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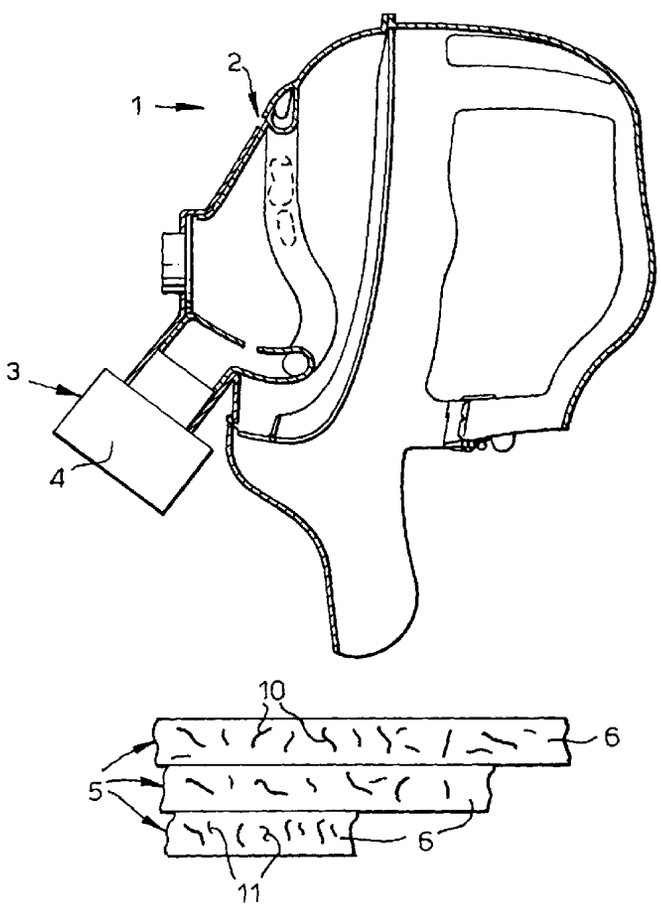
(54) Title: COMBINED VAPOUR AND PARTICULATE FILTER



(57) Abstract: With reference to figures (1 and 2), a personal respirator (1) has a face mask (2) and is provided with a filter unit (3) comprising a canister (4) housing contiguous layers (5) of novel filter material (6). The filter material (6) is suitable for both particulate and vapour filtration, and comprises a composite of first and second groups (10, 11) of chopped fibres, the fibres of the first group (10) having a relatively large diameter (about 7 x 10^{-6}m) and the second group (11) having a relatively small diameter (about 0.5 x 10^{-6}m).

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COMBINED VAPOUR AND PARTICULATE FILTER

This invention relates to filter material and is concerned with both the production and use of the material.

Material according to the invention is suitable for both particulate and vapour filtration.

As used herein, the term "vapour" includes air and gases.

According to one aspect of the invention, filter material suitable for both particulate and vapour filtration comprises a composite of first and second groups of fibres, the fibres of the first group having a relatively large diameter, and the fibres of the second group having a relatively small diameter.

Typically, the fibres of the first group have a diameter of about 7.0×10^{-6}m and the fibres of the second group have a diameter of about 0.5×10^{-6}m.

Also typically, the composite material contains about 70% (by mass) of first group fibres.

The fibres of the first group may comprise carbon fibres the fibres of the second group may comprise glass and/or carbon fibres.

According to a second aspect of the invention, a method of producing filter material of composite form suitable for both particulate and vapour filtration, comprises mixing together with binder, first and second groups of fibres, fibres of the first group having a relatively large diameter and fibres of the second group having a relatively small diameter.

The invention also comprises filter material produced by the foregoing method.

The invention further comprises a respirator provided with a filter unit incorporating the novel filter material.

The various aspects of the invention will now be described, by way of example only, with reference to the accompanying drawings wherein:-

Figure 1 is a side view of a respirator provided with a filter unit,

Figure 2 is a cross-section of filter material employed by the filter unit,

Figure 3 is a flow chart illustrating manufacturing steps used in producing the filter material and

Figures 4, 5 and 6 illustrate various forms of filter materials.

Figure 1 shows a personal respirator 1 of the form disclosed by GB 2,080,120 (Secretary of State for Defence), having a face mask 2, a filter unit 3 and a canister 4.

By the current invention, canister 4 houses contiguous layers 5 of filter material 6 according to the invention (figure 2).

Filter material 6 is suitable for both particulate and vapour filtration, and comprises a composite of first and second groups 10, 11 of chopped fibres, the fibres of the first group 10 having a relatively large diameter (about 7.0×10^{-6}m) and the fibres of the second group 11 having a relatively small diameter (about 0.5×10^{-6}m).

The preferred range of fibre diameter is:-

First group	6.0 to 14×10^{-6}m
Second group	0.1 to 1.0×10^{-6}m

Preferred length of fibres:-

First group	1.0mm to 6.0mm
Second group	100.0×10^{-6}m to 200.0×10^{-6}m

First group fibres 10 of this example comprises Polyacrylonitrile (PAN) or pitch carbon fibres which have been activated by conventional steam or CO_2 activation methods so as to render them porous whereby they are capable of adsorbing high boiling point (say >50° C) vapours. These fibres have also been chemically treated with impregnants so as to render them capable of adsorbing low (e.g. <50° C) boiling point vapours. The fibres

10, which may be regarded as macrofibres, make up approximately 70% (by mass) of the composite material. The range of fibre mix may vary, with the fibres 10 of the first group ranging from 60% to 90% (by mass) and fibres 11 of the second group making up the remainder of the mass.

Fibres 11 of the second group, which may be regarded as microfibres, comprise vapour grown carbon (or glass) fibres.

The first group fibres filter vapours and the second group fibres filter particulates. By combining the two groups of fibres a combined vapour and particulate filter material results.

The dual role of the filter material results in a reduction in weight (when compared with conventional two filter units), as well as a reduction in breathing resistance, due to a lesser requirement for total filtration media.

Figure 3 illustrates how the filter material is produced.

The desired portions of first and second groups of fibres are mixed in a mixing vessel 15 together with water, a soluble binder, such as sodium carboxymethyl cellulose or acrylic base binder and a viscosity modifier such as glycerol, which aids dispersion and ensures a substantially uniform mixture. The mixture is then passed to a sheet former 16, of the type used in the paper industry to make test samples. Water slouble binder (such as mentioned above) can be added to ensure that the subsequent composite has good mechanical properties.

If binder is added, the material is heated to 130° C to 150° C to cure the binder for 10-20 minutes.

Use of the former 16 results in composite filter material of mat form which is subsequently cut to size for incorporation as layers into the filter canister 4 of Figure 1, using cutter 17.

The composite material can be produced in mats of flat sheet form, such as rectangles (Figure 4) or discs (Figure 5). Alternatively, the mats may be pleated (Figure 6). The finished shapes are produced so as to allow ease of integration in the respirator system.

Examples

1.PARTICULATE REMOVAL

A 25g activated pitch carbon fibre mat has been produced that can remove 99.5% of NaCl particles (mean particle diameter 0.6 x 10^{-6}m) when tested at a face velocity of 30 cc/min. The associated pressure drop is low, 0.9 mmH2O.

2.VAPOUR REMOVAL

Activated pitch carbon fibres tested against hexane (concentration 4 000 mg/m3 @ 1l/min) in dry conditions (<5% relative humidity), and dry sample. Weight of carbon fibres is 0.8g in a 2.5 cm brass sample tube. One of the activated carbon fibres did not display any hexane breakthrough until 63 minutes.

CLAIMS

1. Filter material suitable for both particulate and vapour filtration comprising a composite of first and second groups of fibres, the fibres of the first group having a relatively large diameter and the fibres of the second group having a relatively small diameter.

2. Filter material as claimed in Claim 1, wherein the fibres of the first group have a range of 6.0 to 14.0 x 10^{-6}m diameter.

3. Filter material as claimed in claim 1 or 2, wherein the fibres of the second group have a range of 0.1 to 1.0 x 10^{-6}m in diameter.

4. Filter material as Claimed in claim 1, 2 or 3 wherein the fibres of the first group have a range of 1.0 mm to 6.0 mm in length.

5. Filter material as claimed in any one of Claims 1 to 4, wherein the fibres of the second group have a range of 100.0 to 200.0 x 10^{-6}m in length.

6. Filter material as claimed in any one of Claims 1 to 5, wherein the fibres of the first group are about 7 x 10^{-6}m in diameter.

7. Filter material as claimed in any one of Claims 1 to 6, wherein the fibres of the second group are about 0.5 x 10^{-6}m in diameter.

8. Filter material as claimed in any one of Claims 1 to 7, wherein the fibres of the first group range from 60% to 90% by mass.

9. Filter material as claimed in Claim 8, wherein the fibres of the first group comprise approximately 70% by mass.

10. Filter material as claimed in any one of Claims 1 to 9, wherein the fibres of at least the first group comprise carbon fibres.

11. Filter material as claimed in any one of Claims 1 to 10, wherein the fibres of the second group comprise glass fibres.

12. Filter material as claimed in any one of Claims 1 to 11, wherein the fibres of the first group have been treated so as to render them capable of adsorbing both high and low boiling point vapours.

13. Filter material as claimed in Claim 12, wherein the high boiling point vapours are greater that 50° C and the low boiling point vapours are less than 50° C.

14. A method of producing filter material of composite form suitable for both particulate and vapour filtration, comprising mixing together with binder, first and second groups of fibres, the fibres of the first group having a relatively large diameter and the fibres of the second group having a relatively small diameter.

15. The method as claimed in claim 14, wherein the material is produced as sheets, subsequently cut to size for incorporation as layers in a respirator system.

16. A respirator provided with a filter unit incorporating a filter material of any one of Claims 1 to 15.

Fig.1.

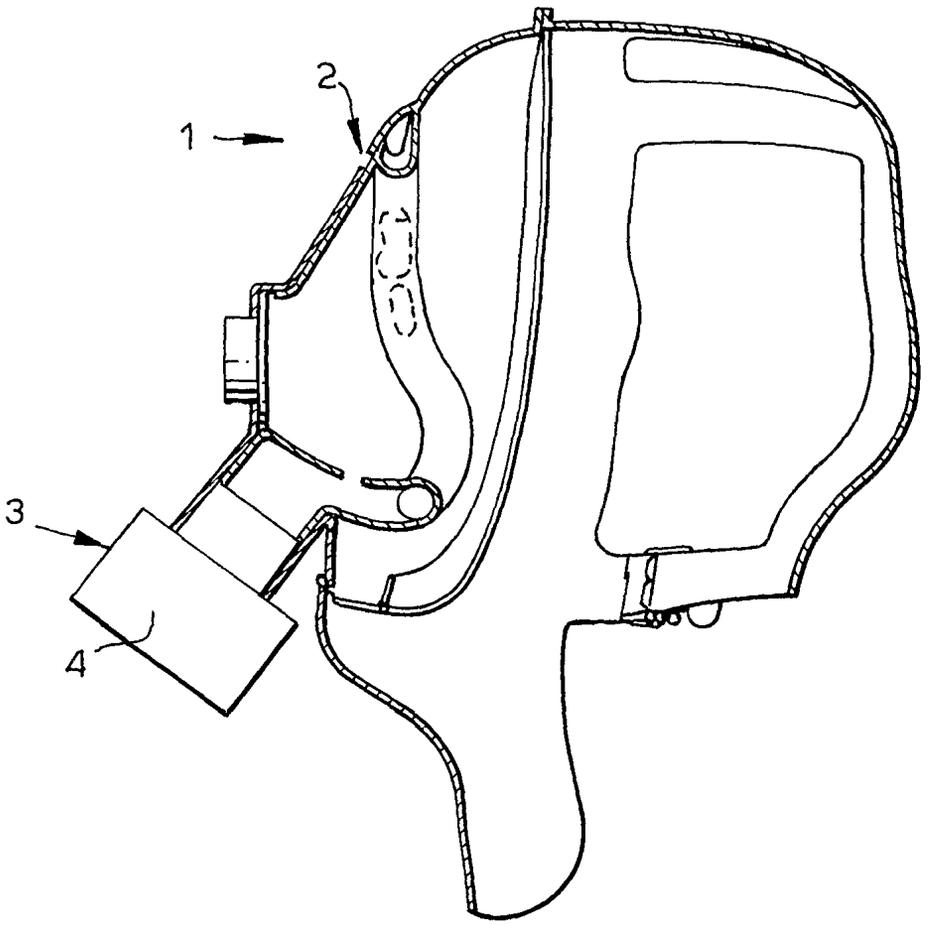


Fig.2.

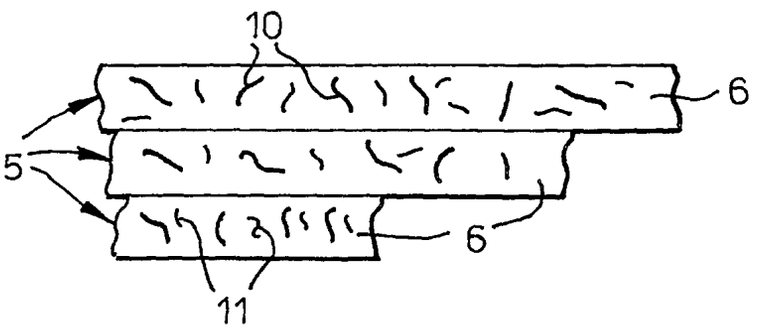


Fig.3.

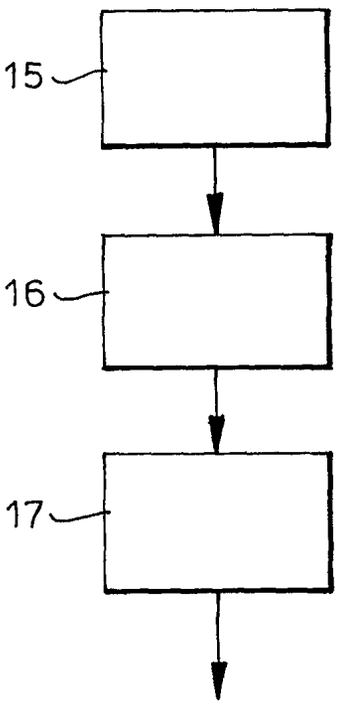


Fig.4.

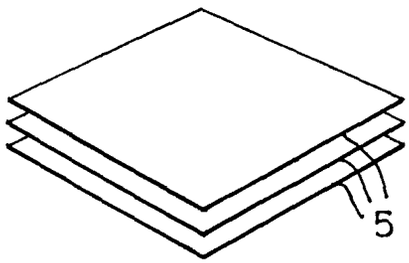


Fig.5.

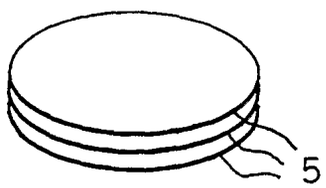
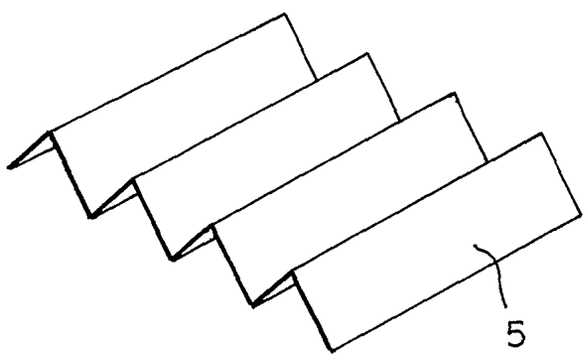


Fig.6.



INTERNATIONAL SEARCH REPORT

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PCT/GB 01/00836

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B01D39/08 B01D39/20 B01D53/02

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)
IPC 7 B01D

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 practical, search terms used)
WPI Data, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DATABASE WPI Section Ch, Week 198733 Derwent Publications Ltd., London, GB; Class A97, AN 1987-231919 XP002165203 & JP 62 155914 A (TOYO ROSHI KK), 10 July 1987 (1987-07-10) abstract ---	1,7,8, 10,11
X	DATABASE WPI Section Ch, Week 198506 Derwent Publications Ltd., London, GB; Class A88, AN 1985-034894 XP002165204 & JP 59 228918 A (TEIJIN LTD), 22 December 1984 (1984-12-22) abstract --- -/--	1-3,14

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA	Authorized officer
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