such as wood, petroleum, coconut shell, coal, blood, bone and other materials and is preferably applied in admixture with the polyolefin bonding agent.

As to the matter of particle size of both the additive and the bonding material this is measured in terms of "mesh". By this is meant the size of particle which will pass through the square openings between the wires of a wire mesh screen or sieve of standard construction as to the number of openings per inch and as to the diameter of wire employed. For example, a 12 mesh particle will just pass through the .0661 inch openings in a screen or sieve having 12 openings

per inch formed between wires each having a diameter of .0272 inch on the U.S. Standard Sieve Series, likewise a 100 mesh particle will just pass through the .0059 inch opening in a screen having 100 openings per inch formed between wires each having a diameter of .0040 on this standard and so on. When reference is made to a range of particle sizes, as for example, 20×50 mesh, this includes all particles which have a mesh size falling within this range. Thus, this range would exclude all particles too coarse to pass through a 20 mesh and particles no larger than those which would just pass a 50 mesh screen.

The solid particulate additive, such as granulated activated carbon, and which can have a particle size ranging from 12 to 200 mesh, preferably has a particle size within the range 12×30 to 100×200 mesh. In other words, if it is desired to deposit relatively coarse particles the particle size will fall within the range of 12×30 mesh. For finer material the size will fall within the range of 100×200 mesh. The preferred range is 20×50 mesh.

As to the particle size of the bonding agent it has been found that the coarsest particle size should in general not be greater than 10 mesh and the smallest particle size should not be finer than 300 mesh, with a preferred range for most practical purposes of 40-120 mesh. In general, the particle size of the bonding agent will be selected with reference to the particle size of the solid particulate additive it is desired to employ. If one employs a solid additive having relatively large particles, the particle size of the bonding agent in general may be relatively large although in some cases it may be advantageous to employ a bonding agent of relative small particle size when employing relatively large particle size additive. On the other hand, if one employs a fine particle size additive, the particle size of the bonding agent will be proportionately small.

The actual deposition of both the solid particulate additive, such as activated carbon particles, and solid particulate bonding agent may be accomplished by any appropriate method and means. For example, the solid particulate additive may be first sprinkled on a flat band of bloomed or opened continuous filament cellulose acetate tow made up of a large number of crimped filaments after which the solid particulate bonding agent may be sprinkled over the surface of the tow bearing the carbon particles. The thus treated band of tow may be subjected to a sufficient degree of heat from any appropriate source to cause the particles of the bonding agent in contact with both particles of carbon and the filaments to soften and become slightly tacky and in that condition to cause the carbon

particles to become firmly attached to the filaments at random points, throughout the filamentary structure, after which the tow is caused to assume a substantially cylindrical form, wrapped and cut to the desired lengths to form the finished cigarette filter.

Another method of depositing the additive particles and the bonding agent particles is to spread them on the tow from a mixture thereof, as for example, a mixture containing 95-50 percent by weight of an additive such as an activated carbon of 20 × 50 mesh and the balance particles of a dry bonding agent such as a propylene-butylene copolymer of 12 × 40 mesh.

Alternatively, the complete cylindrical rod containing the carbon particles and the bonding agent may be preformed into a filter rod then subjected to a heating step to accomplish the bonding action.

It will be understood that the actual amounts or proportions of both the additive and the bonding agent will be determined by the type of filters being produced. For example, some cigarette producers may prefer a filter of 10 mm. standard length and 25 mm. circumference to contain 100 mg. of activated carbon while others may prefer to have a greater or less amount of carbon present and the amount of carbon or other solid additive deposited thus will vary in accordance with the requirements of any given user.

In the accompanying drawing:—

Figure 1 illustrates an enlarged segment of a single filament of a tobacco smoke filter produced in accordance with the invention and shows the manner in which solid particles are firmly bound to the filament by means of solid particles of a thermoplastic polyolefin;

Figure 2 is a cross section to an enlarged scale, taken on the line 2-2 of Fig. 1 and illustrating the manner in which the bonding agent acts to attach the solid particle firmly to the filament leaving a major portion of the porous surface of the particle exposed; and

Fig. 3 is a highly magnified section of a small portion of a cigarette filter tow produced in accordance with the invention and illustrating distribution of relatively large activated carbon or other particles in the filamentary network.

Figure 2 illustrates only a typical cross sectional configuration of a filament and it should be realized that this invention is equally effective with all types of filaments having varying cross sectional configurations.

As illustrated filaments 1 have carbon particles 2 bonded thereto by means of heat sensitive polyolefin particles 3.

In the following Examples I, II and III, a mixture of carbon granules and a finely ground polyolefin was shaken evenly over a 150 mm. length of crimped cellulose acetate tow which had been spread to a width of 15 inches. The tow was then compacted and wrapped in a paper tape to form a filter rod. This rod was heated in an oven and, after being allowed to cool to room temperature, was cut into filters having a length of 10 mm. These filters were attached to king size cigarettes by means of a cellulose acetate tape and smoked by an automatic smoking device. The vapour which passed through the filter was collected and analyzed by gas chromatography, the amounts of several components of the collected gas being tabulated in Table I, which also includes for comparison, a tabulation of the corresponding components found in unfiltered smoke.

Example I

A mixture of 1125 mg. of 12 × 30 mesh coconut carbon granules and 281 mg. of finely ground polypropylene was spread on a tow comprised of 6000 filaments of 5 denier per filament. The resulting filter rod was heated in an oven at 130°C. for 10 minutes.

Example II

A mixture of 1650 mg. of 20 × 50 mesh petroleum carbon granules and 550 mg. of powdered polyethylene was spread on a tow comprised of 3700 filaments of 5 denier per filament. The resulting filter rod was heated in an oven at 113°C. for 15 minutes.

Example III

A mixture of 810 mg. of 30 × 60 mesh carbon granules derived from wood and 145 mg. of a finely ground copolymer of propylene and butylene which had a particle size of 20 × 50 mesh and analyzed as 40 per cent butylene was spread on a tow comprised of 20,000 filaments of 1.6 denier per filament. The resulting filter rod was heated in an oven at 85°C. for 8 minutes.

Table I

Component	μg. found in smoke from one cigarette			
	Unfiltered	Example I	Example II	Example III
Acetaldehyde	800	240	200	560
Propionaldehyde	40	12	10	20
Acrolein	85	21	9	42
Methanol	120	36	40	72
Methyl ethyl ketone	75	22	15	45
Isoprene	600	180	150	360

Example IV

A mixture of 150 mg. of 40 × 60 mesh cellulose acetate flake and 30 mg. of finely ground polyethylene having a softening point of 92°C. was shaken on to a 150 mm. length of crimped cellulose acetate tow comprising 6000 filaments of 5 denier per filament spread out to a width of 15 inches. The tow was then compacted and wrapped in a paper tape to form a filter rod which was heated in an oven at 105°C. for 5 minutes. After cooling to room temperature, the rod was cut into 20 mm. length filters

containing approximately 20 mg. of cellulose acetate flake bonded to the cellulose acetate tow.

Several filters made in this manner were opened and examined. It was observed that the cellulose acetate flake particles were firmly attached to the cellulose acetate fibres. None of the particles sifted out of the filters when they were tapped on a hard surface.

The per cent of particulate matter removed by one of these filters and by two other similar filters from which the additive was omitted, are compared in Table 2.

Table 2

Filter	Filter Length	Pressure Drop	Per cent Removal of Particulate Matter
(a) 5 den./fil., 16,000 filaments, cellulose acetate with no additive	20 mm.	2.8	33
(b) 5 den./fil., 12,000 filaments, cellulose acetate with 20 mg. of cellulose acetate flake bonded to tow	20 mm.	2.8	51
(c) 5 den./fil., 12,000 filaments, cellulose acetate with no additive	20 mm.	2.0	28

While in the above Examples we have described heating preformed rods containing an additive to cause the heat sensitive polyolefinic component to soften and bond the additive to the filaments, the bonding may be accomplished by heating the spread out tow prior to forming the tow into a filter.

Example V

A tow composed of crimped cellulose acetate filaments of 5 denier per filament and having a total denier of 30,000 (60,000 filaments) was continuously withdrawn from a bale and drawn continuously through a cigarette filter rod processing machine. At one point in the process, the tow was opened and bloomed to a width of 15 inches. The tow then passed under a vibrating pan applicator which sprinkled it with a mixture of 90 per cent of 20 × 50 mesh activated carbon and 10 per cent finely divided polyethylene binder having a softening temperature within the range of 70-160°C. The tow containing the carbon-polyethylene mixture then passed under a series of infrared heating elements which were attached to the filter rod making machine. The heat from these elements caused the polyethylene to soften. The continuously moving tow then entered that part of the filter rod making machine containing a series of tensioning rolls. Finally it was drawn into a garniture which compacted it and wrapped it with paper to form a filter rod. Analysis of the rods showed that they contained on the average 110 mg. of carbon and 11 mg. of polyethylene per 10 mm. length of filter rod.

A 10 mm. filter rod prepared as described above was attached to a king-size cigarette

by means of a cellulose acetate tape. The cigarette was then smoked with an automatic smoking device, the vapour which passed through the filter being collected and analyzed by gas chromatography. The amounts of several components of the collected gas are listed in the following table. The amounts of the same components found in unfiltered smoke are listed for comparison.

Table 3

Component	μ.g. Found in Unfiltered Smoke From One Cigarette	μ.g. Found in Filtered Smoke From One Cigarette
Acetaldehyde	800	200
Propionaldehyde	40	10
Acrolein	85	9
Methanol	120	40
Methyl Ethyl Ketone	75	15
Isoprene	600	150

It will be seen from the above description of the invention that we have provided a means of producing an improved tobacco smoke filter which satisfactorily meets the rather stringent requirements of the tobacco industry and particularly when such filter rods or plugs are employed as cigarette filters. The improved filters produced in accordance with the invention are clean, non-dusting and have high filtration efficiency and permeability to the gaseous components of tobacco smoke. In the case where an activated carbon type filter is employed, excellent permeability is obtained by the fact that relatively large carbon particles can now be effectively secured to the filamentary structure of the cigarette filter

by a bonding agent which not only precludes mechanical removal of the carbon during manufacture of the filter and in its use in a cigarette or other tobacco smoke filter element, but also does not fill up the pores of the carbon to such an extent as to render it ineffective or inoperative to adsorb or remove gaseous components from tobacco smoke.

10 WHAT WE CLAIM IS:—

1. A method of making tobacco smoke filters from crimped filaments comprising applying to the filaments, either separately or in admixture, a solid particulate filter additive having a particle size in the range of 12 to 200 mesh and a solid particulate thermoplastic polyolefin having a particle size in the range of 10 to 300 mesh and having a softening point below the softening or charring point of the filaments, the amount of filter additive representing from 50 to 95 percent by weight of the combined weights of additive and polyolefin, and heating the filaments, either before or after conversion into filters, to the softening temperature of the polyolefin so that upon cooling the polyolefin particles bond the additive particles to the filaments.

2. A method according to claim 1 wherein the filter additive comprises carbon granules and is applied to the filaments in admixture with the polyolefin.

3. Methods of making tobacco smoke filter from crimped filaments substantially as hereinbefore described.

4. A tobacco smoke filter of crimped filaments whenever made by the method according to claim 1, 2 or 3.

5. A tobacco smoke filter made of crimped filaments wherein filter additive particles having a particle size in the range of 12 to 200 mesh are bonded to the filaments by means of thermoplastic polyolefin.

6. A tobacco smoke filter according to Claim 5, wherein the filter additive particles comprise carbon particles.

7. A tobacco smoke filter according to Claim 5 or Claim 6, wherein the polyolefin comprises a polyethylene having a softening temperature within the range of 70-160°C.

8. A tobacco smoke filter according to Claim 5 or Claim 6, wherein the polyolefin comprises a polypropylene having a softening temperature within the range of 90-180°C.

9. A tobacco smoke filter according to Claim 5 or Claim 6, wherein the polyolefin comprised an ethylene propylene copolymer having a softening temperature within the range of 80-170°C.

10. A tobacco smoke filter according to Claim 5 or Claim 6, wherein the polyolefin comprises a propylene butylene copolymer having a softening temperature within the range 50-110°C.

11. Tobacco smoke filters substantially as hereinbefore described.

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