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(54) **FILTER FOR SMOKING ARTICLE**

(57) The present invention addresses the problem of providing a filter for a smoking article that can reduce a stimulus component such as formaldehyde, and that does not reduce any more than necessary a component affecting the smoke flavor included in mainstream smoke. This problem is solved by providing a smoking article filter comprising a filter segment that has a porous material containing: a hydrotalcite particle; and a nonfibrous binder resin.

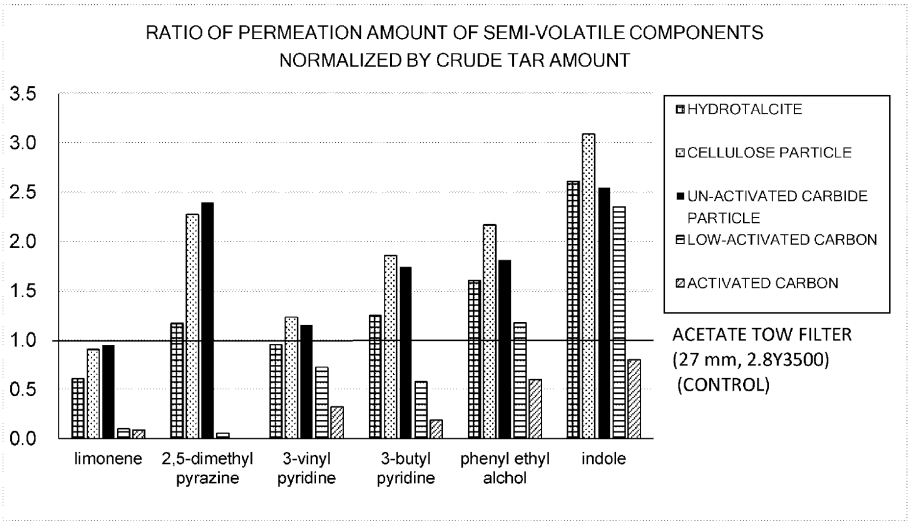

Fig. 1

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Description

[Technical Field]

[0001] The present invention relates to a filter for a smoking article.

[Background Art]

[0002] Research and development have been actively conducted to provide filters with a function of removing, during smoking, only unnecessary components out of the components contained in tobacco smoke, or a function of imparting specific flavor and taste to tobacco smoke when using a filter cigarette.

[0003] As a means for achieving this, it is known to prepare a porous substance including a material for adjusting the components contained in tobacco smoke and use the porous substance as a constituent material of the filter (see, for example, Patent Document 1 to 3).

[0004] Materials for adjusting components contained in tobacco smoke are exemplified by active particles (Patent Document 1 to 3).

[0005] Also known is a cigarette filter having a filter plug including a filter material in which filtration rate controlling particles selected from cellulose particles, cellulose triacetate particles, and mixtures thereof are dispersed in a tow of cellulose acetate fibers (Patent Document 4).

[Citation List]

[Patent Document]

[0006]

[Patent Document 1] Japanese Translation of PCT Application No. 2016-510993
[Patent Document 2] Japanese Translation of PCT Application No. 2014-509833
[Patent Document 3] Japanese Patent Application Publication No. 2013-215196
[Patent Document 4] Japanese Translation of PCT Application No. 2016-510995

[Summary of Invention]

[Technical Problem]

[0007] When a porous substance including active particles described in Patent Document 1 to 3 is used as a constituent material of a filter, irritating components such as carbon monoxide, phenol and formaldehyde in tobacco smoke can be reduced but other mainstream smoke components are also reduced.

[0008] Further, with the filter material described in Patent Document 4, since the filtration rate controlling particles such as cellulose particles are dispersed inside the tow of cellulose acetate fibers and the occupation ratio of the tow of cellulose acetate fibers in the filter is large, the mainstream smoke components may be reduced more than necessary.

[0009] As indicated above, according to the techniques described in Patent Document 1 to 4, in addition to irritating components such as carbon monoxide, phenol and formaldehyde, the mainstream smoke components are also reduced. As a result, the user may not be able to enjoy smoking fully.

[0010] With the foregoing in view, the present invention provides a filter for a smoking article or the like which can reduce irritating components, such as formaldehyde, and does not reduce more than necessary the components affecting the flavor and taste in mainstream smoke.

[Solution to Problem]

[0011] As a result of intensive research by the inventors of the present invention, it has been found that the above-mentioned problem can be resolved by a filter for a smoking article, the filter comprising a filter segment including a porous material containing a hydrotalcite particle and a nonfibrous binder resin.

[0012] Thus, the present invention is as follows.

[1] A filter for a smoking article, the filter comprising a filter segment including a porous material containing a hydrotalcite particle and a nonfibrous binder resin.
[2] The filter for a smoking article according to [1], wherein the porous material further contains a cellulose particle.

[3] The filter for a smoking article according to [2], wherein the hydrotalcite particle and the cellulose particle are in a weight ratio of from 10:90 to 30:70.

[4] The filter for a smoking article according to any one of [1] to [3], wherein the hydrotalcite particle is formed of a hydrotalcite compound represented by the formula (1):

$$M^{2+}_{1-x}M^{3+}_{x}(OH)_2(A^{n-})_{x/n}\cdot mH_2O \qquad (1)$$

wherein M^{2+} is a divalent metal ion selected from the group consisting of Mg, Zn, Ni, and Ca, M^{3+} is Al ion, A^{n-} is an anion having a valency of n and selected from the group consisting of CO_3, SO_4, OOC-COO, Cl, Br, F, NO_3, $Fe(CN)_6^{3-}$, $Fe(CN)_6^{4-}$, phthalic acid, isophthalic acid, terephthalic acid, maleic acid, alkenyl acid and derivatives thereof, malic acid, salicyl ic acid, acrylic acid, adipic acid, succinic acid, citric acid and sulfonic acid, $0.1 < x < 0.4$, and $0 < m < 2$.

[5] The filter for a smoking article according to any one of [1] to [4], wherein the hydrotalcite particle has a mean particle diameter of from 200 to 800 μm.

[6] The filter for a smoking article according to any one of [1] to [5], wherein the nonfibrous binder resin is a thermoplastic resin.

[7] The filter for a smoking article according to any one of [1] to [6], wherein the filter segment including the porous material containing the hydrotalcite particle and the nonfibrous binder resin includes no plasticizer.

[8] The filter for a smoking article according to any one of [1] to [7], wherein the hydrotalcite particle and the nonfibrous binder resin are at a weight ratio of from 70:30 to 80:20 in the porous material.

[Effects of Invention]

[0013] According to the present invention, there is provided a filter for a smoking article or the like which can reduce irritating components, such as formaldehyde, and does not reduce more than necessary the components affecting the flavor and taste in mainstream smoke.

[Brief Description of the Drawings]

[0014]

[Fig. 1] Fig. 1 is a diagram showing measurement results of a ratio of a permeation amount of semi-volatile components normalized by a crude tar amount.

[Fig. 2] Fig. 2 is a diagram showing measurement results of a permeation amount of formaldehyde normalized by a crude tar amount.

[Fig. 3] Fig. 3 is a schematic diagram showing an example of an embodiment of a filter for a smoking article.

[Fig. 4] Fig. 4 is a schematic diagram showing another example of an embodiment of a filter for a smoking article.

[Fig. 5] Fig. 5 is a schematic diagram showing an apparatus for measuring formaldehyde.

[Description of Embodiments]

[0015] Hereinafter, the present invention will be described in detail with reference to embodiments, examples, and the like, but the present invention is not limited to the following embodiments and examples, and the like and may be implemented while being arbitrarily changed without departing from the gist of the present invention.

<Hydrotalcite Particle>

[0016] A filter for a smoking article according to an embodiment of the present invention includes a filter segment including a porous material containing a hydrotalcite particle and a nonfibrous binder resin.

[0017] The hydrotalcite particle is completely different in properties from the active particles described in the above-mentioned Patent Document 1 to 3.

[0018] Specifically, while the active particles described in Patent Document 1 to 3 have a property of demonstrating adsorptivity or a property of inducing chemical reactions with respect to components contributing to flavor and taste, the hydrotalcite particle used in the embodiment of the present invention has lower ability to adsorb components contributing to flavor and taste than the active particles described in Patent Document 1 to 3 and does not induce chemical reactions with the components contributing to flavor and taste.

[0019] In addition, the hydrotalcite particle used in this embodiment has higher ability to adsorb formaldehyde as an irritating component than cellulose particles described in Patent Document 4.

[0020] The hydrotalcite particle is a particle of a known compound having a layered structure similar to that of hydrotalcite; see, for example, WO 2003/056947.

[0021] Specifically, the hydrotalcite compound constituting the hydrotalcite particle can be represented by the following formula (1):

$$M^{2+}_{1-x}M^{3+}_{x}(OH)_2(A^{n-})_{x/n}\cdot mH_2O \qquad (1)$$

wherein M^{2+} is a divalent metal ion selected from the group consisting of Mg, Zn, Ni, and Ca, M^{3+} is Al ion, A^{n-} is an anion having a valency of n and selected from the group consisting of CO_3, SO_4, OOC-COO, Cl, Br, F, NO_3, $Fe(CN)_6^{3-}$, $Fe(CN)_6^{4-}$, phthalic acid, isophthalic acid, terephthalic acid, maleic acid, alkenyl acid and derivatives thereof, malic acid, salicylic acid, acrylic acid, adipic acid, succinic acid, citric acid and sulfonic acid, $0.1 < x < 0.4$, and $0 < m < 2$.

[0022] It is preferable that in the above general formula, M^{2+} is a Mg ion, M^{3+} is an Al ion, A^{n-} is CO_3^{2-} or SO_4^{2-}, x is $0.1 < x < 0.4$, m is $0 < m < 2$. Such Mg-Al hydrotalcite compound is stable when x is in the range of from 0.20 to 0.33. The above general formula is most preferably $Mg_6Al_2(OH)_{16}CO_3\cdot 4H_2O$.

[0023] The Mg-Al hydrotalcite compound can be manufactured by adding an alkali carbonate or an alkali carbonate and a caustic alkali to an aqueous solution of a water-soluble aluminum salt selected from aluminum sulfate, aluminum acetate and alum, or aluminic acid and a water-soluble magnesium salt, and conducting a reaction while keeping the pH of the reaction mixture at 8.0 or more. The obtained hydrotalcite compound can be pulverized and classified to obtain particles of the hydrotalcite compound.

[0024] The hydrotalcite particles can be granulated, classified, and processed to a preferable particle diameter. As a granulation method, granulation by extrusion molding or compression molding is preferable because particles having a BET specific surface area of 500 m^2/g or less are easily formed. In particular, granulation by extrusion molding is preferable because particles having a BET specific surface area of 100 m^2/g or less are easily formed.

[0025] The BET specific surface area of the hydrotalcite particles is preferably from 1 to 200 m^2/g.

[0026] The average particle diameter of the hydrotalcite particles is preferably from 200 to 800 μm. This average particle diameter is an average of secondary particles of hydrotalcite particles. Such particle diameter contributes to good adsorption to semi-volatile components. The average particle diameter can be measured using an image analysis-type particle size distribution measuring device (for example, Camsizer X2 manufactured by Retsch Technology).

[0027] The "components contributing to flavor and taste", as referred to herein, are semi-volatile components contained in tobacco smoke, and can be more specifically exemplified by limonene, 2,5-dimethylpyrazine, 3-vinylpyridine, 3-butylpyridine, phenylethyl alcohol, and indole.

[0028] The hydrotalcite particle according to the embodiment of the present invention, when used in a filter for a smoking article, does not selectively reduce any component contributing to flavor and taste, specifically, the abovementioned semi-volatile components, relative to crude tar in tobacco smoke.

[0029] The porous material included in the filter segment according to the embodiment of the present invention may include a cellulose particle in addition to the hydrotalcite particle.

[0030] The cellulose particle can be prepared by compression molding a commercially available cellulose powder such as microcrystalline cellulose as a raw material by a compression type granulating apparatus, pulverizing the obtained molded body and classifying. The cellulose particle can be made with reference to WO 2013/084661. Alternatively, a commercially available cellulose molded body may be used.

[0031] The cellulose particles may have a volume-based median diameter (D50) of from 100 to 1700 μm, preferably 200 to 1500 μm, and more preferably 300 to 1300 μm.

[0032] The median diameter (D50) can be measured with a laser diffraction/scattering type particle diameter distribution (granulometric distribution) measuring device.

[0033] The bulk density of the cellulose particles may be from 0.05 to 1.00 g/cc, preferably 0.10 to 0.90 g/cc, and more preferably 0.15 to 0.85 g/cc.

[0034] The bulk density of the cellulose particles can be measured with, for example, a Powder Characteristics Tester PT-X manufactured by Hosokawa Micron Corporation.

[0035] The BET specific surface area of the cellulose particle is preferably 10 m^2/g or less, and more preferably equal to or less than the detection limit. The lower limit of the BET specific surface area of the cellulose particle may be more than 0 m^2/g, for example.

[0036] Like the above-mentioned hydrotalcite particle, the cellulose particle has the ability not to selectively reduce the semi-volatile components contained in tobacco smoke relative to crude tar of tobacco smoke.

[0037] When the cellulose particle is used in combination with the hydrotalcite particle, it is possible to design the desired flavor and taste produced by tobacco smoke by adjusting the compounding ratio of the particles, without adjusting the length of the filter segment including the particles.

[0038] When the above hydrotalcite particle and cellulose particle are used in combination, the weight ratio thereof is preferably from 10:90 to 30:70, and more preferably from 10:90 to 20:80.

[0039] Also, it is preferable that the cellulose particle have a particle diameter of from 10 to 70 mesh based on JIS Z 8801-1 (2006). Within such a particle diameter range, cellulose particles can be evenly present inside the porous material, and contribution is made to not selectively reducing the semi-volatile component.

[0040] The hydrotalcite particle and cellulose particle are thermally stable at 150°C. "Thermally stable", as referred to herein, means that the ability of not selectively reducing components contributing to flavor and taste relative to crude tar in tobacco smoke before heating to 150°C is not different from that after the heating, and that the particles do not deform when heated to 150°C.

[0041] Conventionally, it was not thought that hydrotalcite particles are very resistant to heat, but the inventors of the present invention have found that hydrotalcite particles do not lose their properties even when heated to 150°C.

[0042] In addition to the hydrotalcite particle, the porous material of the filter segment according to the embodiment of the present invention may or may not include other inert particles together with the cellulose particle or instead of the cellulose particle, within the range in which the effect of the present invention is not impaired.

[0043] In the present specification, the wording "not selectively reducing relative to crude tar in tobacco smoke" means that the delivery amount of semi-volatile components normalized by a crude tar amount which is determined by the below-described method for measuring the delivery amount of semi-volatile components, which is performed with respect to the filter for a smoking article according to the embodiment of the present invention, is generally larger than that of the below-described typical filter for a smoking article.

[0044] A filter (airflow resistance is 85 mmH_2O/27 mm) including about 7% by weight of triacetin as a plasticizer in a cellulose acetate fiber bundle is used as a typical (control) filter.

(Smoking Test)

[0045] The permeation amount (delivery amount) of a semi-volatile component is measured as follows.

[0046] Automatic smoking is performed using an automatic smoking device (RM20D, manufactured by Borgwaldt KC Inc.) under the conditions of a suction capacity of 35.0 mL/2 sec, a suction time of 2 sec/puff, and a suction frequency of 1 puff/min, the crude tar is collected using a Cambridge filter (CM-133, manufactured by Borgwaldt KC Inc.), and the smoke passing through the Cambridge filter is collected in 10 mL of methanol cooled to -70°C with a coolant composed of dry ice and isopropanol. Further, d-32 pentadecane as an internal standard substance is contained in the methanol solution at a concentration of 5 μg/mL.

[0047] The Cambridge filter that collected the crude tar and 10 mL of the methanol solution that collected the cigarette smoke are transferred to a serum bottle and shaken for 30 min. After shaking, the supernatant is collected and used as an analytical sample.

[0048] The analytical sample is analyzed by gas chromatograph mass spectrometry (GC-MSD). Agilent 7890A (Agilent Technologies Inc.) is used for GC and Agilent 5975C (Agilent Technologies Inc.) is used for MSD.

<Binder Resin>

[0049] The porous material of the filter segment of the filter for a smoking article according to the embodiment of the present invention includes a nonfibrous binder resin. "Nonfibrous", as referred to herein, means that the resin is not fibrous like a cellulose acetate tow.

[0050] As the binder resin, for example, a thermoplastic resin can be mentioned.

[0051] Examples of the thermoplastic resin include, but are not limited to, polyolefins, polyesters, polyamides (or nylon), polyacrylates, polystyrene, polyvinyl, polytetrafluoroethylene (PTFE), polyether ether ketone (PEEK), copolymers thereof, derivatives thereof, combinations thereof, and the like. Examples of polyolefins include, but are not limited to, polyethylene, polypropylene, polybutylene, polymethylpentene, copolymers thereof, derivatives thereof, combinations thereof, and the like. Examples of suitable polyethylene further include low-density polyethylene, linear low-density polyethylene, high-density polyethylene, copolymers thereof, derivatives thereof, combinations thereof, and the like.

[0052] Examples of suitable polyesters include polyethylene terephthalate, polybutylene terephthalate, polycyclohexylenedimethylene terephthalate, polytrimethylene terephthalate, copolymers thereof, derivatives thereof, combinations thereof, and the like.

[0053] Examples of suitable polyacrylates include, but are not limited to, polymethyl methacrylate, copolymers thereof, derivatives thereof, combinations thereof, and the like.

[0054] Examples of suitable polystyrenes include, but are not limited to, polystyrene, acrylonitrile butadiene styrene, styrene acrylonitrile, styrene butadiene, styrene maleic anhydride, copolymers thereof, derivatives thereof, combinations thereof, and the like.

[0055] Examples of suitable polyvinyls include, but are not limited to, ethylene vinyl acetate, ethylene vinyl alcohol, polyvinyl chloride, copolymers thereof, derivatives thereof, combinations thereof, and the like.

[0056] In the embodiment of the present invention, it is preferable to use at least one of polyethylene, a copolymer of

polyethylene, a derivative of polyethylene, and a combination thereof as the binder resin.

[0057] Polyethylene can be exemplified by GUR (registered trademark) polymers marketed by Celanese Corporation such as GUR (registered trademark) 2000 series (2105, 2122, 2122-5, 2126), GUR (registered trademark) 4000 series (4120, 4130, 4150, 4170, 4012, 4122-5, 4022-6, 4050-3/4150-3), GUR (registered trademark) 8000 series (8110, 8020), and GUR (registered trademark) X series (X143, X184, X168, X172, X192).

[0058] The melt flow rate of the binder resin used in the embodiment of the present invention is preferably 3.5 g/10 min or less and more preferably 2.0 g/10 min or less at 190°C and 15 kg.

[0059] The binder resin used in the embodiment of the present invention can be in the form of particles. The particles can be in the form of powder, pellets or fine particles.

[0060] When the binder resin is in the form of particles, the range of the diameter thereof may be from about 0.1 nm to 5000 μm, preferably from about 10 nm to 500 μm, and more preferably from about 100 nm to 300 μm.

[0061] The binder resin used in the embodiment of the present invention may have a bulk density of from 0.10 g/cm^3 to 0.55 g/cm^3, preferably from 0.17 g/cm^3 to 0.50 g/cm^3, and more preferably from 0.20 g/cm^3 to 0.47 g/cm^3.

<Porous Material>

[0062] A porous material according to the embodiment of the present invention is a constituent element of at least one filter segment constituting the filter for a smoking article according to the embodiment of the present invention.

[0063] The porous material according to the embodiment of the present invention contains the hydrotalcite particle and the binder resin described above, and any method can be used for producing the porous material.

[0064] For example, the hydrotalcite particles (together with, for example, cellulose particles, if necessary) and the binder resin are mixed and placed in a mold having an appropriate shape. The mold is heated to the melting point of the binder resin or above, for example, in one embodiment to from about 150°C to 300°C, and held for sufficient time and at sufficient temperature to heat the mold and the contents thereof to a desired temperature.

[0065] The substance is thereafter taken out of the mold and cooled to room temperature, thereby producing a porous material having voids formed therein.

[0066] The void volume ratio of the porous material can be, for example, from 40% to 90%, and the void volume ratio can be calculated on the basis of the description of Patent Document 2. The shape of the porous material is not particularly limited but can be exemplified by a cylindrical shape. The length of the porous material in the airflow direction is not particularly limited and can be exemplified by from about 3 to 30 mm.

[0067] In the filter segment having the porous material according to the embodiment of the present invention, since the hydrotalcite particle is fixed in the porous material by the binder resin, the hydrotalcite particle does not escape from the filter segment when the filter segment having the porous material, or a filter for a smoking article including the filter segment, or a smoking article including the filter for a smoking article is transported.

[0068] Further, since the filter for a smoking article according to the embodiment of the present invention is provided with the filter segment having the porous material, the filtration rate of tar and nicotine per airflow resistance of the filter is lowered (delivery to the user is facilitated). In addition, it is possible to design a filter for a smoking article having a high ventilation rate at a low filtration rate when the amount of tar during smoking is made constant, and the amount of generated carbon monoxide can be reduced.

[0069] In the porous material according to the embodiment of the present invention, it is preferable that the hydrotalcite particle and the nonfibrous binder resin be at a weight ratio of from 70:30 to 80:20. By including the hydrotalcite particles and the nonfibrous binder resin in such ranges, it is possible to provide voids inside the porous material with an appropriate void ratio, and it is possible to adjust suitably the airflow resistance and the permeation amount of semi-volatile components in tobacco smoke.

[0070] Further, in the case where the hydrotalcite particle and the cellulose particle are used in combination, the weight ratio of the total weight of these particles and the nonfibrous binder resin is from 70:30 to 80:20.

[0071] With the porous material according to the embodiment of the present invention, there is no need to use a plasticizer such as triacetin which has been used for conventional filters for smoking articles. This makes it possible to prevent semi-volatile components in tobacco smoke from being removed by being adsorbed by the plasticizer.

<Filter for Smoking Article>

[0072] The filter for a smoking article of the present invention comprises at least the above-described filter segment having the porous material (hereinafter also simply referred to as "segment having the porous material").

[0073] The filter segment having the porous material can have a circumferential length and a length in the airflow direction similar to the circumferential length and the length in the airflow direction of the filter constituting the conventional filter cigarette.

[0074] For example, the circumferential length can be from 16 to 26 mm and preferably from 24 to 26 mm. This

corresponds to the filter segment diameter of from 5.1 to 8.3 mm and from 7.6 to 8.3 mm, respectively.

[0075] The filter segment having the porous material may have the abovementioned circumferential length, but this filter segment is not limited to the size of the filter included in the conventional filter cigarette and may also have a circumferential length and a length in the airflow direction suitable for other smoking articles to be described hereinbelow.

[0076] The filter segment having the porous material may be wrapped around the outer circumferential surface thereof with a wrapper for a filter to be described hereinbelow.

[0077] The filter for a smoking article according to the embodiment of the present invention may include, in addition to the above-described filter segment having the porous material, a filter segment (hereinafter can be also referred to as "conventional filter segment") constituted by a cellulose acetate tow similar to that of the filter constituting the conventional filter cigarette.

[0078] As an example of a configuration according to one embodiment, the conventional filter segment is arranged at the suction end side, and the above-described filter segment having the porous material is arranged between a tobacco rod having a tobacco cut and the conventional filter segment.

[0079] A filter for a smoking article can be produced by connecting the filter segment having the porous material and the conventional filter segment by using molding paper. This configuration is shown in Fig. 3. This configuration is also referred to as a dual segment.

[0080] When a dual segment is used, the porous material is not exposed at the suction end, so that the appearance can be improved. It is also possible to prevent the porous material from directly contacting the user's mouth.

[0081] In the configuration according to another possible embodiment of the present invention, the conventional filter segment is arranged on the suction end side, the filter segment having the porous material is arranged so as to be adjacent to the conventional filter segment, and the conventional filter segment is further arranged between the filter segment having the porous material and a tobacco rod having a tobacco cut. This configuration is shown in Fig. 4. This configuration is also referred to as a triple segment. When the triple segment is used, it is possible to prevent the porous material from being deteriorated by the transmission of high-temperature heat from the tobacco rod side to the porous material.

[0082] As shown in Fig. 3, the number of filter segments constituting the filter for a smoking article according to the embodiment of the present invention may be not only two as shown in Fig. 3, or three as shown in Fig. 4, but also four or more. In that case, two or more filter segments each having the porous material can be provided.

[0083] Figs. 3 and 4 show the configurations when a filter cigarette is used as a smoking article, but the smoking article may be other than a filter cigarette as will be described hereinbelow, and in this case, the configuration be changed as appropriate. Thus, an embodiment in which the filter 7 without the tobacco rod is appropriately used as the filter for a smoking article according to the embodiment of the present invention in other smoking articles can be also mentioned.

[0084] It is to be noted that the outer surface of the filter formed by joining the filter segments may be wrapped with tip paper.

[0085] In the case where the filter segment is composed of an acetate tow, the single yarn fineness, total fineness, and cross-sectional shape of the acetate tow are not particularly limited.

[0086] The filter segment other than the filter segment having the porous material may be configured of a material other than the acetate tow.

[0087] It is possible to design, as appropriate, the adjustment of airflow resistance and addition of additives (known adsorbents, flavors, flavor holding materials, and the like) to the acetate tow or other material.

[0088] Tip paper, molding paper, and wrapper for wrapping the outer surface of filters used in the conventional filter cigarettes can be used for the filter for a smoking article according to the present embodiment. Here, the wrapper is in direct contact with the porous material or the filter tow or the like and is wrapped in a cylindrical shape. The molding paper is used to fix a plurality of filter sections when there is a plurality of filter segments wrapped with the wrapper. The tip paper is used to connect the filter for a smoking article to a tobacco rod when the smoking article has the tobacco rod.

[0089] The tip paper can be provided with ventilation holes for adjusting the presence ratio of tobacco smoke and air to be inhaled during smoking of the smoking article (the ventilation holes are shown by dotted lines in the tip paper shown in Figs. 3 and 4). The arrangement of the ventilation holes is not particularly limited. For example, the ventilation holes can be arranged in one row or two rows in the circumferential direction of the smoking article. The pitch of the ventilation holes, the size of the holes, and the method for opening the holes are not particularly limited.

<Smoking Articles>

[0090] The filter for a smoking article according to the embodiment of the present invention can be used for the following smoking articles.

[0091] A combustion type smoking article in which a tobacco filler is burned, for example, a filter cigarette; a non-combustion heating type smoking article in which a tobacco filler is heated without burning; and a non-heating type smoking article in which flavor and taste components of a tobacco filler are inhaled without burning or heating the tobacco

filler. The non-combustion heating type smoking article can be exemplified by a carbon heat source inhalation device in which a tobacco filler is heated by combustion heat of a carbon heat source (see, for example, WO 2006/073065); an electric heating type inhalation device equipped with an inhalation device and a heating device for electrically heating the inhalation device (see, for example, WO 2010/110226); and a liquid atomizing type inhalation device in which a liquid aerosol source including a flavor and taste source is atomized by heating (see, for example, WO 2015/046385). Another preferred application is to a non-combustion heating type smoking article in which an aerosol generating rod is used instead of a tobacco filler and a flavor component is generated by heating from the outside of the aerosol generating rod. Such a smoking article has a battery, an electric heating unit, and an aerosol generating rod member which is detachably plugged in. The electric heating unit is a so-called heater and has a heat generating element. The heat generating element of the electric heating unit heats the aerosol generating rod and releases the flavor from the filler of the aerosol generating rod into the surrounding air. The heating temperature of the aerosol generating rod by the electric heating unit is, for example, 400°C or less. The smoking articles having the aerosol generating rod member are described in detail in Japanese Patent No. 4889218 and Japanese Patent No. 4762247.

[0092] The filter for a smoking article according to the embodiment of the present invention can be used as a filter for these non-combustion heating type smoking articles.

[0093] A non-heating type smoking article can be exemplified by a flavor inhalation device which includes a suction holder and a tobacco filler filled in the main flow path of the suction holder and in which flavor and taste components of the tobacco filler are inhaled (see, for example, WO 2010/095659).

[0094] The filter for a smoking article according to the embodiment of the present invention can be appropriately used in the smoking articles exemplified hereinabove.

[0095] In this case, the shape of the filter segment having the porous material, the shape of the filter for a smoking article including the filter segment, and the like can be changed as appropriate.

[Examples]

[0096] The present invention will be described hereinbelow more specifically with reference to examples, but the present invention is not limited to the description of the examples, provided that the scope of the invention is not exceeded.

(Production Example 1)

<Preparation of Filter Segment Having Porous Material Containing Hydrotalcite Particle and Polyethylene Resin>

[0097] A hydrotalcite compound represented by $Mg_6Al_2(OH)_{16}CO_3 \cdot 4H_2O$ was used as the hydrotalcite particle. The hydrotalcite compound product was pulverized and classified to prepare particles having a particle diameter of from 250 to 500 μm. Polyethylene was used as the binder resin.

[0098] The hydrotalcite particles (75 parts by weight) and polyethylene (GUR (registered trademark) 25 parts by weight, manufactured by Celanese Corporation) as the binder resin were mixed, placed in a mold and heated to 200°C over 40 min. The material after heating was removed from the mold and cooled to obtain a porous material 1 having a circumference of 23.75 mm and a length of 20 mm. The BET specific surface area of the hydrotalcite particles was 65 m^2/g.

(Production Example 2)

[0099] A porous material 2 was obtained in the same manner as in Production Example 1 except that cellulose particles were used instead of hydrotalcite particles.

[0100] The cellulose particles were produced by using a commercially available cellulose powder (Endurance MCC VE-090, manufactured by FMC Corporation) as a raw material, compression molding by using a compression granulating apparatus (Roller Compactor TF-208, manufactured by Freund Corporation), pulverizing and classifying. The cellulose particles had a median diameter (D50) of 1190 μm, a bulk density of 0.832 g/cc, and a BET specific surface area equal to or less than the detection limit. The bulk density was measured with a Powder Characteristics Tester PT-X manufactured by Hosokawa Micron Corporation.

(Production Example 3)

[0101] A porous material 3 was obtained in the same manner as in Production Example 1 except that un-activated carbide particles were used instead of hydrotalcite particles, the weight thereof was 80 parts by weight and the weight of polyethylene was 20 parts by weight. The benzene adsorption capacity of the un-activated carbide particles measured according to JIS K 1474 was 0.6.

[0102] The un-activated carbide particles were obtained by subjecting coconut shells to carbonization treatment in an

inert gas atmosphere in a carbonization furnace.

(Production Example 4)

[0103] A porous material 4 was obtained in the same manner as in Production Example 3 except that low-activated carbon prepared by a steam activation method was used instead of hydrotalcite particles. The low-activated charcoal had a BET specific surface area of 725 m^2/g.

(Production Example 5)

[0104] A porous material 5 was obtained in the same manner as in Production Example 3 except that activated carbon prepared by a steam activation method was used instead of hydrotalcite particles. The activated charcoal had a BET specific surface area of 1142 m^2/g.

<Test Example 1: Comparison of Permeation Amounts of Semi-volatile Components>

[0105] A tobacco rod including a tobacco cut was removed from a commercially available filter cigarette, and the above-described porous material (20 mm) as a filter segment and a cellulose acetate tow filter (7 mm; 5.5Y31000) were successively connected to the tobacco rod to prepare a filter cigarette for testing.

[0106] As a control, a filter cigarette was prepared by connecting a cellulose acetate tow filter (27 mm; 2.8Y35000) to the tobacco rod same as described hereinabove.

[0107] A smoking test was carried out using these filter cigarettes, and the amount of crude tar and also limonene, 2,5-dimethylpyrazine, 3-vinylpyridine, 3-butylpyridine, phenylethyl alcohol, and indole as semi-volatile components from among the components of tobacco smoke were selectively analyzed.

[0108] The smoking test was carried out using the equipment and conditions described above.

[0109] The results are shown in Fig. 1. The type of semi-volatile component is indicated on the abscissa in Fig. 1. The ratio of the amount of the semi-volatile component normalized by the amount of crude tar in each sample to the control is indicated on the ordinate in Fig. 1, and a larger value thereof indicates that a selective reduction has not occurred (the permeation amount is large).

[0110] It follows from the results shown in Fig. 1 that in the sample having the porous material using the hydrotalcite particle as a filter segment, the delivery amount (permeation amount) of semi-volatile components was substantially equal to or larger than the control. In the sample using cellulose particles, the permeation amount (delivery amount) of semi-volatile components was generally larger than that of the control. In the sample having the porous material using low-activated carbon or activated carbon as a filter segment, the permeation amount (delivery amount) of semi-volatile components was generally smaller than that of the control.

[0111] These results indicate that the hydrotalcite particle and cellulose particle have the ability not to selectively reduce the semi-volatile components relative to the crude tar of tobacco smoke.

<Test Example 2: Comparison of Adsorption Capacity of Formaldehyde>

(Measurement of Amount of Formaldehyde in Mainstream Smoke)

[0112] The amount of formaldehyde in mainstream smoke was measured by Canadian official method (2,4-DNPH-HPLC method) to determine the formaldehyde adsorption capacity.

[0113] First, 9.51 g of 2,4-dinitrophenylhydrazine (DNPH) was heated and dissolved in 1 L of acetonitrile, then 5.6 mL of 60% perchloric acid was added, and ultrapure water was added to prepare 2 L of a collection solution.

[0114] The outline of the measuring apparatus will be described with reference to Fig. 5. As shown in Fig. 5, the DNPH collection solution 13 was placed in the collection gas wash bottle 12. The volume of the gas wash bottle 12 was 100 mL and the amount of the DNPH collection solution 13 was 80 mL. The gas wash bottle 12 was placed in an ice water bath 14 and cooled with ice. The lower end of a glass tube 15 to which a cigarette 11 was attached was immersed in the collection solution 13 in the gas wash bottle 12. A glass tube 16 and a Cambridge pad 17 were attached so as to be in communication with the dead volume of the gas wash bottle 12, and the Cambridge pad 17 and an automatic smoking device 18 were connected.

[0115] The cigarette 11 was attached to the glass tube 15, and the cigarette 11 was automatically smoked under the standard smoking condition stipulated by ISO. Thus, for each cigarette, the operation of sucking 35 mL for 2 sec in one empty puff was repeated at 58 sec intervals. While mainstream smoke was bubbling, formaldehyde was derivatized by DNPH. Two cigarettes for measurement were set. At this time, all the cigarettes using the particles of the preparation examples were adjusted so that the pressure loss was the same.

[0116] The derivative thus produced was measured by high performance liquid chromatography (HPLC). First, the collected solution was filtered and then diluted with Trizma Base solution (4 mL of collection solution, 6 mL of Trizma Base solution). The resulting solution was measured by HPLC. The HPLC measurement conditions are as follows.

Column: HP LiChrospher 100 RP-18 (5 μ) 250 × 4 mm
Guard column: HP LiChrospher 100 RP-18 (5 μ) 4 × 4 mm
Column temperature: 30°C
Detection wavelength: DAD 356 nm
Injection volume: 20 μL
Mobile phase: gradient with three phases (solution A: ultrapure water solution containing 30% of acetonitrile, 10% of tetrahydrofuran, and 1% of isopropanol; solution B: ultrapure water solution containing 65% of acetonitrile, 1% of tetrahydrofuran, and 1% of isopropanol; solution C: acetonitrile 100%).

[0117] As a control test, the amount of formaldehyde in mainstream smoke was measured for a cigarette provided with a filter not containing any particle (hereinafter referred to as control). The amount of crude tar collected directly on the Cambridge pad was also measured separately.

[0118] The permeation amount of formaldehyde normalized by the crude tar amount of was determined by substituting the measured amount of formaldehyde into the following formula:

(Permeation amount of formaldehyde normalized by crude tar amount) = [{(measured amount of formaldehyde (μg/cig)/(crude tar amount) (mg/cig)].

[0119] The results are shown in Fig. 2. It is clear that the smaller the numerical value on the ordinate in Fig. 2, the smaller the permeation amount (delivery amount) of formaldehyde per crude tar and the larger the amount of formaldehyde adsorbed to the particles contained in the porous material.

[0120] From the results shown in Fig. 2, it was found that when a porous material containing hydrotalcite particles is used, the amount of formaldehyde delivered can be kept low, like when using low-activated carbon and activated carbon.

[0121] From the results of Test Examples 1 and 2, it was found that the hydrotalcite particle used in the embodiments of the present invention has the ability not to selectively reduce the semi-volatile components in tobacco smoke relative to crude tar of tobacco smoke and also has the ability to selectively reduce irritating volatile components such as formaldehyde.

<Evaluation of Sensory Properties>

[0122] For each filter cigarette for testing for which semi-volatile components were measured, the ventilation ratio and the tar amount were adjusted to 37% and 10 mg, respectively, and sensory properties at the time of smoking were evaluated.

[0123] As a result, it was found that in the sample provided with the filter segment having the porous material including the hydrotalcite particle, the cellulose particle or the un-activated carbide particle, the flavor and taste originating from tobacco smoke increased and irritation decreased. Meanwhile, in the sample provided with the porous material using the low-activated carbon or activated carbon, which is an active particle, as a filter segment, the flavor and taste originating from tobacco smoke decreased.

[0124] From the results obtained in measurement of semi-volatile components and sensory evaluation, it was confirmed that when using the filter for a smoking article according to the embodiment of the present invention, it is possible to cause selective permeation of semi-volatile components (without the removal thereof by the filter), thereby making it possible to give the user stronger flavor and taste inherent to tobacco leaves.

[0125] Further, when the filter for a smoking article according to the embodiment of the present invention is used, formaldehyde which is an irritating component can be efficiently reduced.

[Reference Signs List]

[0126]

1 Tobacco rod portion
2 Conventional filter segment
3 Filter segment having porous material
4 Wrapper

5 Molding paper
6 Tip paper
7 Filter

Claims

1. A filter for a smoking article, the filter comprising
a filter segment including
a porous material containing

a hydrotalcite particle and
a nonfibrous binder resin.

2. The filter for a smoking article according to claim 1, wherein
the porous material further contains a cellulose particle.

3. The filter for a smoking article according to claim 2, wherein
the hydrotalcite particle and the cellulose particle are in a weight ratio of from 10:90 to 30:70.

4. The filter for a smoking article according to any one of claims 1 to 3, wherein
the hydrotalcite particle is formed of a hydrotalcite compound represented by the formula (1):

$$M^{2+}_{1-x}M^{3+}_{x}(OH)_2(A^{n-})_{x/n} \cdot mH_2O \qquad (1)$$

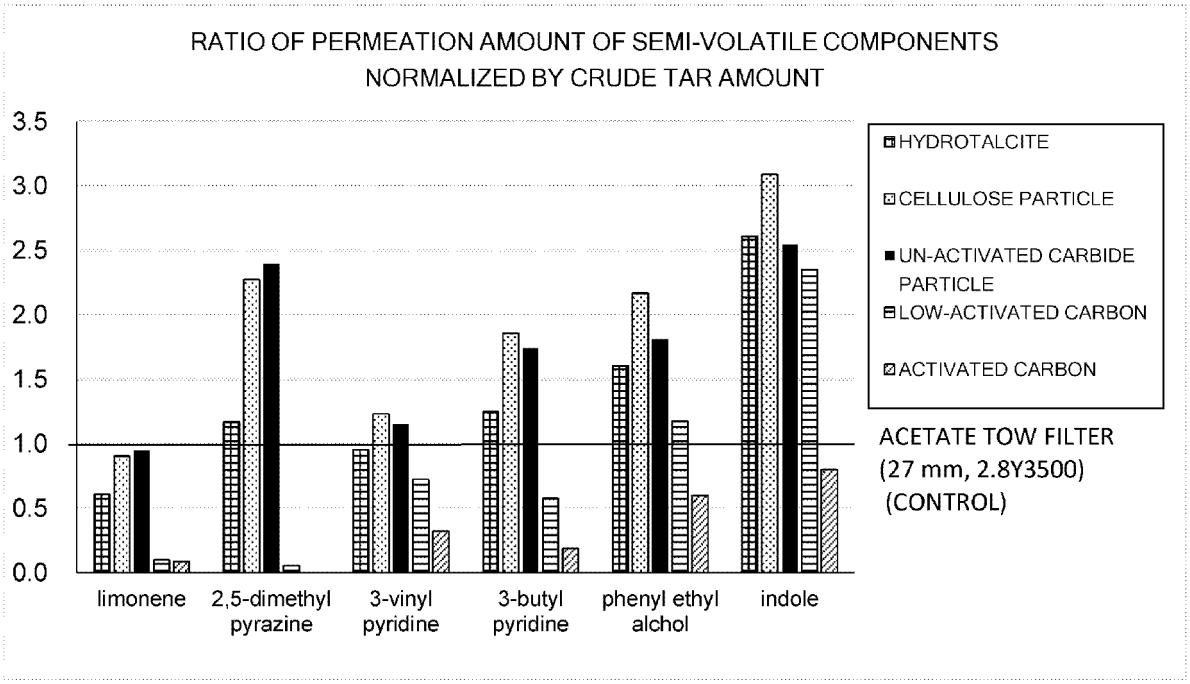
wherein M^{2+} is a divalent metal ion selected from the group consisting of Mg, Zn, Ni, and Ca, M^{3+} is Al ion, A^{n-} is an anion having a valency of n and selected from the group consisting of CO_3, SO_4, OOC-COO, Cl, Br, F, NO_3, $Fe(CN)_6^{3-}$, $Fe(CN)_6^{4-}$, phthalic acid, isophthalic acid, terephthalic acid, maleic acid, alkenyl acid and derivatives thereof, malic acid, salicylic acid, acrylic acid, adipic acid, succinic acid, citric acid and sulfonic acid, $0.1 < x < 0.4$, and $0 < m < 2$.

5. The filter for a smoking article according to any one of claims 1 to 4, wherein
the hydrotalcite particle has a mean particle diameter of from 200 to 800 μm.

6. The filter for a smoking article according to any one of claims 1 to 5, wherein
the nonfibrous binder resin is a thermoplastic resin.

7. The filter for a smoking article according to any one of claims 1 to 6, wherein
the filter segment including the porous material containing the hydrotalcite particle and the nonfibrous binder resin includes no plasticizer.

8. The filter for a smoking article according to any one of claims 1 to 7, wherein
the hydrotalcite particle and the nonfibrous binder resin are at a weight ratio of from 70:30 to 80:20 in the porous material.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2.5
2.0
1.5
1.0
0.5
0.0
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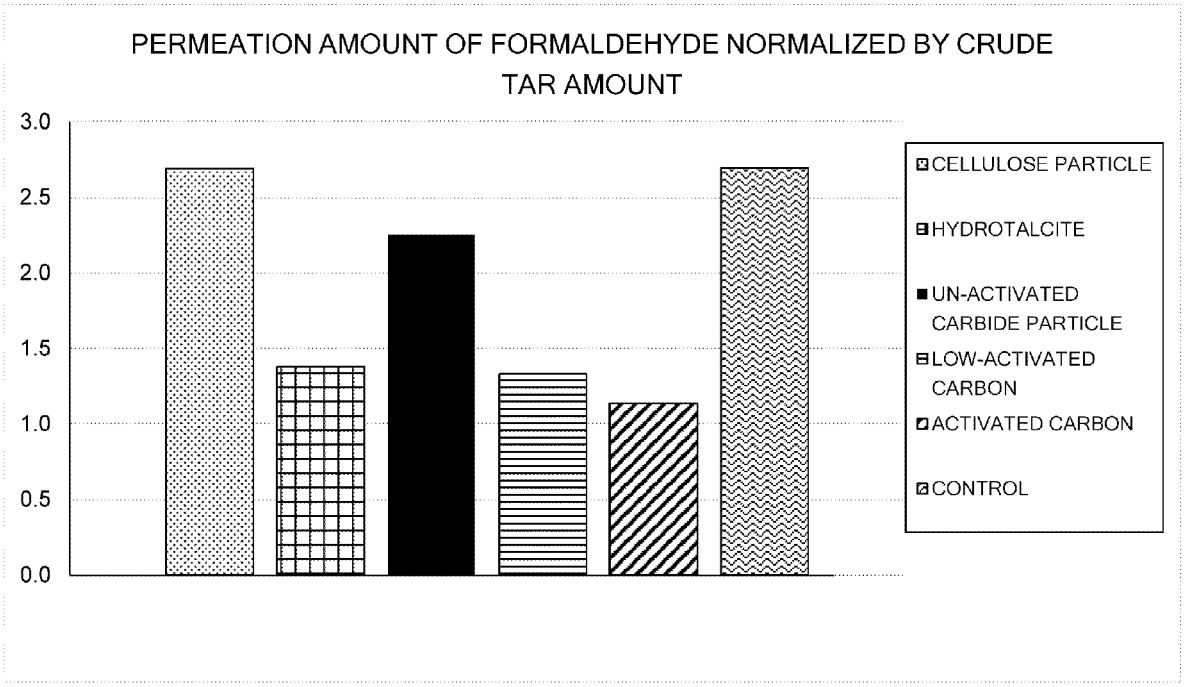
2,5-dimethyl pyrazine
3-vinyl pyridine
3-butyl pyridine
phenyl ethyl alchol
indole
HYDROTALCITE
CELLULOSE PARTICLE
UN-ACTIVATED CARBIDE PARTICLE
LOW-ACTIVATED CARBON
ACTIVATED CARBON
ACETATE TOW FILTER
(27 mm, 2.8Y3500)
(CONTROL)

Fig. 1


PERMEATION AMOUNT OF FORMALDEHYDE NORMALIZED BY CRUDE TAR AMOUNT
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2.0
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1.0
0.5
0.0
CELLULOSE PARTICLE
HYDROTALCITE
UN-ACTIVATED CARBIDE PARTICLE
LOW-ACTIVATED CARBON
ACTIVATED CARBON
CONTROL

Fig. 2

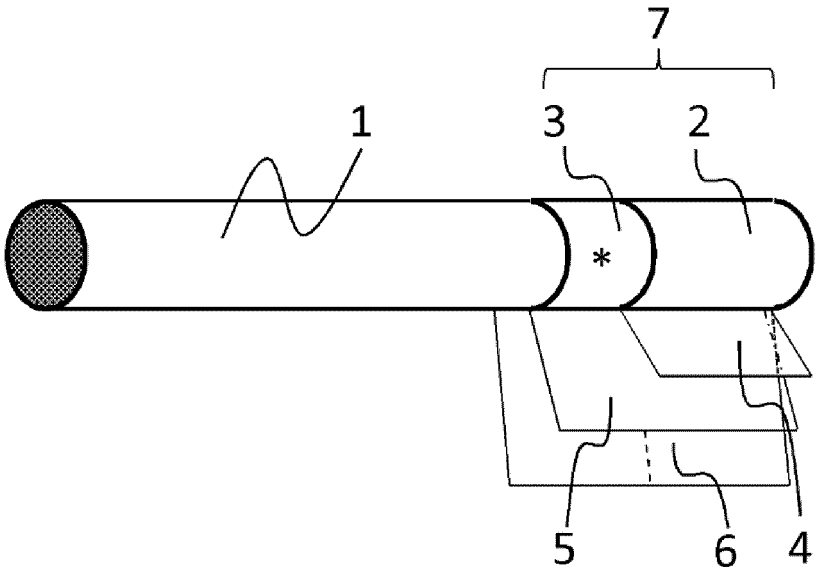

Fig. 3

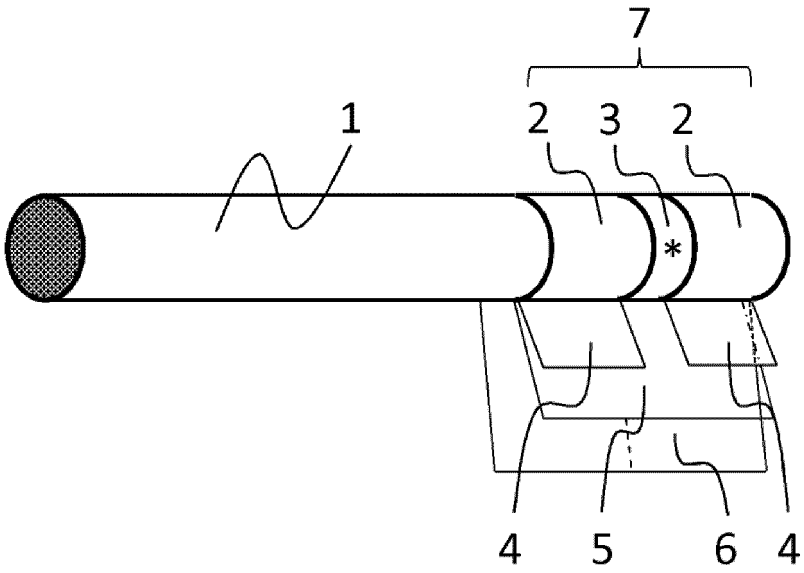

Fig. 4

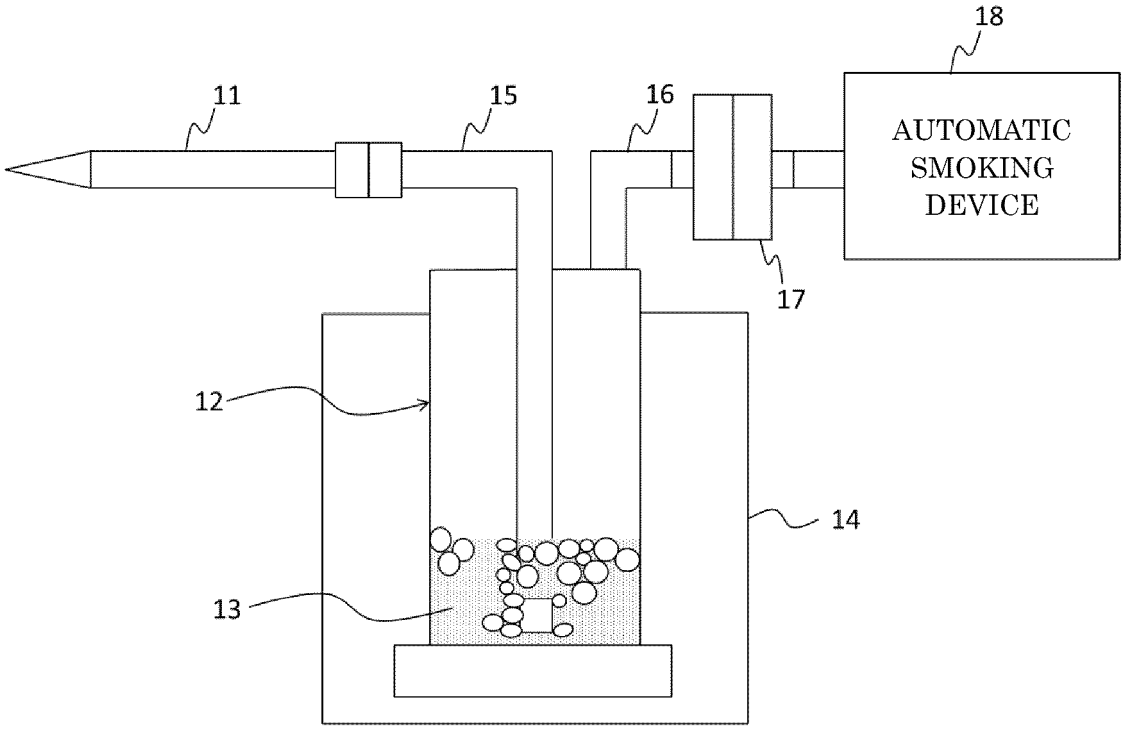

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/002586

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. A24D1/04(2006.01)i, A24D3/06(2006.01)i
FI: A24D3/06, A24D1/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl. A24D1/04, A24D3/06

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2020
Registered utility model specifications of Japan	1996-2020
Published registered utility model applications of Japan	1994-2020

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 49-006120 B1 (U.S. FILTER CORP.) 12.02.1974 (1974-02-12), column 2, line 3 to column 5, line 24	1, 4-8 2-3
Y A	WO 03/056947 A1 (JAPAN TOBACCO INC.) 17.07.2003 (2003-07-17), page 1, line 22 to page 3, line 5, page 4, line 7 to page 6, line 18	1, 4-8 2-3
A	WO 2013/084661 A1 (JAPAN TOBACCO INC.) 13.06.2013 (2013-06-13), paragraphs [0012]-[0017]	2-3
A	US 2008/0295852 A1 (REEMTSMA CIGARETTENFABRIKEN GMBH) 04.12.2008 (2008-12-04), paragraphs [0019], [0021]	1-8

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28.02.2020	31.03.2020

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2020/002586

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WO 03/056947 A1	17.07.2003	US 2004/0237983 A1 paragraphs [0009]-[0016], [0029]-[0040] JP 3895327 B2 EP 1470761 A1 CA 2472385 A1 KR 10-0912311 B1 AU 2003202479 A1 UA 77052 C2 CN 1612701 A RU 2004124060 A CN 102028307 A TW 200301681 A MY 146655 A DK 1470761 T3 ES 2563032 T3 PT 1470761 E
WO 2013/084661 A1	13.06.2013	EP 2789249 A1 paragraphs [0012]-[0017] CN 103987284 A RU 2014127494 A TW 201325478 A ES 2707868 T3
US 2008/0295852 A1	04.12.2008	WO 2006/108470 A1 EP 1868457 A1 DE 102005017478 A1 RU 2007142186 A

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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