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(56) Documents Cited
GB 2242142 A GB 2149686 A EP 0773051 A1
US 5478377 A US 5037455 A

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(54) Abstract Title
Filter composite with electrostatic and mechanical layers

(57) A filter composite comprises a first electrostatic filter layer 1, a second layer 2 comprising a mechanical filter, and a third layer 3 comprising another electrostatic filter. The electrostatic layers preferably comprise a blend of polypropylene and modacrylic fibres, with the ratio of their weights preferably being 2:1, and can have thin scrims 1a and 3a of polypropylene that acts to strengthen and protect them. The second layer can be a melt blown material eg polypropylene, with a lower weight of than that of the electrostatic layers. An additional odour removing layer of activated carbon impregnated foam may be interposed between layers 2 and 3, and/or a prefilter may be used to remove larger particles. The filter composite may be used in respiratory filters for use in prams and pushchairs (see fig 2), where the filter material can form a seal with the frame (9, fig 2), or for cyclists in order to remove road traffic pollution. It may also be used in industrial powered air purifying respirators, and in automotive cabin air filtration systems.

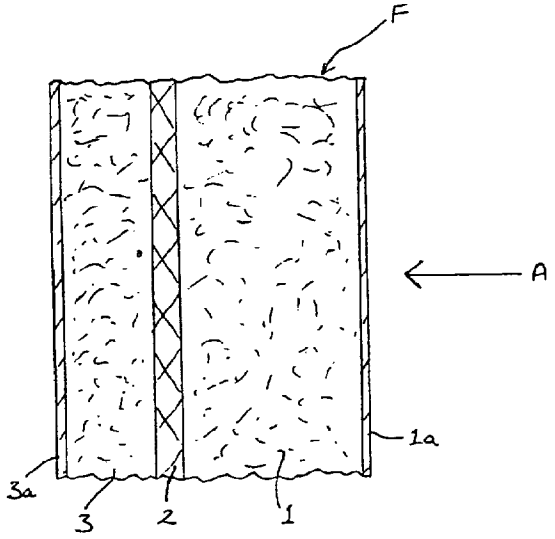

Fig. 1

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1995

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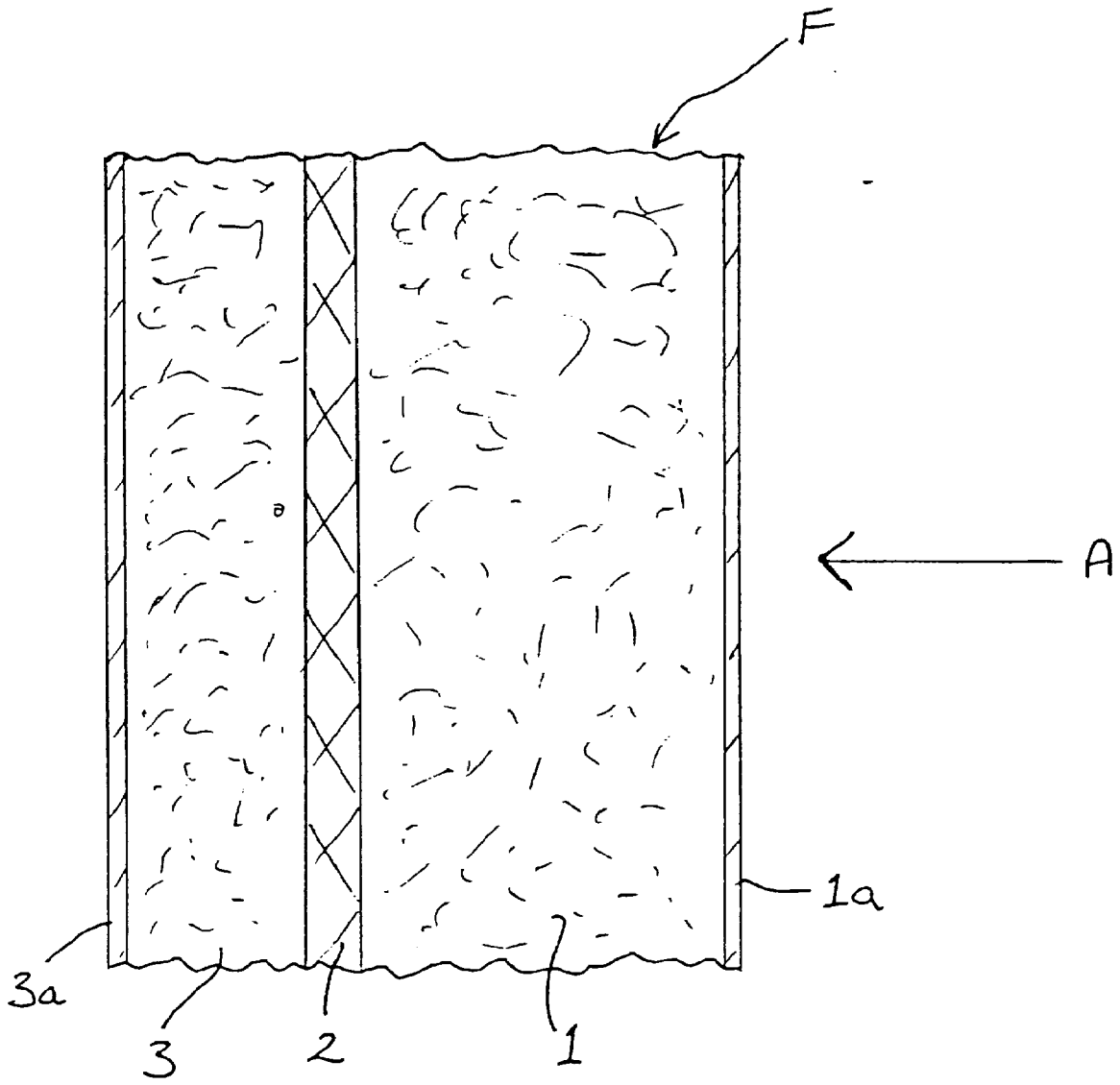

Fig. 1

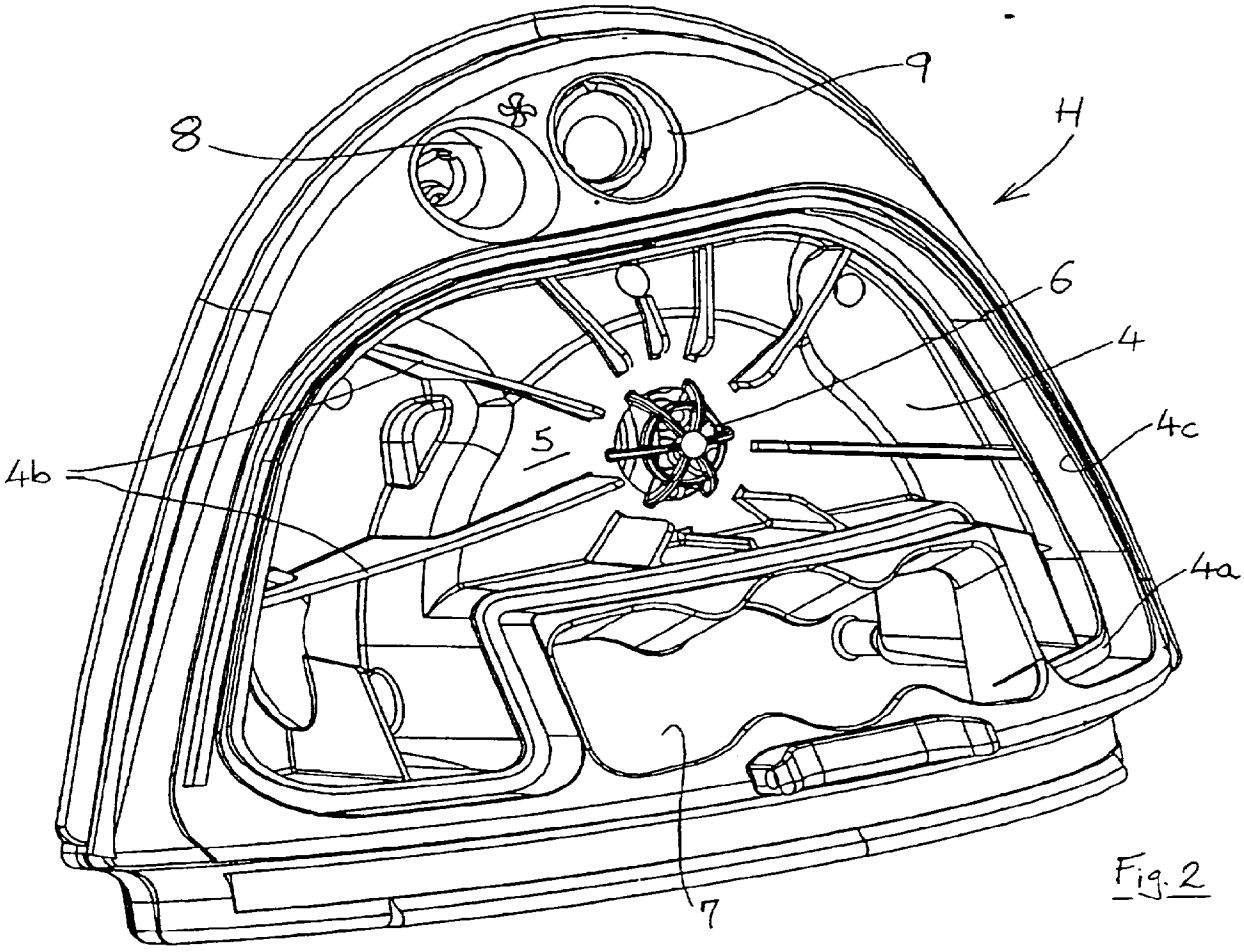

Fig. 2

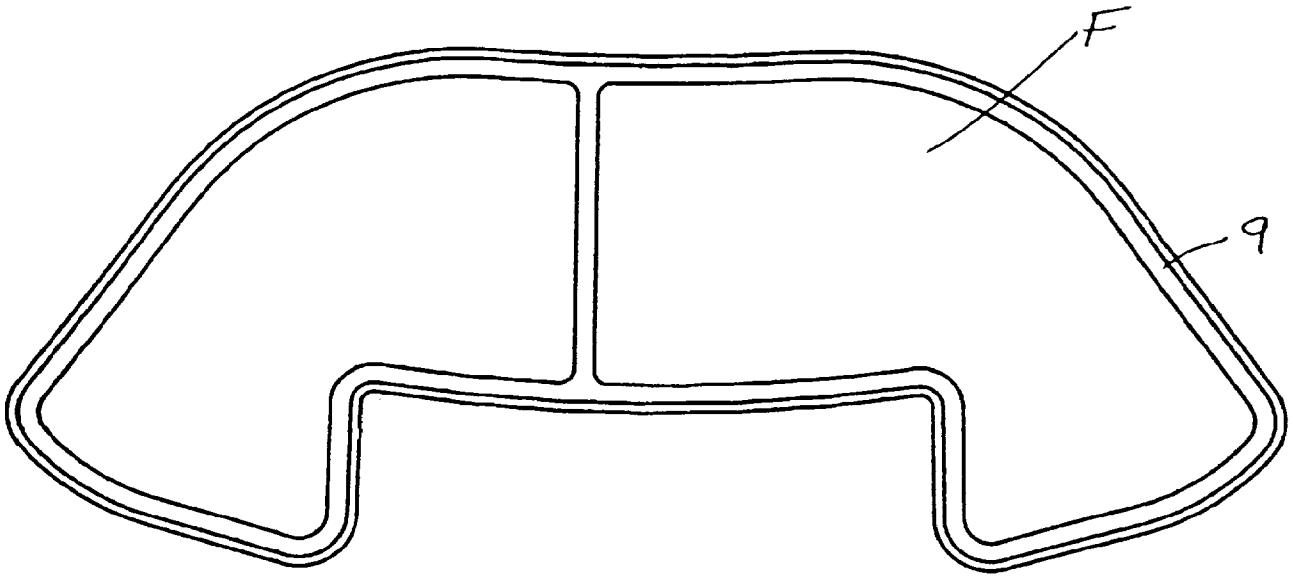

Fig. 3

Filters

The present invention relates to a composite filter for removing particulate contaminants from an air stream. In particular the invention is concerned to provide a respiratory filter composition suitable *inter alia* for removing both wet and dry aerosols associated with road traffic pollution. In one such embodiment the invention may be incorporated in a powered air purifying device to be fitted to an infant's pram (of which an example is shown in DE-A-4241233) or push-chair. The invention may also find application in the composition of personal filter masks (e.g. for cyclists) or as filters for use in industrial powered air purifying respirators or in automotive cabin air filtration systems.

One type of filter material which has been employed with considerable success in respiratory protection products against dry dust aerosols, combining a high filtration efficiency with low flow resistance, comprises a blend of clean polyolefine (e.g. polypropylene) and modacrylic fibres carded together and needled to form a felt, as described in GB-A-2190689. Such materials are available under the registered trade marks Technostat and Tribex. The carding process imparts to both fibres a stable triboelectric charge, capable of

persisting for a number of years under appropriate storage conditions, and it is to the existence of this particle-attracting electrostatic charge that the high filtering efficiency of the material is attributable. At the same time, the relatively open structure of the felt means that it presents relatively little resistance to the flow of air through it. By the same token, however, the structure of the material is not in itself best suited to the mechanical capture of fine particles and in the event of the dissipation of its electrostatic charge the filtering performance of this type of material is very seriously degraded. In this respect tests with such materials have shown them to provide only short duration filtering performance when exposed to road traffic pollution. This is believed to be due to the presence of oil mists (a product in diesel engine exhausts) and metallic fume (a product in leaded petrol engine exhausts) as contaminants in the air, which have the effect of destroying the electrostatic charge.

Composite filters comprising a layer of the above predominantly electrostatic type of filtering material together with a layer of predominantly mechanical filtering material are also known. For example a disposable filter mask composition is known comprising a layer of Technostat® material backed by a thin melt-blown polypropylene material post treated with a corona discharge; (the melt-blown therefore also carries an electrostatic charge but it is of far less significance to the filtering performance of that material than in the case of the Technostat® material and it acts predominantly to capture particulates mechanically by virtue of its smaller pore size). Such a combination has also been tested in a road traffic environment, and found to achieve longer duration than Technostat® alone, albeit with a higher resistance to flow. Particularly at the high flow rates associated with powered air purifying devices, however, filter life is in this case limited by flow resistance as the melt-blown layer becomes clogged with particles.

In accordance with the present invention a composite filter for removing particulate contaminants from an air stream comprises, in order in terms of the direction of flow: (i) a first layer of a material adapted to capture particulates predominantly by means of electrostatic attraction; (ii) a layer of a material adapted to capture particulates wholly or predominantly mechanically by virtue of its pore size; and (iii) a second layer of a material adapted to capture particulates predominantly by means of electrostatic attraction.

Preferably, the material of layers (i) and (iii) comprises a non-woven blend of fibres to which a triboelectric charge is imparted in the course of manufacture, more preferably a blend of polypropylene and modacrylic fibres. The basis weight of the material in layer (i) may be higher than that of the material in layer (iii), for example in a ratio of approximately 2:1.

Preferably, the material of layer (ii) comprises a melt-blown material, e.g. polypropylene, the basis weight of which may be substantially less than that of the materials in layers (i) and (iii). Other wholly or predominantly mechanical filtering materials may be used for layer (ii), however, for example paper.

The invention will now be more particularly described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic cross-section through a preferred embodiment of filter according to the invention;

Figure 2 is an isometric front view of the housing of a powered air purifying device with which a filter according to the invention may be used; and

Figure 3 is a front view of the filter assembly for use with the housing of Figure 2.

Figure 1 illustrates in schematic cross-section a preferred embodiment of a composite filter F according to the invention, designed especially for use in a powered air purifying device to supply filtered ambient air into an enclosure fitted on an infant's push-chair and to provide protection against road traffic pollutants. This filter comprises three consecutive layers in face-to-face contact. The first such layer (in terms of the intended direction of air flow shown by the arrow A) comprises a 200g/m^2 felt 1 of blended polypropylene and modacrylic fibres manufactured as described in GB-A-2190689 and available under the registered trade mark Technostat. A thin scrim 1a of e.g. spunbond polypropylene is needled to the felt of layer 1 on its exposed face to physically strengthen and protect the same, but this scrim has no significant effect on the filtration performance of the material. The second layer 2 comprises a 30g/m^2 melt-blown polypropylene material such as that available from Hollingsworth & Vose Limited as grade PE13030RA. The third layer 3 comprises the same material as layer 1, except of a basis weight of 100g/m^2, and is similarly protected by a scrim 3a.

In the course of carding during manufacture of the material within layers 1 and 3 the fibres acquire a triboelectric charge, and the filtration performed by that material is predominantly attributable to electrostatic attraction. The material within layer 2 is subject to a corona discharge after it is blown and thereby also acquires an electrostatic charge; it is, however predominantly a mechanical filtering medium and can still perform quite efficiently after loss of its charge.

The three-layer filter exemplified in Figure 1 has been found to achieve a desirable combination of protection against the oil mists and metallic fume aerosols found in road traffic pollution together with low flow resistance over an extended period of operation (typically 100+ hours use). In particular, tests have shown its performance in this respect to be substantially superior

both to a single 300g/m^2 layer of Technostat® material and to a two-layer combination of 300g/m^2 Technostat® and 30g/m^2 melt-blown. This three-layer combination is believed to optimise the strengths of both types of filtering material while minimising the effects of their respective weaknesses. That is to say the first predominantly electrostatic layer 1 is effectively a "sacrificial" layer whose filtering performance diminishes as its charge becomes dissipated through capture of oil mists and metallic fume, but it significantly extends the time taken for the subsequent predominantly mechanical layer 2 to become clogged and its flow resistance to reach a limiting level. At the same time the melt-blown layer 2 is relatively unaffected by oil mists and metallic fume and in turn it protects the second predominantly electrostatic layer 3 from such contaminants for an extended period, that layer itself picking up the minor proportion of particles which pass through both of the previous layers.

Optionally an additional odour-removing layer may be incorporated in the filter of Figure 1. This may comprise a layer of activated carbon-impregnated foam interposed between the illustrated layers 2 and 3. Its purpose is to remove malodorous gaseous contaminants which may be present in the air stream but it has no effect upon the particulate filtering performance of the composite.

In other embodiments an additional low-performance pre-filter may be used with the illustrated (main) filter, to remove larger sized particles which might otherwise prematurely clog the main filter.

Referring to Figure 2, this shows a plastics-moulded housing H, with its front cover removed, with which replaceable filters in accordance with the invention may be used and which comprises the main part of a powered air purifying device for fitting to a push-chair as aforesaid. It defines a filter chamber 4 of inverted "U" planform (as viewed) on one side of a main dividing wall 5. On

other side of the wall 5 is a centrifugal fan driven by a DC electric motor (not shown), the inlet to the fan from the filter chamber 4 being seen at 6. Batteries for the fan motor are located in a compartment 7, an on-off switch at 8 and a flow indicator at 9.

In use, a filter of complementary planform is fitted in the chamber 4 and when the motor is switched on air is drawn in through an inlet in the cover (removed in Figure 2), passes through the filter, and is blown through outlets in the rear of the illustrated housing into an enclosure fitted to the push-chair. The filter assembly for this purpose is shown in Figure 3, comprising a moulded-plastics frame 9 to the periphery of which a composite filter F made up from the layers described above with reference to Figure 1 is attached e.g. by adhesive or ultrasonic welding. The area of the filter F is slightly greater than that of the frame 9, however, so that a small amount of the filter material extends peripherally beyond the margins of the frame. The filter assembly is inserted into the chamber 4 and located against a peripheral ledge 4a and a number of support fingers 4b upstanding from the wall 5. The overall shape of the housing H and of the chamber 4 is in fact somewhat convex and the flexible filter assembly is bent correspondingly to locate properly within its chamber. The peripheral portion of the filter material overlapping the frame 9 is pressed against the surrounding side wall 4c of the chamber and an efficient seal is thereby formed, particularly with the fleecy Technostat® material of layers 1 and 3, to prevent air leakage around the edges of the filter. The use of a peripheral portion of a filter to form a seal in this way constitutes a separate aspect of the invention.

CLAIMS

1. A composite filter for removing particulate contaminants from an air stream comprising in order in terms of the direction of flow: (i) a first layer of a material adapted to capture particulates predominantly by means of electrostatic attraction; (ii) a layer of a material adapted to capture particulates wholly or predominantly mechanically by virtue of its pore size; and (iii) a second layer of a material adapted to capture particulates predominantly by means of electrostatic attraction.

2. A composite filter as claimed in Claim 1 in which the material of layers (i) and (iii) comprise a non-woven blend of fibres to which a triboelectric charge is imparted in the course of manufacture.

3. A composite filter as claimed in Claim 2 in which the material of layers (i) and (ii) comprise a blend of polypropylene and modacrylic fibres.

4. A composite filter as claimed in any preceding Claim in which the basis weight of the material in layer (i) is higher than that of the material in layer (iii).

5. A composite filter as claimed in any preceding Claim in which the material of layer (ii) comprises a melt-blown material, e.g. polypropylene, the basis weight of which is substantially less than that of the materials in layers (i) and (iii).

6. A composite filter as claimed in Claim 1 substantially as herein described with reference to the accompanying drawings.

Amendments to the claims have been filed as follows

1. A composite filter for removing particulate contaminants from an air stream comprising in order in terms of the direction of flow:

(i) a first layer of a material adapted to capture particulates predominantly by means of electrostatic attraction;

(ii) a layer of a material adapted to capture particulates wholly or predominantly mechanically by virtue of its pore size; and

(iii) a second layer of a material adapted to capture particulates predominantly by means of electrostatic attraction,

in which the basis weight of the material in layer (i) is higher than that of the material in layer (iii).

2. A composite filter as claimed in Claim 1 in which the material of layers (i) and (iii) comprise a non-woven blend of fibres to which a triboelectric charge is imparted in the course of manufacture.

3. A composite filter as claimed in Claim 2 in which the material of layers (i) and (ii) comprise a blend of polypropylene and modacrylic fibres.

4. A composite filter as claimed in any preceding Claim in which the material of layer (ii) comprises a melt-blown material, e.g. polypropylene, the basis weight of which is substantially less than that of the materials in layers (i) and (iii).

5. A composite filter as claimed in Claim 1 substantially as herein described with reference to the accompanying drawings.

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Application No: GB 9720291.5
Claims searched: 1-6

Examiner: Gareth Prothero
Date of search: 27 November 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): B1T (TCCA, TNAD); B2J (JM)

Int Cl (Ed.6): B03C 3/28, 3/30

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2242142 A	(WHEWAY) see whole document.	1-3, and 5
X	GB 2149686 A	(DOMESTIC) see abstract, and fig 2.	1-3, and 5
X	EP 0773051 A1	(SMITHS) see fig 1, and col 1, para 5.	1-3, and 5
X	US 5478377 A	(USA) see abstract, and col 2, lines 31 to 37.	1-3, and 5
X	US 5037455 A	(GREAT) see abstract, fig 3, and col 2, lines 62 to 64..	1-3, and 5

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.