



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top; padding: 5px;"> <b>(21) International Application Number:</b> PCT/GB00/00850   <b>(22) International Filing Date:</b> 8 March 2000 (08.03.00)   <b>(30) Priority Data:</b>  <div style="display: flex; justify-content: space-between; margin-top: 5px;"> <div>9905406.6</div> <div>9 March 1999 (09.03.99)</div> <div>GB</div> </div> <div style="display: flex; justify-content: space-between; margin-top: 5px;"> <div>9921734.1</div> <div>14 September 1999 (14.09.99)</div> <div>GB</div> </div>   <b>(71) Applicant (for all designated States except US):</b> FILTRONA INTERNATIONAL LIMITED [GB/GB]; Filtrona Technology Centre, Shaftesbury Avenue, Jarrow, Tyne &amp; Wear NE32 3UP (GB).   <b>(72) Inventor; and</b>  <b>(75) Inventor/Applicant (for US only):</b> CLARKE, Paul, Francis [GB/GB]; 25 Turners Way, Kirkhill, Morpeth, Northumberland (GB).   <b>(74) Agent:</b> GEERING, Keith, Edwin; Reddie &amp; Grose, 16 Theobalds Road, London WC1X 8PL (GB).       </td> <td style="width: 50%; vertical-align: top; padding: 5px;"> <b>(81) Designated States:</b> AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).   <b>Published</b>  <i>With international search report.</i> </td> </tr> </table>			<b>(21) International Application Number:</b> PCT/GB00/00850  <b>(22) International Filing Date:</b> 8 March 2000 (08.03.00)  <b>(30) Priority Data:</b> <div style="display: flex; justify-content: space-between; margin-top: 5px;"> <div>9905406.6</div> <div>9 March 1999 (09.03.99)</div> <div>GB</div> </div> <div style="display: flex; justify-content: space-between; margin-top: 5px;"> <div>9921734.1</div> <div>14 September 1999 (14.09.99)</div> <div>GB</div> </div> <b>(71) Applicant (for all designated States except US):</b> FILTRONA INTERNATIONAL LIMITED [GB/GB]; Filtrona Technology Centre, Shaftesbury Avenue, Jarrow, Tyne & Wear NE32 3UP (GB).  <b>(72) Inventor; and</b> <b>(75) Inventor/Applicant (for US only):</b> CLARKE, Paul, Francis [GB/GB]; 25 Turners Way, Kirkhill, Morpeth, Northumberland (GB).  <b>(74) Agent:</b> GEERING, Keith, Edwin; Reddie & Grose, 16 Theobalds Road, London WC1X 8PL (GB).	<b>(81) Designated States:</b> AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).  <b>Published</b> <i>With international search report.</i>
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<b>(54) Title:</b> CIGARETTE FILTER				
<b>(57) Abstract</b>  A thermoformed filter rod having a tubular body (4) of tobacco smoke filtering material which is open at at least one end and blocked by a filtering plug (6) of said tobacco smoke filtering material integral with the tubular body.				

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CIGARETTE FILTER

The present invention concerns a filter suitable, for example, for papirosi-type cigarettes.

5 Previous attempts to incorporate a filter in a stiff wrap or in a rolled tube have been commercially unsuccessful because the assembly could not be manufactured reliably in practice.

The present invention solves this problem by providing a tobacco smoke filter which comprises a thermoformed filter  
10 rod having a tubular body of tobacco smoke filtering material which is open at at least one end and blocked by a filtering plug of said tobacco smoke filtering material integral with the tubular body. The tubular body may be open at one end and closed at the other by the filtering  
15 plug. It may instead be open at both ends and blocked between these ends by the filtering plug; in this case there are two tubular terminal portions joined by the integral filtering plug. In all cases the tubular length of the rod will usually be at least the same as the length of the  
20 filtering plug and will preferably be longer - e.g. two to three or more times as long; thus the tubular length : filtering plug length ratio might be 6:1 or about 4:1 but is often suitably about 5:2, particularly in a rod of about 70 mm total length.

25 Externally, the integral thermoformed filter rod will usually be uniform in circumference and configuration from end to end; it will most usually have a uniform circular cylindrical outer surface from end to end. The bore of the tubular body may be circular in cross-section, but its  
30 cross-section might instead be non-circular, for example

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triangular or other polygonal, cruciform, or star-shaped (with for example 4, 5 or 6 points).

When used in a filter cigarette the filter rod of the invention may have a terminal integral filtering plug at the buccal end and the open end of the tubular body towards the tobacco. Preferably, however, a filter rod according to the invention with a terminal or in-board integral filtering plug is joined to a wrapped tobacco rod to form a papirosi filter cigarette with an open tubular buccal end. With a short wrapped tobacco rod (e.g. 25-50 mm) and a long filter rod according to the invention (e.g. 50 to 80 mm) having only a short filtering plug (e.g. 10 to 20 mm, or about 15 mm), such cigarettes would suit smokers wanting only a short smoke (e.g. just 2 to 5, preferably 3 or 4, puffs) and would be low tar (because of the consumption of a low quantity of tobacco rod) whilst giving a satisfying smoke (because filtration is limited predominantly to the filtering plug section).

The filter rod is preferably thermoformed from fibres or filamentary tow of plasticised cellulose acetate, but other thermoformable fibres or filaments (e.g. of polyolefin) or other thermoformable filter material, e.g. thermoformable open-cell foam, could be employed instead. Because the filter rod is thermoformed, the tubular body retains or develops firmness to resist collapse during subsequent handling (e.g. wrapping and/or assembly with a cigarette rod) or on smoking.

The robust thermoformed filter rod according to the invention can be manufactured reliably at commercial speeds by a single-pass in-line procedure. Thus in one such process thermoformable filter material (e.g. plasticised tow

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or tow mix) is fed longitudinally into and through a rod-forming garniture to which heat is supplied and into which a central mandrel reciprocates longitudinally so that there issues continuously from the garniture outlet an integral thermoformed rod of tobacco smoke filtering material in which tubular body sections of the filtering material alternate longitudinally with filtering plug sections of the filtering material. A conventional rod wrapper may be fed simultaneously into and through the garniture to provide a wrapped rod product, though the rod may be stable without such a wrapper. The continuously emerging rod, wrapped or unwrapped, can be cut laterally mid-way through the tubular and filtering plug portions to form individual papirosi type filter rods according to the invention with the integral filtering plug at one end. It may be preferred instead to cut the emerging rod only through the tubular portions to give rods with the integral filtering plug spaced from both open ends; an advantage with this embodiment is that it facilitates production of rods of constant reproducible pressure drop and retention because the initially formed integral filtering plug remains complete and uncut; in embodiments where there is cutting through the filtering plug then off-centre cutting (which is difficult to avoid in practice) results in successive rods with filtering plugs of different lengths and hence different pressure drop and retention values.

When individual rods are cut directly from the initial continuously produced rod in this way, they would normally be wrapped as part of the rod-forming process and the individual wrapped rods would normally be attached to cigarettes by ring tipping. An additional advantage of the individual rods having an in-board filtering plug between and integral with tubular portions open at both ends is

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that, since they have both ends the same, they do not have to be oriented before attachment to a tobacco rod; in contrast, rods with a terminal filtering plug have to be oriented to ensure that all filtering plugs are at the same end relative to the tobacco rod to which they are attached.

It is possible instead for the initial continuously produced rod to be cut first into integral double or other multiple length rods which are subsequently cut further into individual rods. For example, where tipping overwrap is to be used, a double length integral rod can be abutted between and in longitudinal alignment with two wrapped tobacco rods and joined to them by a tipping overwrap extending over the double length rod and the adjacent ends of the tobacco rods, and the assembly is then cut centrally of the double length rod to give two filter cigarettes. If the double length rod has a filtering plug at each end integral with a double length tubular body therebetween, the resulting filter cigarettes will be papirosi filter cigarettes with the tubular body open at the buccal end; the double length rod could instead be cut to have a double length filtering plug between and integral with two tubular bodies open at opposite ends, in which case the resulting filter cigarettes would have the filtering plug at the buccal end and the tubular body open to the tobacco rod. To avoid cutting through integral filtering plugs, so as give the advantages mentioned above, it may be preferred to make all cuts - from those through the initial continuously produced rod to those through the double length rod in filter cigarette production - only through tubular portions, resulting in filter cigarettes with tubular filter portions open at the buccal and upstream ends with the integral filtering plug therebetween.

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Where a tipping overwrap is employed, the initial double or multiple length rods may be produced with or without their own wrapper. The integral double or multiple length rods, from which the individual rods can be cut, are included within the invention; such multiple length rods  
5 comprise a plurality of the individual rods according to the invention joined integrally end-to-end in mirror image fashion, and can for example have a filtering plug exposed at each end or a tubular body open at each end.

10 The lengths of the tubular and filtering plug portions can be chosen to give a papirosi-type product having a desired filtering effect. The degree of filtering will also depend on the identity and degree of compaction of the smoke filtering material, and to a small extent on the surface  
15 area of the bore of the tubular body.

The length of a filter rod according to the invention would typically be about 70 mm, but it can vary widely - e.g. from 20 to 90 mm. The length of the filtering plug portion would normally be from 8 or 10 to 50 mm, but as  
20 indicated above is preferably less than that of the tubular portion(s). The filtering plug will usually not be less than 8 or 10 mm long (since otherwise its filtration effect may be too low), and it will not usually be longer than 20 or 25 or 30 mm (since otherwise its filtration effect or  
25 resistance to draw may be too great); particularly for a papirosi filter cigarette, the tubular length is usually of less technical consequence and may be set by the overall length required of the final product, and so as indicated above may be 2 or 3 (e.g. about 2.5) times as long as the  
30 filtering plug.

The wall of the tubular portion(s) of rods according to

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the invention is preferably relatively thin, e.g. from about one quarter to one eighth or less of the rod diameter, so that the tube bore is about one half to three quarters or more of the rod outer diameter. The tube wall of the integral rod should be sufficiently strong to resist collapse during manufacture, handling, storage and use. The wall thickness of the tubular portions may for example be from 1 to 2 mm, preferably about 1.5 mm. The outer diameter of the rod is preferably between 7 and 9 mm, similar to that of conventional papirosi cigarettes.

One manufactured filter rod according to the invention had a total length of 74 mm with a terminal plug 18 mm long integral with a tubular body 56 mm long, the wall of the tubular body being about 1.5 mm thick. This filter rod had a pressure drop (measured on the enclosed rod as usual) of 64 mm water gauge. This rod, of 24.5 mm circumference, was attached to a wrapped tobacco rod 50 mm long with the filter plug against the tobacco to give an unventilated filter cigarette having a tar retention of 40% and a nicotine retention of 38%.

The thermoformed filter rod according to the invention may be manufactured unwrapped or with its own wrapper, longitudinally coterminous with the rod. When the filter rod has its own wrap, ring tipping may be employed to join it to a wrapped tobacco rod to form a filter cigarette; in this case the filter wrapper, exposed in the final cigarette assembly, is preferably water-resistant or water-repellant to avoid adherence to the lips during smoking. Whether the filter rod is unwrapped or provided with its own wrapper, it can instead be incorporated in the filter cigarette product by a full tipping overwrap which covers the whole length of the filter rod and the adjacent end of the wrapped tobacco



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rod; in this case the tipping overwrap is preferably water-repellant or water-resistant. The wrapped tobacco rod of the filter cigarette would usually be 30 or 40 mm long, but could for example be up to 90 mm long. The tobacco would be wrapped in a conventional combustible cigarette paper.

Tar delivery by the filter cigarette product can be reduced by ventilating the thermoformed filter rod through the wrapper(s) around the rod. For example where ring tipping is used, the rod wrapper may be pre-perforated to provide, during smoking, air dilution into the filter rod; similarly, where a tipping overwrap is employed this may be pre-perforated in the region to cover the rod (with the rod wrap, if any, between the overwrap and the rod being air permeable). On-line laser techniques could instead be used during assembly of the filter cigarette product to provide ventilation holes through the wrapper(s) around the thermoformed filter rod.

The tar delivery of the filter cigarette product depends on the tar yield of the tobacco element, the filtration efficiency of the filter rod and the degree (if any) of ventilation. The tar delivery might for example be from 1 to 65 mg under standard ISO conditions, but can be controlled to under 15 mg. A papirosi filter cigarette according to the invention suffers minimal staining of the buccal end of the filter, whatever the tar delivery.

The filter rod and filter cigarette according to the invention are illustrated in the accompanying drawings, which are not to scale and in which :

**FIGURE 1** is a schematic side sectional view of a thermoformed filter rod according to the invention;

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**FIGURES 2 and 3** are similar views of the Figure 1 filter rod incorporated in papirosi filter cigarettes by ring tipping and a tipping overwrap respectively;

5 **FIGURE 4** is a similar view of the Figure 1 filter rod incorporated in a filter cigarette with its filtering plug at the buccal end; and

**FIGURE 5** is a schematic side sectional view of a different thermoformed filter rod according to the invention.

10 The thermoformed filter rod [2] shown in Figure 1 has a tubular body [4] of filtering material integral with a filtering plug [6] of said filtering material. The integral thermoformed rod [2] is of plasticised cellulose acetate filamentary tow. The overall length l of the rod is typically about 70 mm, with the length t of the tubular body  
15 [4] being for example about 50 mm. The wall [8] of the tubular body [4] is about 1.5 mm thick and the outer surface [10] of the rod is of constant circular section throughout its length, with a diameter of about 8 mm. The bore [12] of the tubular body is also of circular section.

20 Figure 2 shows the Figure 1 rod, having a rod wrap [20] longitudinally coterminous therewith, joined to a wrapped tobacco rod [14] by means of ring tipping [16]. Figure 3 shows the Figure 1 rod, without wrapper [20], joined to wrapped tobacco rod [14] by a tipping overwrap [18]. In  
25 Figures 2 and 3, the tobacco rod [14] is about 40 mm. long.

In Figure 4 the thermoformed filter rod [2] is in the opposite orientation to that in Figure 3, being joined by tipping overwrap [18] to wrapped tobacco rod [14] with the open end of its tubular body against the tobacco and its

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filtering plug at the buccal end. The dimensions are as indicated for Figures 1 to 3.

In Figures 2 to 4 the wrappers [20 and 18] are air impermeable, but in each case they could instead be ventilating wraps.

The thermoformed filter rod [3] shown in Fig.5 is essentially the same as rod [2] of Fig.1 except that the filtering plug [6] is centrally placed between and integral with two tubular body portions [5] which are open to the two ends of the rod. The rod is of plasticised cellulose acetate filamentary tow and has an overall length of 70 mm; the integral filtering plug [6] is about 20 mm long so that the total tubular length is about 50 mm with each tubular portion [5] being about 25 mm long. The tubular wall [8] is about 1.5 mm thick with an outer diameter of about 8 mm, the outer surface [10] of the rod being of constant circular section and the bore [12] also being of circular section.

The rod [3] of Fig.5 could be provided with a rod wrap (impermeable or ventilating) longitudinally coterminous therewith, and be joined to a wrapped tobacco rod by means of ring tipping, in the manner illustrated in Fig.2. Instead, the rod [3], without such coterminous rod wrap, could be joined to a tobacco rod by a tipping overwrap (impermeable or ventilating) extending the length of the rod and over the downstream end of the wrapped tobacco rod, in the manner illustrated in Fig.3.

#### EXAMPLES

Physical details of various individual thermoformed filter rods and filter cigarettes according to the invention are set out in the Table below.

- 10 -

Examples A to C are integral filter rods of the type shown in Fig.1; each has a length of 70 mm made up of substantially 50 mm of tubular body and substantially 20 mm of filtering plug.

5

Examples A, B and C were made using a 50/50 mix of 5Y40 and 7Y34 cellulose acetate tows; a "dYn" tow is one of  $n \times 10^3$  total tow denier made up of Y-shaped cross-section filaments each of individual filament denier d. The plasticised tow and air-impermeable wrapper therefor are fed longitudinally into and through a heated rod-forming garniture with reciprocating mandrel as described above to give a wrapped integral rod of thermoformed tow in which 100 mm long tubular sections of the tow alternate with 40 mm long filtering plugs of the tow; the cross-sectional shape of the bore of the tubular body is dictated by the cross-sectional shape of the mandrel. The continuously produced wrapped rod is cut laterally mid-way through the tubular body and filtering plug portions to form the individual papirosi type filter rods according to the invention. The hardness measurements were made on the filtering plug portion of the filter rod; the wall of the tubular body portion has a slightly higher hardness than the filtering plug.

Examples L and T involve rods made as for Examples A to C, but wholly from 7Y/34 cellulose acetate tow; each wrapped rod was attached to a standard wrapped tobacco rod by ring tipping with filtering plug against the tobacco and tubular body open at the buccal end, to give a papirosi filter cigarette. The tar and nicotine retention were measured under standard conditions; in each case tar delivery was reduced to about 13 mg. The values quoted, other than for retention, are those of the unattached filter rods.

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For Examples X and Y, rods of the type shown in Fig.5 were made wholly of 8Y/39 cellulose acetate tow. The procedure was substantially as described for Examples A, B and C except that the initial continuously produced rod had 50 mm tubular sections alternating with 20 mm filtering plugs integral therewith, and that cuts were made only across the middle of the tubular portions. This has the advantages that successive individual rods have filtering plugs of uniform length (and hence are of substantially uniform pressure drop and retention), and that the resulting rods are symmetrical and so do not require any special handling techniques and equipment to orient them for filter cigarette manufacture. Wrapped rods X and Y were incorporated in filter cigarettes (and rod and filter cigarette properties were measured and reported) as described for Examples L and T. Tar delivery was reduced to about 13 mg.

EXAMPLE	LENGTH (mm)	CIRCUMFERENCE (mm)	PRESSURE DROP (mm water)	HARDNESS	WEIGHT (g)	TUBE SHAPE
A	70	24.10	174.9	95.9	0.913	Round
B	70	24.09	145.3	96.2	0.954	Star
C	70	24.21	181.9	95.7	0.937	Star

EXAMPLE	LENGTH (mm)	CIRCUMFERENCE (mm)	PRESSURE DROP (mm water)	WEIGHT (g)	PLASTICISER LEVEL (%)	TAR RETENTION (%)	NICOTINE RETENTION (%)
T	70	24.16	86.4	0.824	16.5	42.2	39.1
L	70	24.20	87.4	0.845	16.5	42.5	42.0
X	74	24.4	114	0.75	16	44	41
Y	74	24.5	80	0.72	16	41	38

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Examples D and E illustrate filter cigarettes according to the invention with a short tobacco column and a long filter, suitable for a brief "smoking break". Apart from its cooling effect, a long filter is desirable since the end of the cigarette is a comfortable distance from the nose and face of the smoker when lighting up. In these Examples, the tobacco columns, in conventional cigarette paper, are 30 mm long, and the filter rods according to the invention are 51 mm long and joined to the tobacco rods by conventional tipping overwrap which is impermeable in the case of Example D and perforated to give ventilation in the case of Example E. The filter rods are integral thermoformed bodies of plasticised cellulose acetate tow of 5 filament denier having a tubular body extending from an open buccal end to a filtering plug 17 mm long abutting against the tobacco rod and closing the tubular body at that upstream end. The outer diameter of the tobacco and filter rods is 24.5 mm, and the tubular wall thickness of the filter rod is 1.5 mm.

Other data on Examples D and E is given in the following Table.

	EXAMPLE D	EXAMPLE E
Draw Resistance (mm water)	192	133
Filter Ventilation (%)	0	69
Tar Yield (mg/cig)	6.4	1.7
Nicotine Yield (mg/cig)	0.3	0.12
CO Yield (mg/cig)	6.7	1.2
Puff Number	2.8	3.0

The preferred embodiments of the present invention involve the thermoforming of filter material (preferably bonded fibrous and/or filamentary material) to provide an

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integral body having a relatively long and thin-walled  
tubular body closed (terminally or at an intermediate  
region) by a relatively short filtering plug. This  
combination of features provides a readily and economically  
5 manufacturable filter which is robust enough to survive  
manufacture, handling, storage and use undamaged, and which  
gives a cool but satisfying smoke of controlled filtering  
efficiency and which is especially suitable for use in  
conjunction with a relatively short tobacco rod (giving, for  
10 example, just two or three or four puffs).



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C L A I M S :

1. A thermoformed filter rod having a tubular body of tobacco smoke filtering material which is open at at least one end and blocked by a filtering plug of said tobacco smoke filtering material integral with the tubular body.  
5
2. A filter rod according claim 1 wherein said tubular body is open at one end and closed by the filtering plug at the other.
3. A filter rod according to claim 1 wherein the tubular  
10 body is open at both ends and blocked between its open ends by said filtering plug.
4. A filter rod according to any preceding claim wherein the filtering plug is shorter than the remainder of the rod.
5. A filter rod according to any preceding claim  
15 thermoformed from fibres or filamentary tow of plasticised cellulose acetate.
6. A filter rod according to any preceding claim surrounded by an optionally ventilating rod wrap longitudinally coterminous with the rod.
7. A filter rod according to claim 6 wherein the rod wrap  
20 is a ventilating wrap.
8. A filter cigarette comprising a wrapped tobacco rod joined to a filter according to any preceding claim.
9. A filter cigarette according to claim 8 wherein the

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filter rod is according to claim 6 or 7 and the filter rod and cigarette rod are joined by ring tipping.

10. A filter cigarette according to claim 8 wherein the filter rod and cigarette rod are joined by a tipping  
5 overwrap.

11. A filter cigarette according to claim 10 wherein the filter rod is ventilated.

12. An integral multiple length rod from which a rod according to any of claims 1 to 7 can be cut.

10 13. A multiple length rod according to claim 12 having a filtering plug at each end.

14. A multiple length rod according to claim 12 having tubular bodies open at both ends of the rod.

1 / 2

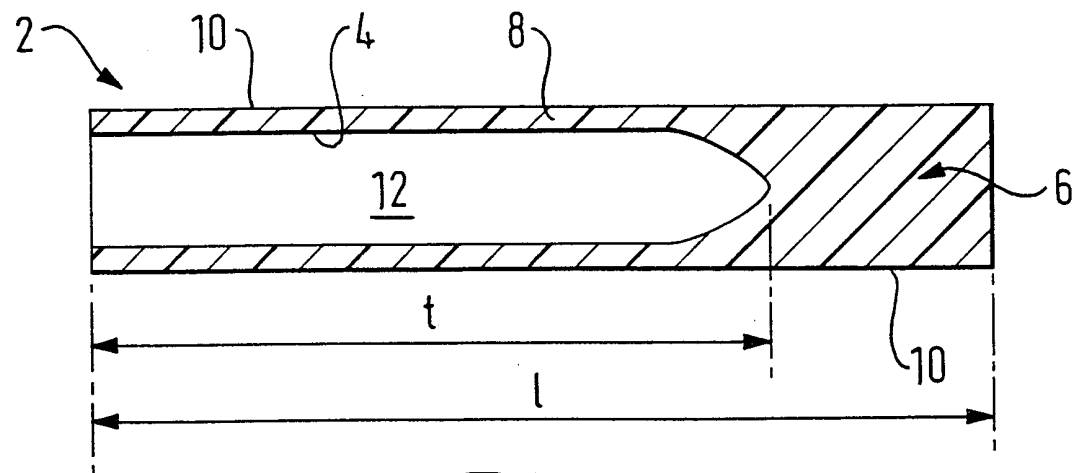


FIG. 1

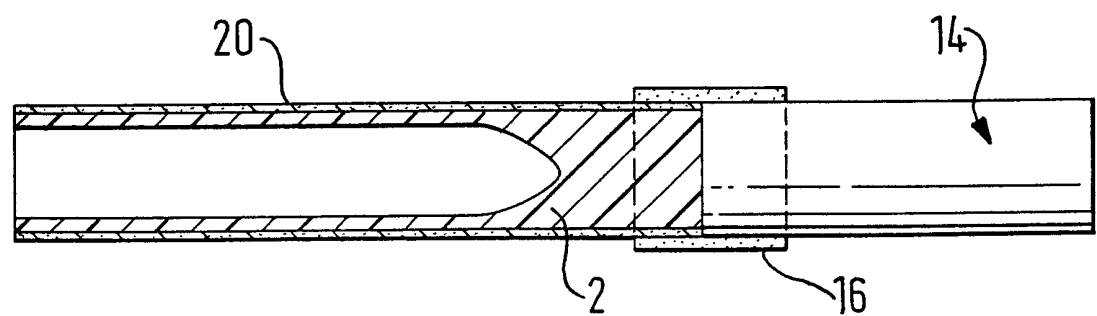


FIG. 2

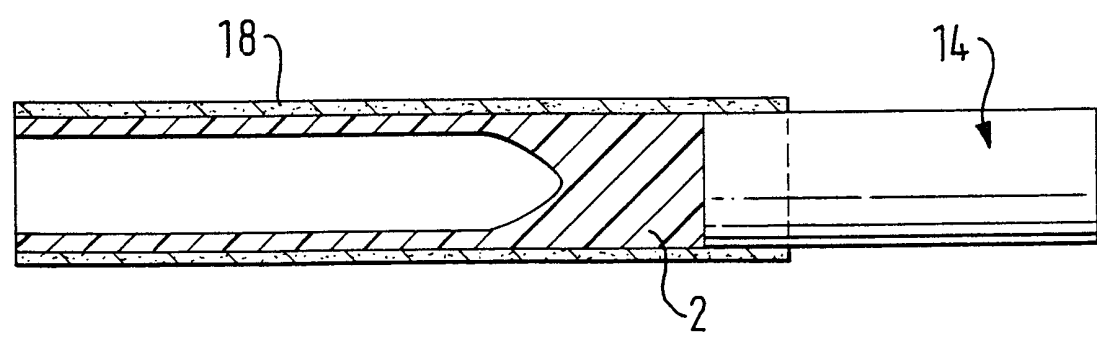


FIG. 3

2/2

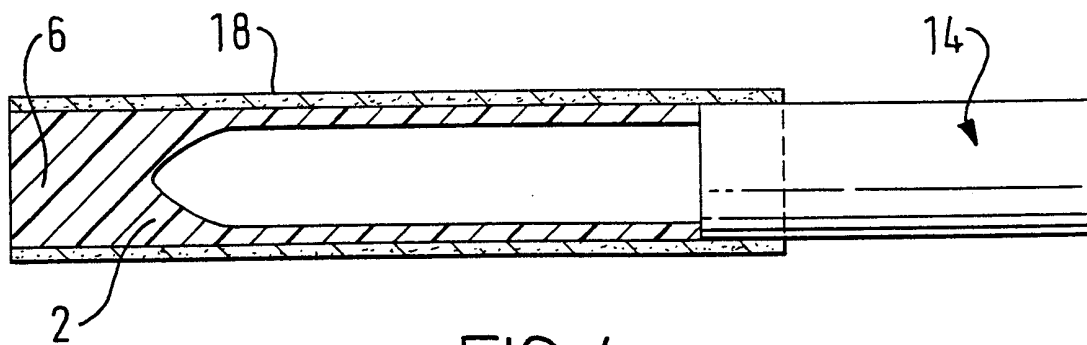


FIG. 4

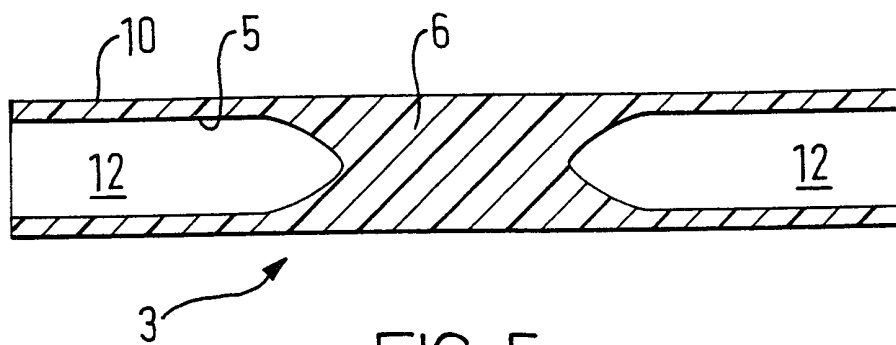


FIG. 5

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 00/00850

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 A24D3/04

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)

IPC 7 A24D

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)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 388 934 A (LUKE JOHN A) 21 June 1983 (1983-06-21) column 1, line 53 - column 2, line 45; figure 1	1-14
Y	US 4 583 560 A (SAKAI TAKASHI ET AL) 22 April 1986 (1986-04-22) column 4, paragraph 2; figures 8,9	1,2,4, 6-11
Y	US 4 007 745 A (RANDALL JOHN COURTRIGHT ET AL) 15 February 1977 (1977-02-15) column 2, line 55 - line 61; claim 1	1,2,4, 6-11



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

## \* Special categories of cited documents :

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"P" document published prior to the international filing date but later than the priority date claimed

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"&amp;" document member of the same patent family

Date of the actual completion of the international search

7 June 2000

Date of mailing of the international search report

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

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