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(54) CIGARETTE FILTER

(57) The present invention relates to a cigarette filter comprising at least one filtration member that includes at least one source of a magnetostatic field. The source of magnetostatic field preferably consists of a particulate material, which is preferably a hard magnetic material.

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Description

Field of the Invention

[0001] The present invention relates to removing, from tobacco smoke, harmful components having toxic and/or carcinogenic behavior, and it particularly relates to the materials of tobacco smoke filters, which can be used in production of cigarettes.

Background of the Invention

[0002] It is known that tobacco smoke contains thousands of various compounds that comprise at least 50 carcinogenic compounds and about 200 compounds reputed to be toxic. Therefore, in view of the steadily growing concern of the smokers about their health, it is important to reduce as much as possible the intake of carcinogenic and toxic substances with the inhaled tobacco smoke.

[0003] To this end, various tobacco smoke filters are used now, comprising sorbent materials in form of particles, fibers, ribbons and combinations thereof. Some sorbents, such as cellulose acetate fiber and activated charcoal, are very widely used in the tobacco smoke filters. The retaining efficiency of the modern and rather complicated multi-component systems for filtration of tobacco smoke is as high as the expenses for their production. Furthermore, it should be understood that the complicated multi-component filters (e.g. US 4,201,234 or CH 526928) have an increased weight/length and thus they generally require greater efforts for a draw, annoying the smoker. The dissatisfaction of the smoker increases due to the fact that such filters retain the significant amount of nicotine. It is known that a "low nicotine" cigarette provides the opposite result - after quenching said cigarette the smoker immediately takes another, having not received his usual portion of nicotine from the first cigarette. Thus the health benefit of the known high effective filters is arguable.

[0004] Correspondingly, the object of the invention is to provide a high-effective tobacco smoke filter having simple design, without an undesirable enlargement of the filter weight/length (and thus the weight/length of the whole cigarette), and without such disadvantages as the difficult draw and the retention of too much nicotine.

Summary of the invention

[0005] The authors of the present invention have surprisingly found that the filtration efficiency of the tobacco smoke filters of the most known types can be improved by including a source of magnetostatic field into the filter material. Said source of magnetostatic field is preferably a magnetized particulate material, e.g. in form of powder or granules, particularly in form of elongated, rodlike granules. A person skilled in the art will appreciate that the shape of the particles can be selected so that to provide the maximal strength of magnetostatic field around each particle. Preferably, said particulate material is formed of a hard magnetic material, and the particles can have amorphous and/or crystalline structure.

[0006] Alternatively, the source of magnetostatic field can, be in form of a film comprising any material that can be magnetized. Said film can consist of two or more different layers comprising at least a layer of a magnetic (magnetized) material and a layer of a sorbent. In this embodiment of the invention, the filter elements will be manufactured by twisting a continuous strip of said at least two-layer film, and then the resulting filter rods will be wrapped with a filter wrapper.

[0007] Although activated charcoal is a preferable sorbent, the use can be also made of conventional fibrous materials or their combinations with activated charcoal or other sorbents.

[0008] The magnetized material in form of particles can be applied directly onto the sorbent, or vice versa, - a thin layer of the sorbent can be applied on the surface of the magnetic particles. The magnetic particles are generally not greater than 100 μm, and preferably less than 5 μm. When magnetic films are used as the source of magnetostatic field, their thickness generally does not exceed 300 μm, and preferably it is less than 50 μm. When magnetic fibers are employed, their diameter is not greater than 300 μm and preferably it is less then 20 μm.

Detailed Description of the Invention

[0009] The authors of the present invention have found that the retention of the major part of harmful components of the tobacco smoke, especially the retention of charged particles and metal components of the smoke is surprisingly more effective in a magnetostatic field.

[0010] The mechanism of the influence of the magnetostatic field on the filtration efficiency is not quite clear. It is known that any magnetostatic field can change the trajectory of a charged particle, resulting in the slightly increased total length of the trajectory. Nevertheless, the increase of the filtration efficiency in the magnetostatic field is unexpectedly greater. The theory is supposed to be as follows. During the draw, a pressure difference appears at the opposite

ends of the filter, and the gas stream containing harmful particles flows through the filter material.

[0011] The filter material has generally non-uniform structure comprising micro-voids or small spaces, and the gas stream pushes its way through the filter material along tortuous paths connecting said spaces. Some smoke particles moving through the filter along said paths collides with their walls and are caught by the sorbent material, but the major part of the particles goes, together with the gases, through the total length of the filter and goes into the lungs of the smoker. If the smoker makes a stronger draw, permeation of the smoke particles through the filter is certainly higher, since the flow rate of the gases increases. In our opinion, although the magnetic particles in the filter material deflect the flight trajectory of the smoke particles only slightly, the probability of their collision with the filter material increases, thus increasing the portion of the adsorbed particles. Owing to the tortuousness of the paths and the unevenness of the trajectory of the flight of the smoke particles through the filter, said slight deflection provides the surprising improvement of the retention of metal ions and charged particles.

[0012] Another possible explanation of the achieved advantageous effect lies in the fact that the charged particles of the smoke change their orientation in the magnetostatic field. To be adsorbed, the charged particle should be caught by the end of the sorbent molecule, having opposite charge. Probably, the magnetic particles included in the sorbent material orient the charged particles so that they are more easily entrapped by the sorbent.

[0013] It should be also noted that magnetostatic field has no significant influence on entrapping aromatic compounds and nicotine, therefore the flavor and other feelings obtained by smoking the cigarette having the filter according to the present invention remain the same as those obtained by smoking the conventional cigarette which does not comprise any source of magnetostatic field.

[0014] It should be also noted that the strength of magnetostatic field around the whole cigarette and around the pack filled with the cigarettes according to the present invention is insignificantly small when the source of magnetostatic field is in form of the particles randomly distributed in the filter material. This detail is important in view of the fact that magnet fields are harmful for the widely used data carriers, such as diskettes and credit cards.

[0015] The source of the magnetostatic field can also be a compact individual magnet (molded, sintered or composite) instead of the particulate magnetic material in form of powders, granules, films or fibers. However, the authors of the present invention found that the particulate magnetic materials provide higher filtration efficiency, than a single magnetic solid. Presumably, a plurality of the sources of magnetostatic field in the filter material provides varying, gradient field having local peak values near the surfaces of the magnetic particles, and this enhances the influence of magnetostatic field on the charged particles of smoke moving through the filter.

[0016] The magnetic particles can be obtained by various methods well known to a person skilled in the art, to obtain the magnetic particles having crystalline or amorphous structure.

[0017] The magnetic particles having crystalline structure, especially single-domain particles, can be employed to create local magnetostatic fields having maximal magnetic energy. In some cases the use of the particles having amorphous structure provides an advantage connected with the minor chemical activity of such particles and allows longer storage without demagnetizing. Said advantage is most pronounced in case of the particles of Nd-Fe-B alloy, which allows to create magnetostatic field with greatest possible magnetic energy.

[0018] High-energy local magnetostatic fields improve the efficiency of filtration of the harmful components of tobacco smoke. For this reason, it is preferable to use magnets or magnetic particles formed of hard magnetic materials which allow to create higher magnetic density (i.e. to impart higher magnetic energy to the volume of material). Such magnets can be molded (e.g. magnets of Fe-Al-Ni-Co alloy) or sintered (e.g., preferably, ferrites of Ba, Sr), or they can be alloys of Sm-Co, Nd-Fe-B. The magnetic particles and the individual compact magnets can be also composite, i.e. they can be at least two component mixture of a hard magnetic material and a binding agent which is usually a polymeric binder. The known representatives of the group of the composite magnets are various rubber ferrites having the content of hard magnetic material up to 95-97 wt.%. The composite magnets are conveniently used in the preparation of compact magnet bodies (e.g. rods) having a complicated design (e.g. hollow rods having ridged surface etc.), which allows to enlarge the surface area of said bodies, and in the preparation of magnetic material in form of particles, especially in form of films and/or fibers. The use of a non-magnetic substrate (layer) can facilitate the manufacturing of magnetic films, and in this case the magnetic film will be composed of at least two layers, one of which is magnetic, and another can be, for example, a layer of sorbent.

[0019] Since the higher local energy of magnetostatic field results in a more efficient filtration of harmful components of tobacco smoke, it is quite evident that the maximal effect can be achieved with a sorbent applied onto the surface of a magnet (magnetic particles), or with the magnetic particles fixed on the surface of the sorbent, i.e. when there is a direct interaction of the sorption components and magnetic components of the filter element. At the same time at least a part of magnetic particles can carry a layer of a catalyst to burn up harmful substances in the main stream of tobacco smoke. Said catalytic layer can be, for example, a platinum or palladium layer being as thin as from 0.01 to 1 μm to hold the production expenses within reasonable limits.

[0020] One of the particulate sorbents, which are well known and widely used, is activated charcoal. When activated charcoal is employed as a sorbent, it is convenient to sediment the sorbent on the surface of the magnetic parti-

cles from, e.g. a gaseous phase.

[0021] The prior art techniques allows to grow of a thin layer of a sorbent or catalyst on the surface of the magnetic particles. When the sorbent in form of fibers, ribbons or films is used, the magnetic particles can be applied onto the surface of said sorbing elements.

[0022] As it is mentioned above, the size of the magnetic particles can be up to 100 μm, and in case of fibers or films it can be up to 300μm. However smaller size of the magnetic particles is preferable. It is due to the well-known fact that the total surface area of the particles increases by comminuting. Assuming that the particles have generally spherical shape, their total surface area S can be calculated according to the formula

$$S = 6M/pD,$$

where **M -** weight of the particles, **p** - specific weight ("density") of the material of the particles and **D -** average diameter of the particles. Basic hard magnetic materials have **p** about 7 g/cm^3 (0.25 lb/in^3). If **D** is about 5 μm, the 0.05 g of the particulate magnetic material (in total, 1 g pro pack of 20 cigarettes) has the surface area greater than 80 cm^2, which is quite sufficient to obtain the desired result.

[0023] Furthermore, minor particles can be conveniently employed in manufacturing filters, in particular because they can be easily introduced into the filter tow due to their small size, for example by means of blowing them into the loose cellulose acetate fibers. At the same time it should be taken into account that the size of the particles is selected so that the particles can not be sucked out from the filter material by smoking.

[0024] Hard magnetic materials, e.g. Nd-Fe-B alloys, are quickly oxidized in the air, therefore it is preferable to use composite magnetic materials, multi-layer magnetic films or magnetic particles coated with a layer of non-magnetic material, optionally sorbent. The particles having amorphous structure can be also used in the embodiments indicated here.

[0025] When a compact individual magnet is used as the source of magnetostatic field, the magnetostatic field can be oriented in the filter element radially or axially in relation to the axis of the filter tow, and also it can has a complex or random structure depending on such parameters as a specific geometry of the compact magnet employed, its position in the filter and the method of magnetizing. The magnetic material according to the invention can be magnetized before it is introduced in the filter material, although it is more convenient to magnetize already finished filter cigarettes, prior to or even after packing. Thus the magnetic material can be manufactured and stored without the operations of magnetizing or re-magnetizing before the magnetic material will be used in the process of manufacturing filters.

[0026] The radial magnetostatic field is created when the rodlike magnet is axially located within the filter element. Said magnet can be hollow inside, and it can have, for example, a form of a cylinder. The axial magnetostatic field can be created, for example, by ringlike magnets, which can be embedded in the filter material and/or in the filter wrapper. As a matter of fact, the specific arrangements of the magnetostatic field are not inventive, since they are described in corresponding handbooks about magnetic systems.

[0027] Said compact magnet(s) and the particulate magnetic material can be also used in combination to obtain one major magnetostatic field superimposed with a plurality of local magnetostatic fields.

[0028] In one embodiment, the source of the magnetostatic field can be a magnetic film, e.g. a multi-layer film capable to carry a coded information such as the date and place of manufacturing to prevent falsifications or infringements.

[0029] Furthermore, the progressive weakening of the magnetostatic field can be used for the evaluation of the storage period or it can be used to reveal possibly substandard conditions of the storage.

[0030] The following examples are provided only for illustrating some embodiments of the present invention but not for limiting the invention.

Materials and methods

[0031] Conventional filter cigarettes from one batch were used for the effected tests. The weight of the cigarettes varied from 920 to 970 mg (945 ± 25 mg). Said cigarettes had two-component filter composed of two filter elements. The sorbent in the first element was composed substantially of activated charcoal in form of a powder, and the second element consisted of cellulose acetate fibers (i.e. chemically treated paper having a thickness of 60-70 μm). All cigarettes were prepared for tests as follows. The cigarettes were held in the atmosphere of 65% relative humidity for 24 hours at 20°C. After that, they were burnt in a rotary smoker automate (Borgwaldt, Germany) using the following parameters:

volume of one draw	35 ml
drawing time	2 s
frequency	1 draw/min.

[0032] For comparison, it was used the filter of "Cambridge" type (according to ISO 3308, 1986). The measurements were effected to find the levels of harmful substances in the filtered mainstream smoke. The precision of the measurements was ± 10%.

Examples

Example 1

[0033] The retention of harmful substances was tested according to the above procedure, using conventional filters, which did not comprise any source of magnetostatic field ("check batch"). The contents N of some metals (µg per cigarette) in the mainstream smoke of the check batch of the cigarettes were found to be as follows:

Metal	Cu	Zn	Ca	Ni	Cr	Cd	Sr	Co	Pb	As	Fe	Al	Mn
N	1.1	7.0	30.5	7.6	0.6	1.3	0.5	0.4	0.35	2.3	7.3	6.8	0.25

Example 2

[0034] The retention of harmful substances was tested according to the above procedure, using known filters comprising activated charcoal as the main sorbent and an included magnet of Fe-Al-Ni-Co alloy (UNDK 35T5AA). The employed magnet was in form of a rod axially located in the filter and having diameter 1 mm, length 9 mm and weight about 55 mg. Said rod was magnetized prior to the filter assembling and it generated substantially radial-oriented magnetostatic field. The metal contents in the mainstream smoke were found to be as follows:

Metal	Cu	Zn	Ca	Ni	Cr	Cd	Sr	Co	Pb	As	Fe	Al	Mn
N	0.9	6.0	24.5	7.2	0.5	1.0	0.3	0.25	0.20	1.6	3.2	5.7	0.18

Example 3

[0035] The retention of harmful substances was tested according to the above procedure, using known filters comprising activated charcoal as the main sorbent and included a composite magnet on the basis of a powder comprising a Nd-Fe-B alloy and a polypropylene binder. The content of the hard magnetic component was 96 wt.%, and the weight of the magnet was about 50 mg. The magnet was in form of a cylindrical rod axially located in the filter (filter element) and having diameter 1 mm, length 9 mm, and it was magnetized according to Example 2. The metal contents in the mainstream smoke were found to be as follows:

Metal	Cu	Zn	Ca	Ni	Cr	Cd	Sr	Co	Pb	As	Fe	Al	Mn
N	0.75	5.2	21.5	6.1	0.35	0.8	0.25	0.15	0.14	1.2	2.6	4.8	0.15

Example 4

[0036] This example was accomplished according to Example 3, except for the fact that the composite magnet was in form of a ring having the inner diameter of 2 mm, the outer diameter of 2.7 mm and further having six ribs along the outer surface, having width 0.5 mm and height 0.6 mm, respectively. The ribs were used to enhance the surface area of the compact magnet for approximately 7 times and to increase the gradient of magnetostatic field near the rib edges. The metal contents in the mainstream smoke were found to be as follows:

Metal	Cu	Zn	Ca	Ni	Cr	Cd	Sr	Co	Pb	As	Fe	Al	Mn
N	0.45	4.1	13.5	4.7	0.20	0.50	0.18	0.11	0.10	0.85	1.5	2.9	0.11

[0037] A serious disadvantage of this embodiment is a relatively great weight of the source of magnetostatic field - in this case it is more than 220 mg, which is actually one forth of the total weight of the conventional filter cigarette.

[0038] The results similar to the results obtained in Examples 2 to 4 were obtained by using the analogous compact individual magnets in combination with the second filter element of the conventional filter cigarette, having a sorbent based on cellulose acetate fibers.

Example 5

[0039] According to the procedure described above, the retention of harmful substances was tested, using the filters, which comprised the filter element having activated charcoal as the main sorbent and included Ba ferrite powder of 19BA260 alloy. The total weight of the magnetic powder was 50 mg, and the average size of the powder crystals was about 10 μm. The magnetic powder and the sorbent powder were thoroughly mixed. The assembled filter cigarette was magnetized. The magnetostatic field was substantially axial. The metal contents in the mainstream of tobacco smoke were found to be as follows:

Metal	Cu	Zn	Ca	Ni	Cr	Cd	Sr	Co	Pb	As	Fe	Al	Mn
N	0.65	4.8	20.0	5.6	0.30	0.65	0.20	0.15	0.12	1.0	1.9	4.6	0.15

Example 6

[0040] This example was accomplished according to Example 5, except for the fact that average size of the particles of the magnetic powder was about 1 μm, and the total weight of the powder was 40 mg. The metal contents in the mainstream of tobacco smoke were found to be as follows:

Metal	Cu	Zn	Ca	Ni	Cr	Cd	Sr	Co	Pb	As	Fe	Al	Mn
N	0.25	2.8	10.0	3.6	0.15	0.30	0.12	0.08	0.06	0.60	1.3	1.9	0.06

[0041] The addition of the compact magnet according to Example 2 into the filter element further lowered the metal contents in the mainstream smoke for approximately 10%.

Example 7

[0042] According to the procedure described above, the retention of harmful substances was tested, using the filters, which comprised the filter element having activated charcoal as the main sorbent and included films of amorphous magnetic alloy Nd-Fe-B. The films were obtained by pouring the alloy on a disk rotating with high speed, and then comminuted. The thickness of the films were 20 μm, and their other dimensions were from 50 to 100 μm. The total weight of the films used in one filter was 70 mg. The magnetic films and the sorbent powder were mixed. The assembled filter cigarette was magnetized. The magnetostatic field was substantially axial. The metal contents in the mainstream

smoke were found to be as follows:

Metal	Cu	Zn	Ca	Ni	Cr	Cd	Sr	Co	Pb	As	Fe	Al	Mn
N	0.15	1.8	7.0	1.9	0.12	0.14	0.08	0.05	0.05	0.25	0.9	1.5	0.04

[0043] A separately magnetized film of 150 μm thickness was applied on the surface of the filter element. Said film was obtained by extruding the composition of the composite magnet on the basis of the powder comprising alloy Nd-Fe-B and a polypropylene binder. The length of the filter element coated with said film was 10 mm, and its weight was about 200 mg. Further lowering the metal levels in the mainstream smoke was from 15 to 25%.

Example 8

[0044] According to the procedure described above, the retention of harmful substances was tested, using the filters, which comprised the filter element having cellulose acetate fibers as the main sorbent and included fibers of a composite magnet obtained by extrusion from the powder alloy Nd-Fe-B and a polypropylene binder. The average diameter of the fibers was 25 μm, and their total weight was 75 mg. The magnetic fibers were mixed with the sorbent fibers. The assembled filter cigarette was magnetized. The average metal content in the mainstream smoke was reduced 2 to 4 times as compared to conventional cigarettes. When 40 mg of the fine powder (particle size of 1μm) of Ba ferrite was applied and fixed on the surface of the paper carrier used later in the chemical treatment process for producing the cellulose acetate fibers, the filtration efficiency was enhanced as significantly as in Example 6 and exceeded the result obtained by simple inclusion of the powder into the filter element of cellulose acetate fibers.

Example 9

[0045] According to the procedure described above, the retention of harmful substances was tested, using the filters, which comprised the filter element having activated charcoal as the main sorbent and included fibers of a composite magnet obtained by extrusion from the powder alloy Nd-Fe-B and a polypropylene binder. The average diameter of the fibers was 25 μm, and their total weight was 70 mg (as in Example 7). The assembled filter cigarette was magnetized. The magnetostatic field was substantially axial. The average metal content in the mainstream smoke was reduced 2,5 to 4 times as compared to conventional cigarettes.

Example 10

[0046] This example was accomplished according to Example 9, except for the fact that a fine powder of activated charcoal was further applied on the surface of magnetic fibers according to the procedure disclosed in SU 1834648, the content of the SU patent being included in this specification by means of reference. The total weight of activated charcoal was about 15 mg, the content of non-bound charcoal in the filter element being reduced by the same amount. The metal levels in the mainstream smoke were lowered by at least 40-50% as compared to the previous Example.

Metal	Cu	Zn	Ca	Ni	Cr	Cd	Sr	Co	Pb	As	Fe	Al	Mn
N	0.20	1.4	6.7	1.1	0.05	0.02	0.07	0.03	0.02	0.35	0.3	1.1	0.02

[0047] In relation to Examples 2 to 10 it should be noted that besides the reduction of metal levels in the mainstream smoke, the contents of CO, tar and nitroso compounds were also reduced. Especially excellent filtration efficiency was achieved in Example 10. It is probably connected with the fact that the metal components of the smoke (particularly metal ions) are located on the smoke particles and they form complex compounds with organic molecules, thus allowing the magnetostatic field to influence the neutral components of the tobacco smoke.

[0048] Furthermore, the retention of other harmful substances and aromatic compounds was examined in comparative tests, in which a conventional filter comprising activated charcoal and the inventive filter according to Example 5 were used. For that aim, the collected mainstream tobacco smoke was analyzed by gas chromatography using automated chromato-mass-spectrograph "Saturn" 4D MS-M5 available from Varian (France).

[0049] For better clarity, in the following table the data are shown in percents, where the data obtained with the con-

ventional filter are always 100%.

	toluols	xylols	carenes	trimetyl indol	nicotine	aromatic compounds
conventional filter	100	100	100	100	100	100
inventive filter	71	60	36	76	108	101

[0050] The data obtained by the gas chromatography have shown a slightly greater amount of nicotine in the tobacco smoke. This is difficult to explain, and probably it is merely a statistical error. However, it is evident that the filter according to the invention does not improve the retention of nicotine and aromatic compounds. Although the present invention is illustrated above by means of specific embodiments and examples, it should be understood that the invention is not limited by said embodiments, but it embraces all possible modifications being within the scope of the appended claims.

Claims

1. A cigarette filter comprising at least one filtration member, characterized in that said at least one filtration member includes at least one source of a magnetostatic field to increase the filtration efficiency.

2. The cigarette filter according to claim 1, characterized in that the source of magnetostatic field is magnetized particles in form of a powder and/or films and/or fibers.

3. The cigarette filter according to claim 1, characterized in that the source of magnetostatic field is at least one magnetized rod of hard magnetic material.

4. The cigarette filter according to claim 3, characterized in that said magnetized rod is a molded and/or sintered and/or composite constant magnet.

5. The cigarette filter according to claim 2, characterized in that said magnetized particles are formed from a hard magnetic material.

6. The cigarette filter according to claim 5, characterized in that said magnetized particles are formed from a composite hard magnetic material.

7. The cigarette filter according to claim 6, characterized in that at least part of said magnetized particles has amorphous structure.

8. The cigarette filter according to claim 6, characterized in that at least part of said magnetized magnetic particles has crystalline structure.

9. The cigarette filter according to claim 2, characterized in that at least part of said magnetized magnet films consists of at least two different layers.

10. The cigarette filter according to claim 3, characterized in that a layer of non-magnetic, preferably sorbent, material is applied on at least a part of the surface of the magnetized magnetic rod.

11. The cigarette filter according to claim 2, characterized in that a layer of non-magnetic, preferably sorbent, material is applied on at least a part of the surface of the magnetized magnetic particles.

12. The cigarette filter according to claim 11, characterized in that the sorbent is activated charcoal.

13. The cigarette filter according to claim 2, characterized in that at least part of magnetized particles is applied on the surface of non-magnetic, preferably sorbent, material.

14. The cigarette filter according to claim 13, characterized in that said non-magnetic material is in form of a fiber

and/or film (ribbon).

15. The cigarette filter according to claim 2, characterized in that the particle size of the magnetized magnetic powder is not greater than 100 μm, preferably less than 5 μm.

16. The cigarette filter according to claim 2, characterized in that the magnetized magnetic film has thickness which is not greater than 300 μm, preferably less than 50 μm.

17. The cigarette filter according to claim 2, characterized in that the magnetized magnetic fiber has a diameter which is not greater 300 μm, preferably less than 20 μm.

18. The cigarette filter according to claim 1, characterized in that the source of magnetostatic field is a combination of magnetized magnetic particles and at least one magnetized rod.

19. The cigarette filter according to claim 18, characterized in that at least one magnetized rod has circular shape.

20. The cigarette filter according to claim 2, characterized in that a magnetized magnetic film is applied on a portion of the surface of the filter.

21. The cigarette filter according to claim 20, characterized in that the magnetized magnetic film applied on a portion of the surface of the filter consists of at least two different layers.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/RU 00/00108

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: A24D 3/06

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)

IPC6: A24D 3/00-3/16, A24C 5/47, B01D 35/06, B03C 1/30

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

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.
A	US 5191905 A (COSTARICA SOGO KAIHATSU CO.,LTD.) 09 March 1993 (09.03.93)	1-21
A	RU 2023476 C1 (AZERBAIDZHANSKY INDUSTRIALNY UNIVERSITET) 30 November 1994 (30.11.94)	1-21
A	SU 915834 A (KRASNODARSKY POLITEKHNICHESKY INSTITUT) 30 March 1982 (30.03.82)	1-21
A	WO 91/13558 A1 (TSUKAMOTO, KENKICHI) 19 September 1991 (19.09.91)	1-21

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

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"E" earlier document but published on or after the international filing date

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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
10 July 2000 (10.07.00)	13 July 2000 (13.07.00)
Name and mailing address of the ISA/ RU Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)