

PATENT SPECIFICATION

(11) 1 592 549

1 592 549

- (21) Application No. 41533/76 (22) Filed 6 Oct. 1976
(23) Complete Specification filed 27 Sept. 1977
(44) Complete Specification published 8 July 1981
(51) INT CL³ A24D 1/04
(52) Index at acceptance A2C 1E2



(54) IMPROVEMENTS RELATING TO TOBACCO-SMOKE FILTERS

(71) We, BRITISH-AMERICAN TOBACCO COMPANY LIMITED, a Company incorporated under the laws of Great Britain, of Westminster House, 7 Millbank, London S.W.1., do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

This invention concerns tobacco-smoke filters, particularly but not exclusively cigarette filters. It seeks to provide such filters having both good filtration efficiency for total particulate matter and an acceptable pressure drop. It seeks especially to achieve this result over the whole puff range of a cigarette, for instance.

In a cigarette filter comprising a rod-shaped body of fibrous material, it is known to provide a disc of smoke-impervious material, a plastics material for example, having a smoke-accelerating orifice formed therein. Also known is a filter body which is compacted to different degrees of density to provide portions of different porosity along the length of the body. The differential porosity of the latter body can be produced by heat-treating one or both ends of the body.

It has also been proposed heretofore, in the Specification of our United Kingdom Patent No. 1,339,238, that a cigarette should comprise a tobacco section and a filter section each covered by an overwrap and assembled together by a tipping paper overlapping the overwraps, openings in the tipping paper and filter overwrap to provide a filter ventilation area, and a plug with openings interposed between the tobacco section and the filter ventilation area, whereby as the plug becomes clogged during smoking the proportion of diluting air drawn through the ventilation area to the smoke drawn through the plug is increased, thus maintaining a steady delivery of smoke or smoke taste on a puff

by puff basis. It is stated that the plug, suitably having the form of a disc, should completely block the filter section except for the openings in the plug.

It has also been proposed, in the specification of our United Kingdom Patent No. 1,330,936 that a filter device for a cigarette should comprise a tube forming the outer wrap of the device and a piston within said tube slidable toward a smoker responsive to suction applied through said tube by the smoker drawing on a cigarette, the face of said piston being perforated and serving as a filter for the cigarette, the side walls of the piston and tube each having openings spaced from each other when the piston is in an initial position prior to smoking of the cigarette, the piston opening(s) being covered by the tube and the tube opening(s) being covered by the piston, said piston opening(s) and tube opening(s) being so aligned that sliding of the piston toward the smoker will cause the opening(s) in the piston and tube to overlap and allow air to be drawn from the atmosphere into the smoker's mouth. The filter device can be used with a conventional filter at either end or inside the piston.

According to the present invention, a tobacco-smoke filter comprises an envelope enclosing a rod-shaped body of smoke-filtration material having interstices through which smoke can pass and be subjected to the filtration effect of the material, which material is pervious, by virtue of the said interstices, throughout the interior of said rod-shaped body apart from a transverse cross section in which the interstices have been closed to render that cross section smoke impervious except in a minor proportion of the cross section which forms at least one smoke accelerating orifice, the said envelope having provision permitting ingress of air into the filter in the region downstream of the orifice. The said interstices may be closed by the sealing material filling or coating an annular groove

in the body. Alternatively or additionally the interstices in the filter material, for instance interstices between cellulose-acetate fibres, may be closed by local application of heat thereto, while leaving the minor proportion of the said area thereof smoke pervious. By a minor proportion in this context is meant no more than 30% of the said area and preferably no more than 20%. A single orifice may, for practical purposes, have a diameter within the range of 1 to 3.5 mm. More than one smoke-accelerating orifice may be provided in an impervious cross section, in which case the diameter of each is advantageously made less than that of a single orifice.

A said cross section may be located intermediately of the length of the rod-shaped body, the envelope being air pervious downstream of the said cross section and impervious upstream thereof. A said cross section may be located at the smoke-entry end of the body. In either case, filter material is present in and/or immediately downstream of the orifice, where it is impinged upon by the accelerated smoke under conditions favourable to separation and retention of particulate matter.

Rendering the aforesaid cross section impervious by closure of the interstices in the smoke-filtration material does not involve the provision of a separate component, such as a plug, disc or piston referred to above, and avoids the necessity for assembling any separate component with the rest of the filter. The operation of sealing the interstices in the aforesaid cross section, whether by a sealant or by the local application of heat, while leaving the minor proportion of that section smoke pervious can be simply achieved in a manner involving little interference with conventional equipment for the production of cigarette filters.

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

Fig. 1 is a diagrammatic longitudinal section through one embodiment of filter shown attached to the tobacco rod of a cigarette,

Fig. 2 a similar view of a second embodiment,

Fig. 3 a similar view of a third embodiment,

Fig. 4 a graphical comparison of the filtration performance of the filters of Figs. 1 to 3 with that of a conventional form of filter.

Fig. 5 a graphical representation, also for comparison purposes, of the delivery of

total particulate matter by another form of conventional filter and

Fig. 6 a graphical comparison of the pressure-drop behaviour of the filter of Fig. 1 with the conventional form of filter whose performance is illustrated by Fig. 5.

The rod-shaped cigarette filter body of Fig. 1, which is composed of self-bonded (non-wrapped) fibrous cellulose acetate, has, close to but spaced from one end, a deep, substantially parallel-sided, annular groove 2 formed by revolving the body against a blade which is maintained at a temperature sufficient to melt the cellulose acetate. The base and sides of the groove 2 will thus be glazed by the hot blade and rendered wholly or partially impervious to tobacco smoke by closure of the interstices in the adjacent cellulose acetate. Particularly in the latter case, a sealant material 3, suitably a polyethylene hot-melt adhesive material, is introduced into the groove 2 so as to complete the sealing of the base and sides of the groove. The material may be in a foamed form provided that it is impervious. Slight outward divergence of the sides of the groove will facilitate the deposition of the sealant therein. The sealant may alternatively be applied so as to form a film over the base and sides of the groove 2. In either case, the sealed region forms an annular smoke-impervious barrier diaphragm 4 around a central circular neck 5 of smoke-pervious cellulose acetate which forms, in effect, an orifice for the through flow of smoke when the filter is in use.

For use in conjunction with the tobacco rod 6, wrapped in cigarette paper 7, of a cigarette, the filter body 1 is enveloped in a tipping 7', of which the portion 8 on the downstream side of the diaphragm 4 is air pervious, whereas the remaining portion 9, which extends over a short length of the cigarette paper 7, is air-impervious. The tipping 7' may be made of non-porous or substantially non-porous material, preferably paper, in which case the portion 8 has been electrostatically or mechanically perforated in known manner to provide a predetermined degree of air-perviousness. The tipping 7' may alternatively be made from a porous paper, in which case, the portion 9 is rendered impervious by treatment with a sealant. For example, it may be coated with a sealant or with an impervious adhesive by which it is adhered to the surface of the body 1. To ensure that no part of the smoke stream by-passes the neck 5, the tipping 7' may be adhered to the plug 1 by circumferential beads of adhesive (not shown), one at each margin of the groove 2. Or use could be made of a tipping paper coated with a hot-melt adhesive by which it

is adhered to the plug around the circumference.

On smoking a cigarette having a filter such as has been described, the smoke stream entering from the tobacco rod 6 through the full cross section of the plug 1 is constricted and caused to flow through the narrow neck 5 which thus acts as a smoke-accelerating orifice. Immediately contiguous to the neck 5, there are cellulose acetate fibres upon which the accelerated smoke particles will impinge and be collected. On the downstream side of the diaphragm 4, air is drawn in through the tipping 7' and mixes with the smoke. This has the effect of ensuring acceptable draw resistance or pressure drop despite the neck 5, as well as achieving other beneficial effects generally attributed to so-called ventilation.

The puff-by-puff delivery of total particulate matter (T.P.M.) from the filter shown in Fig. 1 with an orifice neck 5 of 2.5 mm diameter 5 mm distant from the tobacco end of a 20 mm long body 1 was investigated in comparison with a conventional form of filter body having a similar pressure drop. The conventional body was identical in form with the body 1 of Fig. 1 except for the absence of the diaphragm. The results obtained are shown in Fig. 4 in which delivery D of T.P.M. in mg is plotted against the puff number N over the range of smoking of a cigarette under the standard conditions. Curve *a* represents the results for the T.P.M. delivery from the filter of Fig. 1 and curve *b* those for the conventional filter. It will be seen that the former achieves not only a lower overall delivery, that is higher filtration efficiency, but also a more even, sustained lower delivery of T.P.M.. Fig. 4 also illustrates, by the curve *c*, the puff-by-puff delivery in mg of nicotine with the filter of Fig. 1. An acceptable nicotine delivery which is substantially even over the whole number of puffs is obtained. At the same time, a desirably low ratio of T.P.M. delivery to nicotine delivery can be achieved.

Fig. 2 illustrates a modification of the filter of Fig. 1 in which a ring of small holes 10 is provided in the otherwise impervious portion 9 of the tipping 7' to permit ingress of ventilation air upstream of the diaphragm 4 also. If the said tipping 7' is secured to the body 1 by adhesive, an adhesive-free band 10' may be left where the ring of holes is located. The curve *d* in the Fig. 4 illustrates the pattern of T.P.M. delivery obtained. The delivery is even lower than that indicated by curve *a* and is again relatively uniform over the puff range.

Comparative tests were also carried out between a first filter which had a smoke-

accelerating orifice neck 5 and was otherwise similar to the filter of Fig. 1 except that the whole length of the body 1 was wrapped in an impervious wrapping and a second, conventional, form of filter, without orifice neck, whose whole length was also wrapped in an impervious wrapping.

In Fig. 5, the T.P.M. delivery for the first of these filters is shown by curve *e* and that for the second by curve *f*. As will be seen, the first filter, having the orifice neck 5, gave an overall lower delivery of T.P.M., but the delivery on a puff-by-puff basis was much more uneven than in the case of curves *a* and *d* in Fig. 4. After puff 6, the delivery of T.P.M. rises sharply, which is undesirable and likely to be unacceptable to the smoker.

Comparative tests with respect to filter pressure drop were carried out for the filter of Fig. 1 and the first of the filters just discussed, which differed only by having an impervious wrapping over its whole length. The results are shown in Fig. 6, in which pressure drop *pd* in cm Water Gauge is plotted against puff number N, curve *a'* representing the pressure drop pattern for the filter of Fig. 1 and curve *e'* that for the filter with the impervious wrapping. Curve *a'* indicates a pressure drop which remains acceptable over the whole puff range, whereas curve *e'* indicates a pressure drop which increases so rapidly as to be quite unacceptable after even a few puffs.

The filter of Fig. 3 differs from that of Fig. 1 in that a smoke-accelerating orifice 5 is provided at the upstream end of the cellulose-acetate body 1 instead of at an intermediate point in its length. The orifice 5 is formed by rendering impervious the whole end surface 11 of the body except for a small central portion, suitably of 1.5 mm diameter, which is left as the pervious neck extending towards the tobacco rod 6. The end surface 11 may be rendered impervious by embossing and glazing it by means of a die provided with a central hole whose internal diameter is equal to that of the orifice 5. The die, heated to a temperature suitable for glazing the cellulose acetate, is moved axially of the body to press its end surface against the surface 11 of the body, whereby the interstices in the adjacent cellulose acetate are closed.

The T.P.M. delivery of the filter shown in Fig. 3 is represented by the curve *g* in Fig. 4. The delivery is low and acceptably even over the puff range.

A filter similar to that of fig. 3 may be obtained by using a die which is similar to that just referred to, but lacks the central hole, so that the whole of the end surface of the body 1 is smoke-imperviously glazed. The smoke-accelerating orifice is then formed by piercing the glazed end with a pin. The pin may be heated to a temperature

12

such that local fusing of the cellular acetate fibres is caused. Alternatively, use may be made of a die with a flat glazing face from which a spike extends. The end of the body 1 is smoke-imperviously glazed except for the opening formed by the spike.

Finally, a filter similar to that of Fig. 3 may be produced by coating the body 1 with a sealant material over its whole end surface except for a small central portion which provides the smoke-accelerating orifice.

In a filter otherwise similar to that of Fig. 3, the glazed or sealed end surface, instead of being flat, may be curved, for example dished as viewed in a longitudinal section of the body 1. The surface may be that of a recess extending inwardly from the end of the body.

In any of the filters of Figures 1 to 3, ventilation downstream of the neck 5 could be obtained by providing a ring or rings of holes, such for example as the holes 10 of the filter of Figure 2, in the portion 8 of the tipping 7.

In a filter, there may be more than one smoke-accelerating orifice in a diaphragm. Thus, a diaphragm may be provided with more than one unglazed or uncoated portion in an otherwise glazed or coated surface. Also, in a filter there may be more than one diaphragm, each with a smoke-accelerating orifice, spaced apart along the filter so that the orifices act in series.

The smoke-accelerating orifice may be disposed at or near the end of the body remote from the tobacco rod. However, higher filtration efficiencies are obtainable when the orifice is located at or near the tobacco end of the plug.

The choice of filter material for the body 1 is not restricted to fibrous materials such as cellulose acetate. Bonded granular filter materials, for example carbon, may be employed. Also the filter plug may be composed of a mixture of materials, for example, a mixture of polypropylene fibres and cellulose-acetate fibres and cellulose-acetate fibres and carbon granules.

The invention can be applied in conjunction with filter bodies of non-bonded filter material. In this case, the wrapping material or materials selected must satisfy the requirements of the present invention as well as serving the purpose of effectively containing the unbonded material.

WHAT WE CLAIM IS:—

1. A tobacco-smoke filter comprising an

envelope enclosing a rod-shaped body of smoke-filtration material having interstices through which smoke can pass and be subjected to the filtration effect of the material, which material is pervious, by virtue of the said interstices, throughout the interior of said rod-shaped body apart from a transverse cross section in which the interstices have been closed to render that cross section smoke impervious except in a minor proportion of the cross section which forms at least one smoke accelerating orifice, the said envelope having provision permitting ingress of air into the filter in the region downstream of the orifice.

2. A filter according to claim 1, wherein an annular groove is provided in the filtration material at the said cross section and is filled with or has its walls coated with a smoke-impervious material.

3. A filter according to claim 1, wherein the said interstices in the filtration material are closed by the local application of heat thereto, while the said minor proportion of the area thereof retains the smoke perviousness of the filtration material.

4. A filter according to any one of claims 1 to 3, wherein a said cross section is located intermediately of the length of the filtration material, the envelope being air pervious downstream of the said cross section.

5. A filter according to claim 4, wherein the envelope is air-impervious upstream of the said cross section.

6. A filter according to claim 4, wherein the envelope is provided with ventilation holes upstream of the said cross section.

7. A filter according to any one of claims 1 to 6, wherein a said cross section is located at the smoke-entry end of the filtration material.

8. A filter according to any one of claims 1 to 8, wherein more than one said impervious cross-section is so provided that the orifices are in series.

9. A filter according to any one of claims 1 to 8, wherein the diameter of the said orifice is within the range of 1 to 3.5 mm.

10. A filter according to any one of claims 1 to 10, wherein the body is of fibrous filtration material.

11. A filter according to claim 10, wherein the body is a self-bonded body.

12. A filter according to claim 10 or 11, wherein the fibrous filtration material is cellulose acetate.

13. A tobacco-smoke filter substantially as hereinbefore described with reference to Fig. 1, Fig. 2 or Fig. 3 of the accompanying drawings.

such that local fusing of the cellular acetate fibres is caused. Alternatively, use may be made of a die with a flat glazing face from which a spike extends. The end of the body 1 is smoke-imperviously glazed except for the opening formed by the spike.

Finally, a filter similar to that of Fig. 3 may be produced by coating the body 1 with a sealant material over its whole end surface except for a small central portion which provides the smoke-accelerating orifice.

In a filter otherwise similar to that of Fig. 3, the glazed or sealed end surface, instead of being flat, may be curved, for example dished as viewed in a longitudinal section of the body 1. The surface may be that of a recess extending inwardly from the end of the body.

In any of the filters of Figures 1 to 3, ventilation downstream of the neck 5 could be obtained by providing a ring or rings of holes, such for example as the holes 10 of the filter of Figure 2, in the portion 8 of the tipping 7'.

In a filter, there may be more than one smoke-accelerating orifice in a diaphragm. Thus, a diaphragm may be provided with more than one unglazed or uncoated portion in an otherwise glazed or coated surface. Also, in a filter there may be more than one diaphragm, each with a smoke-accelerating orifice, spaced apart along the filter so that the orifices act in series.

The smoke-accelerating orifice may be disposed at or near the end of the body remote from the tobacco rod. However, higher filtration efficiencies are obtainable when the orifice is located at or near the tobacco end of the plug.

The choice of filter material for the body 1 is not restricted to fibrous materials such as cellulose acetate. Bonded granular filter materials, for example carbon, may be employed. Also the filter plug may be composed of a mixture of materials, for example, a mixture of polypropylene fibres and cellulose-acetate fibres and cellulose-acetate fibres or a mixture of cellulose-acetate fibres and carbon granules.

The invention can be applied in conjunction with filter bodies of non-bonded filter material. In this case, the wrapping material or materials selected must satisfy the requirements of the present invention as well as serving the purpose of effectively containing the unbonded material.

WHAT WE CLAIM IS:—

1. A tobacco-smoke filter comprising an

envelope enclosing a rod-shaped body of smoke-filtration material having interstices through which smoke can pass and be subjected to the filtration effect of the material, which material is pervious, by virtue of the said interstices, throughout the interior of said rod-shaped body apart from a transverse cross section in which the interstices have been closed to render that cross section smoke impervious except in a minor proportion of the cross section which forms at least one smoke accelerating orifice, the said envelope having provision permitting ingress of air into the filter in the region downstream of the orifice.

2. A filter according to claim 1, wherein an annular groove is provided in the filtration material at the said cross section and is filled with or has its walls coated with a smoke-impervious material.

3. A filter according to claim 1, wherein the said interstices in the filtration material are closed by the local application of heat thereto, while the said minor proportion of the area thereof retains the smoke perviousness of the filtration material.

4. A filter according to any one of claims 1 to 3, wherein a said cross section is located intermediately of the length of the filtration material, the envelope being air pervious downstream of the said cross section.

5. A filter according to claim 4, wherein the envelope is air-impervious upstream of the said cross section.

6. A filter according to claim 4, wherein the envelope is provided with ventilation holes upstream of the said cross section.

7. A filter according to any one of claims 1 to 6, wherein a said cross section is located at the smoke-entry end of the filtration material.

8. A filter according to any one of claims 1 to 8, wherein more than one said impervious cross-section is so provided that the orifices are in series.

9. A filter according to any one of claims 1 to 8, wherein the diameter of the said orifice is within the range of 1 to 3.5 mm.

10. A filter according to any one of claims 1 to 10, wherein the body is of fibrous filtration material.

11. A filter according to claim 10, wherein the body is a self-bonded body.

12. A filter according to claim 10 or 11, wherein the fibrous filtration material is cellulose acetate.

13. A tobacco-smoke filter substantially as hereinbefore described with reference to Fig. 1, Fig. 2 or Fig. 3 of the accompanying drawings.



1.3

5

1,592,549

5

JENSEN & SON,
Agents for the Applicants,
8 Fulwood Place,
High Holborn,
London WC1V 6HG.
Chartered Patent Agents

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1981.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from
which copies may be obtained.



* C L M S *