Abstract: A smoking article and method for assembly thereof are disclosed. The smoking article comprises a rod of smokeable material, and an elongate filter coupled adjacent to the rod of smokeable material, wherein the diameter of the whole, or a portion of the filter adjacent to the rod of smokeable material is greater than the diameter of the rod of smokeable material.
Wide Filter Smoking Article

The present invention relates to a smoking article, and more particularly to a smoking article with a filter which is wider than a rod of smokeable material, in order to improve the filtration efficiency.

As used herein, the term "smoking article" includes smokeable products such as cigarettes, cigars and cigarillos whether based on tobacco, tobacco derivatives, expanded tobacco, reconstituted tobacco or tobacco substitutes and also heat-not-burn products. The smoking article may be provided with a filter for the gaseous flow drawn by the user.

Filtration in smoking articles is widely known in the art to remove certain smoke constituents substances from the smoke stream. Filtration efficiency is related to the filter material and the flow path of the smoke stream; techniques for increasing filtration efficiency therefore relate to maximising the adsorption of certain smoke constituents onto the fibres of the filter. It is also known in the art to embed additives into the filter, such as carbon, which may react with smoke constituents, and remove them from the smoke stream.

Existing techniques of improving filtration generally relate to optimising the composition of the filter material through which the smoke passes, or increasing the length of the filter.

According to an aspect of the present invention, there is provided a smoking article comprising a rod of smokeable material, and an elongate filter coupled adjacent to the rod of smokeable material, wherein the diameter of the whole, or a portion of the filter adjacent to the rod of smokeable material is greater than the diameter of the rod of smokeable material.

The filtration efficiency of a smoking article according to this construction is greater than that of a conventional smoking article in which the filter and the smoking article are of the same diameter since the smoke velocity through the filter is reduced, ensuring that the smoke stream maintains contact with the filter for a relatively longer period of time, increasing the adsorption of smoke constituents from the smoke stream onto the fibres of the filter. In addition, the amount of filter additives which are used
can be increased as compared with a smoking article of the same length but with a filter of smaller diameter.

The difference in diameters may correspond to a difference in circumference of between 1 mm and 8 mm.

The diameter of the filter may vary along the length of the filter, enabling a variety of techniques of joining the filter to the rod of smokeable material and a variety of different filtering effects.

The filter may have a tapered profile, such as a bell shape or a cone shape, guiding the smoke away from the central axis of the smoking article.

The filter may be coupled with the rod of smokeable material via a moulded extrusion, which surrounds the outer surface of the join between the filter and the rod of smokeable material, enabling a rectangular profile filter, having constant cross-section, to be coupled to the rod.

The rod of smokeable material may have a plurality of wraps of tipping paper around the filter end of the rod so as to increase its effective diameter to match that of the filter.

The filter may be joined to the rod of smokeable material via a cavity in the filter enabling filtration of mainstream smoke from the filter end of the rod of smokeable material.

The filter may be joined to the rod of smokeable material via an annular extension to the filter, enabling filtration of mainstream smoke from the filter end of the rod of smokeable material.

The filter may contain an annular band of carbon additive having a high surface area so as to maximise filtration effects while minimising the amount of carbon additive used in the filter.

According to another aspect of the present invention, there is provided a method of forming a smoking article, comprising providing a rod of smokeable material and an elongate filter, and coupling the filter adjacent to the rod of smokeable material,
wherein the diameter of the whole, or a portion of the filter adjacent to the rod of smokeable material, is formed to be greater than the diameter of the rod of smokeable material.

5 The diameter of a portion of the filter may be reduced to match that of the rod of smokeable material through compressing fibres of the filter, and coupling the filter and the rod of smokeable material using tipping paper.

A tapered profile may be applied to a plurality of portions of an extrusion rod and the extrusion rod may be cut so as to be divided into a plurality of filters each having a tapered profile. In this manner, the filter cutting process can be performed using existing machines for manufacturing smoking articles.

A plurality of sheets of tipping paper may be formed on the rod of smokeable material so as to match the effective diameter of the rod to the diameter of the filter.

The filter may be coupled to the rod of smokeable material via a cavity in the filter, increasing filtration of mainstream smoke where the rod is coupled to the filter, or using a moulded coupling extrusion, enabling a rectangular profile filter to be coupled to the rod.

An annular extension may be formed on the filter and the filter may be coupled to the rod of smokeable material by coupling the rod to the annular extension. This increases filtration of mainstream smoke where the rod is coupled to the filter.

Embodiments of the present invention will now be described more fully, by way of example only, with reference to the accompanying drawings, in which:
Figure 1 illustrates a cross-section of a wide filter cigarette with a tapered filter according to an embodiment of the present invention;

Figure 2 illustrates a cross-section of a wide filter cigarette with a conical filter according to an embodiment of the present invention;

Figure 3 illustrates the filter rod profile according to the embodiment as per Figure 1;
Figure 4 illustrates the filter rod profile according to the embodiment as per Figure 2;
Figure 5 illustrates a cross-section of a wide filter cigarette, wherein the filter is attached to the tobacco rod via a coupler;
Figure 6 illustrates a cross-section of a wide filter cigarette, wherein the filter is attached to the tobacco rod via multiple wraps of tipping paper;

Figure 7 illustrates a cross-section of a wide filter cigarette, wherein the filter is attached to the tobacco rod via a cavity in the filter rod;

Figure 8 illustrates a cross-section of a wide filter cigarette, wherein the filter is attached to the tobacco rod via an annular filter rod extension;

Figure 9 illustrates a cross-section of a wide filter cigarette, wherein the filter comprises a section of filter containing carbon additive and mouth end plug without carbon additive;

Figure 10 illustrates a cross-section of a wide filter cigarette, wherein the filter contains a central band of carbon additive;

Figure 11 illustrates a cross-section of the filter of the cigarette of Figure 10;

Figure 12 shows a graph illustrating the filtering effect of an embodiment of the invention relative to conventional smoking articles, normalised to tar; and

Figure 13 shows a graph illustrating the filtering effect of an embodiment of the invention relative to conventional smoking articles, normalised to nicotine.

In general, cigarettes may be produced in any size. For large scale production runs, the cigarettes will usually be manufactured in a size that conforms to one of a number of formats. Each format is defined by a set of dimensions of the cigarette. The relevant dimensions will normally include at least the overall length of the cigarette and the circumference of the cigarette, and may include more dimensions, such as the length of the filter, the length of the tipping paper and the circumference of the filter.

Throughout the following description, smoking articles and filters of various sizes as used in embodiments of the invention will be referred to using the terms shown in Table 1 below, which illustrates the typical corresponding dimensions of the cigarettes and filters.

<table>
<thead>
<tr>
<th>Cigarette format</th>
<th>Cigarette circumference</th>
<th>Typical cigarette circumference</th>
<th>Filter circumference</th>
<th>Typical filter length</th>
</tr>
</thead>
<tbody>
<tr>
<td>King</td>
<td>23-25mm</td>
<td>24.6mm</td>
<td>24.3mm</td>
<td>15-27mm</td>
</tr>
<tr>
<td>Slim</td>
<td>22-24mm</td>
<td>23.4mm</td>
<td>23.18mm</td>
<td>22-27mm</td>
</tr>
<tr>
<td>Demi-slim</td>
<td>19-22mm</td>
<td>21.0mm</td>
<td>20.80mm</td>
<td>22-27mm</td>
</tr>
<tr>
<td>Super-slim</td>
<td>16-19mm</td>
<td>16.96mm</td>
<td>16.80mm</td>
<td>22-30mm</td>
</tr>
</tbody>
</table>

Table 1: Typical cigarette formats
In addition to a dependence on the cigarette and filter circumference, typical filter lengths also depend on the length of the cigarette, and cigarette formats are named accordingly. For example, "regular" cigarettes (between 68 and 75 mm in length, e.g. about 68, 70 or 72 mm), and "short" cigarettes (less than 68 mm) are associated with shorter filter lengths, whereas "king-size" (between 75 and 92 mm, e.g. about 79, 83, 88 or 90 mm), "long" or "super-king" (between 92 and 105 mm, e.g. about 94, 99 or 101 mm) and "ultra-long" (between 105 and 125 mm, e.g. about 110, 120 or 121 mm) cigarettes are associated with longer filter lengths. Table 2 below illustrates the relationship between typical combinations of cigarette, filter and tipping paper length.

<table>
<thead>
<tr>
<th>Cigarette Circumference (mm)</th>
<th>24.6</th>
<th>23.4</th>
<th>21</th>
<th>16.96</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filter Circumference (mm)</td>
<td>24.3</td>
<td>23.18</td>
<td>20.8</td>
<td>16.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cigarette Length (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
</tr>
<tr>
<td>Filter length</td>
</tr>
<tr>
<td>Tipping length</td>
</tr>
</tbody>
</table>

| 99                     |
| Filter length         | 27   | -    | -   | 30   |
| Tipping length        | 32   | -    | -   | 35   |

| 94                     |
| Filter length         | 27   | 27   | 27  | 27   |
| Tipping length        | 32   | 24   | 32  | 32   |

| 90                     |
| Filter length         | -    | -    | 27  | -    |
| Tipping length        | -    | -    | 32  | -    |

| 83                     |
| Filter length         | 27   | 27   | 27  | 27   |
| Tipping length        | 32   | 32   | 32  | 37   |

| 79                     |
| Filter length         | 22   | -    | -   | -    |
| Tipping length        | 26   | -    | -   | -    |

| 72                     |
| Filter length         | 17   | 22   | 22  | 22   |
| Tipping length        | 21   | 26   | 26  | 26   |

| 70                     |
| Filter length         | 15   | 22   | 22  | 22   |
| Tipping length        | 19   | 26   | 26  | 26   |

Table 2: Typical cigarette lengths
Figure 1 shows a cross-section of a filter cigarette comprising a king-sized filter (24.6 mm circumference) (la) joined with tipping paper (2a) to a demi slim-sized tobacco rod (21 mm circumference) (3). The filter (la) is elongate in form and manufactured in a bell shape such that the tobacco end is compressed more compactly than the mouth end, in order that the diameter may be converged from king-sized down to demi slim-sized. The compression can be facilitated by heating the sample in a manner known in the art for forming filters for smoking articles. The filter (la) is then be arranged adjacent to, and flush with the tobacco rod (3) and wrapped with the tipping paper (2a) to seal the join. The mouth end of the filter (la) may also be wrapped with a layer of tipping paper (2b).

During puffing, the smoke will have a relatively high velocity through the tobacco rod and the narrow section filter, slowing down as it moves into the wider cross sectional area of the filter. A reduction in smoke velocity compared with a regular cigarette provides an increase in filtration efficiency as the smoke stream maintains contact with the filter for a relatively longer period of time, increasing the rates of adsorption of smoke constituents from the smoke stream onto the fibres of the filter. The retention efficiency of this cigarette is therefore greater than that of a conventional cigarette of the same length, having a filter with a circumference similar to the tobacco rod.

The fibres (4) of the filter tow are arranged to have a particular curvature which is similar to the curvature of the filter shape where it meets the tobacco rod, and this allows the flow of the smoke stream to flow from the centre towards the outer edges of the filter (la), increasing the overall rate of filtration and the uniformity of filtration over the axial cross section compared with a filter in which the fibres have no such curvature.

Referring now to Figure 2, a cross-section of a cigarette of similar construction is shown, whereby the filter rod (lb) is formed into a conical shape to achieve similar benefits as the tapered design in Figure 1, but with a shallow gradient in smoke velocity over the longitudinal cross section of the filter (lb). The diameter at the mouth end may be king-sized and the diameter at the tobacco end may be demi slim-sized.

Figure 3 shows a longitudinal cross sectional profile of a complete filter rod as manufactured to produce the tapered filter design as per Figure 1. The narrow width
sections (5a) are formed by compressing the filter fibres down from king-size format such as to graduate the profile from king-size diameter to demi-size diameter.

The profile shown in Figure 3 is designed such that the ratio of king-size to demi-size diameter of the filter is maximised, thus maximising the overall filter volume, whilst maintaining the demi-size diameter for use at the tobacco rod joint. The filter rod may then be wrapped in tipping paper, or another suitable wrapper, and cut at the regions indicated by dashed markers (6a) into separate filters, in a manner well known in the art for forming filters for smoking articles.

Referring now to Figure 4, which shows the longitudinal cross section of a complete filter rod associated with the conical filter design in Figure 2. The conical shaped sections (5b) are formed by gradually increasing the compression of filter fibres along the length of the filter rod from king-sized diameter down to demi slim-sized diameter to form a cone shape.

This design has further benefits over the filter rod shown in Figure 3, in that the simplified profile shape may be easier to form during manufacture. The pressure gradient in the smoke stream may offer a uniform reduction in pressure per unit length of the filter as per the design in Figure 4 offering a consistent draw resistance to the smoker. The filter rod may likewise be wrapped in tipping paper, or another suitable wrapper, and cut at the regions indicated by dashed markers (6b) into separate filters, in a manner well known in the art for forming filters for smoking articles.

Figure 5 shows a cross-section of a cigarette comprising a standard rectangular profile king-size filter (ic), having a constant cross-section, coupled with a demi-size tobacco rod via a bell shaped outer moulding (7). This may be formed of plastic or from another similar, extrudable material. This embodiment of the present invention offers the advantage of using a rectangular profile, in that the draw resistance of the smoke is maintained as the fibres do not require compacting at the tobacco rod end of the filter (ic). Additionally, both filter (ic) and tobacco rod manufacture are unaffected by the design, therefore standard components can be used, other than the mould itself.

The cigarette may be assembled by adhering the components to the internal surface of the mould (7) or the mould (7) may be shaped such that both the filter (ic) and the tobacco rod (3) may be held in place by friction. This may be achieved either by
manufacturing the mould to fit closely around the filter (lc) and tobacco rod (3), or by designing the inner surface of the mould to include frictional protrusions which may grip both the filter (lc) and the tobacco rod (3) and fix them into position.

An optional aspect of this feature may be to include holes through the outer moulding for filter ventilation, which is otherwise well known in the art.

Figure 6 shows another embodiment of the present invention using a standard king-size filter. The filter may be coupled with the tobacco rod firstly by attaching multiple wraps of tipping paper (2c) around the filter end of the tobacco rod, to increase the diameter of the tobacco rod to match that of the filter. The filter may then be wrapped in a layer of tipping paper (2d), which extends to cover the tipping paper layers on the tobacco rod, thus affixing the filter to the tobacco rod.

This embodiment of the present invention benefits from the use of unmodified filter rods and the associated consistency of draw resistance, and also requires no additional components (e.g. as in the outer mould of Figure 5).

Figure 7 shows a cross-section of a cigarette with a wide filter, which is assembled by slotting the tobacco rod into a cavity (8) within the filter. The filter may be held in position with an adhesive. The filter may then be wrapped with a layer of standard king-sized tipping paper in a manner well known in the art, which offers the benefit of maintaining a consistent manufacturing process of tipping regular king-size cigarettes.

An optional feature of this embodiment is to insert ventilation holes across the cavity, through the tobacco rod, allowing filtration of side stream smoke to take effect in the section of filter surrounding the end of the tobacco rod.

Figure 8 shows a cross-section of a cigarette with a wide filter, which is coupled with the tobacco rod via an extended, annular filter section (id). This may be adhered in position at both the tip of the filter and around the outer surface of the tobacco rod. Tipping paper (2d) may then be wrapped around both the main filter and extended section in a manner known in the art. The filter may optionally be vented through the annular filter (id) in addition to the main filter, as described above.
Figure 9 shows a cross-section of a wide filter cigarette, manufactured according to any previous embodiment, wherein the filter contains a carbon additive (9a). Embedding carbon within the filter fibres has been found particularly effective in adsorption of substances from the smoke stream, particularly volatile components. A mouth end plug (10) may be included at the mouth end of the filter to prevent carbon additive from entering the mouth of the smoker.

The use of a wide filter structure containing carbon offers advantages in that firstly the smoke stream will be in contact with a greater overall volume of carbon for a given length and diameter of tobacco rod. In other words, it is physically possible to include a greater amount of carbon in a wider filter, per unit of length of the filter, and the benefit of having a filter which is wider than the tobacco rod is that it is not necessary to increase the amount of tobacco to the same extent as the carbon in the filter. Secondly, the smoke velocity will be reduced as the smoke stream expands in the wide filter, allowing the smoke stream prolonged contact with the carbon additive. The aforementioned effects will contribute to enhancing the overall filtration efficiency of the filter.

Figure 10 shows a longitudinal cross-section of an alternative embodiment the present invention, in which the carbon is present within the filter (le) in an annular band (9b) around the axis of the filter (le). The filter may be manufactured and assembled with the tobacco rod according to any previous embodiment.

The design illustrated in Figure 10 in which an annular region of filter fibres containing carbon additive (9b) is situated at the tobacco end of the filter (le), offers advantages in that the smoke stream may pass through a region of carbon additive which has a high surface area relative to the smoke stream (offering the benefits described above relating to the adsorption of smoke constituents). In addition, the region in which carbon is added may also be minimised, thereby reducing the unit cost of the filter.

In this embodiment, the band of carbon additive (9b) is situated relatively centrally within the filter (le) in the radial sense, so as to allow the smoke stream to become dispersed over the filter, before coming into contact with the carbon additive, while also ensuring that the radius of the annular band (9b) is not too large. In other embodiments, the annular band (9b) may be positioned closer to the periphery of the
filter, even at the filter’s edge, or closer to the core of the filter as desired. A mouth end plug (10) may be included at the mouth end of the filter as in Figure 9.

Figure 11 shows a cross-section of the filter (le) of the smoking article shown in Figure 10, the cross-section taken in the plane perpendicular to the long axis of the smoking article. The annular band (9b) is shown relatively centrally in the filter (le) in the radial direction. The tipping paper (2d) is also shown.

Although the general principle of improved filtration through use of a widened filter has been described throughout the application, finer control of the filtration characteristics can be achieved through selection of filter materials and dimensions.

Cellulose acetate fibres are used in embodiments of the invention where it is specifically desired to filter certain constituents from the smoke stream to which cellulose acetate has an affinity. Examples of such a material are phenols and phenol derivatives, such as 4-methylphenol (p-cresol), 3-methylphenol (m-cresol), and 2-methylphenol (o-cresol).

However, additional additives and adsorbents (such as carbon) may be added to optimise filtration of certain constituents, through either providing a mechanical influence on the smoke stream flow, or through interacting chemically with the smoke stream constituents.

The ratio between the filter diameter and the tobacco rod diameter is another factor which enables optimisation of filtration effects. For example, for a smoking article having a demi slim-sized tobacco rod, a reduced proportion of the smoke stream is in proximity to the outer wrapper of the smoking article than would be the case with a super-slim tobacco rod (circumference approximately 17mm), due to the reduced surface-area to volume ratio of the interior of the cigarette through which the smoke stream passes. This means that the proportion of the smoke stream which reaches the filter, is greater for a larger diameter tobacco rod, given the same wrapper materials. For such larger smoking articles, the relative effect of the filter would be greater, and so different design considerations may apply to the filter, dependent upon the size of the tobacco rod to which the filter is to be attached.

For example, a priority for a large-diameter smoking article may be a general filtration of a number of different constituents, due to the fact that a higher overall level of tar
and nicotine is expected from the larger tobacco rod. Where the smoking article has a smaller diameter, the priority may be a more selective filtration of certain smoke stream constituents, such as phenols, where the absolute amount of tar-based products is expected to be decreased, due to the smaller tobacco rod. As set out above, selectivity can be dependent on the composition of the filter, for example the cellulose acetate content and structure, whereas more general filtration can be a function of smoke velocity and filter diameter, or additional ventilation effects in the filter leading to smoke dilution.

Another factor influencing filter design is the expected smoke stream velocity. For high velocities, deviation of the smoke stream from a central core, per unit length of the travel of the smoke stream, is likely to be less than for a reduced smoke stream velocity, in which lateral deviation may be enhanced more effectively through ventilation channels in the filter, or curvature of the filter tow. Filtration effects may therefore be optimised by selection of a particular filter diameter for a particular filter rod so as to ensure a balance between reduction in smoke stream velocity is sufficient to achieve the improved filtration effects of the invention while ensuring that not too much of the smoke stream is lost as side stream smoke from the tobacco rod due a low diameter tobacco rod. In other words, the selection of diameters of the tobacco rod and the filter affect whether filtration is primarily a function of the composition and structure of the tobacco rod and the composition and structure of the filter.

An example of a high-performance smoking article manufactured according to embodiments of the invention has been found to be a demi slim-sized tobacco rod (21mm) circumference in conjunction with a king-sized filter (24.6mm). The invention has also been found to be effective with different combinations of structures, however. While the embodiments have been described above in the context of a demi slim-sized rod of smokeable material and a king-sized filter, the invention can also be applied to slim and super-slim structures. For example, a king-sized or demi slim-sized filter can be coupled to either of a slim or super-slim rod of smokeable material, such that the filter has a wider diameter, in whole or in part, than the rod of smokeable material.

An example of the effect of a king-sized (KS) filter on the smoke stream derived from a super-slim tobacco (SS) rod is illustrated by the Hoffmann analyte data shown in Table 3 below. The data shows the amount of a Hoffmann analytes found to be present in smoke extracted from a test smoking article under Health Canada Intensive conditions
<table>
<thead>
<tr>
<th>Constituent</th>
<th>Total amount (µg)</th>
<th>Normalised data</th>
<th>Total amount (µg)</th>
<th>Normalised data</th>
<th>Total amount (µg)</th>
<th>Normalised data</th>
<th>Total amount (µg)</th>
<th>Normalised data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Tar</td>
<td>Nicotine</td>
<td>Tar</td>
<td>Nicotine</td>
<td>Tar</td>
<td>Nicotine</td>
<td>Tar</td>
</tr>
<tr>
<td>Phenol</td>
<td>4.82</td>
<td>0.42</td>
<td>3.57</td>
<td>49.06</td>
<td>0.88</td>
<td>7.30</td>
<td>16.30</td>
<td>1.17</td>
</tr>
<tr>
<td>m-cresols</td>
<td>1.03</td>
<td>0.09</td>
<td>0.76</td>
<td>3.60</td>
<td>0.17</td>
<td>1.38</td>
<td>2.83</td>
<td>0.20</td>
</tr>
<tr>
<td>o-cresol</td>
<td>1.11</td>
<td>0.10</td>
<td>0.82</td>
<td>4.23</td>
<td>0.19</td>
<td>1.62</td>
<td>3.51</td>
<td>0.25</td>
</tr>
<tr>
<td>p-cresols</td>
<td>2.72</td>
<td>0.23</td>
<td>2.01</td>
<td>9.68</td>
<td>0.45</td>
<td>3.71</td>
<td>8.08</td>
<td>0.58</td>
</tr>
<tr>
<td>NFDPM</td>
<td>11.58</td>
<td></td>
<td></td>
<td>21.70</td>
<td></td>
<td></td>
<td>13.91</td>
<td></td>
</tr>
<tr>
<td>Nicotine</td>
<td>1.35</td>
<td></td>
<td></td>
<td>2.61</td>
<td></td>
<td></td>
<td>2.07</td>
<td></td>
</tr>
<tr>
<td>CO</td>
<td>10.32</td>
<td></td>
<td></td>
<td>17.11</td>
<td></td>
<td></td>
<td>10.60</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>6.35</td>
<td></td>
<td></td>
<td>11.65</td>
<td></td>
<td></td>
<td>9.90</td>
<td></td>
</tr>
<tr>
<td>TPM</td>
<td>19.28</td>
<td></td>
<td></td>
<td>35.96</td>
<td></td>
<td></td>
<td>25.88</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Hoffmann Analyte data at HCl conditions
(HCI), namely a 55ml cigarette puff, lasting for 2 seconds, taken every 30 seconds, with filter ventilation blocked. The levels are compared with the Hoffmann analytes extracted from a number of conventional smoking articles, having the same material composition as the test (for control purposes) but different physical diameters, namely (Ci) a smoking article having a king-sized tobacco rod and a king-sized filter, (C2) a smoking article having a super-slim rod and a super-slim filter, and (C3) a smoking article having a king-sized rod and a super-slim filter. The results are normalised to the levels of nicotine and tar produced from each smoking article, these differing due to the size of the tobacco rod as explained above. The total levels, from each smoking article, of nictotine, nicotine-free dry particulate matter (NFDPM), carbon monoxide (CO), water, and the total particulate matter (TPM) is also shown.

The relative reduction in the Hoffmann analytes seen derived from the test smoking article of the invention, relative to conventional arrangements (Ci) to (C3) is shown in Figures 12 and 13, as calculated from the data in Table 3, for the tar-normalised data and nicotine-normalised data respectively, and indicates that for this test example, the invention enables substantial reductions in smoke stream constituents. It is notable that when the data is normalised to either nicotine or tar levels, smoking article (C3) which operates on the basis of the reverse convention of the invention, (i.e. a smaller filter than its tobacco rod), exhibits worse performance, namely a reduced filtration effect, than the conventional arrangements (Ci) and (C2), which would be expected given the improved filtration effects of a wider filter set out in this disclosure. The reduced performance of a smaller filter can also in general be seen due to the enhanced relative improvement of the invention over smoking articles (C2) and (C3) over (Ci).

Whilst certain embodiments of the present invention have been described above, the skilled person will understand that many variations and modifications are possible without departing from the scope of the invention as defined by the accompanying claims.
Claims

1. A smoking article comprising:
   a rod of smokeable material; and
   an elongate filter coupled adjacent to the rod of smokeable material;
   wherein the diameter of the whole, or a portion of the filter adjacent to the rod of smokeable material is greater than the diameter of the rod of smokeable material.

2. A smoking article as claimed in claim 1, wherein the diameter of the filter varies along the length of the filter.

3. A smoking article according to any preceding claim, wherein the filter has a tapered profile.

4. A smoking article according to claim 3 wherein the filter has a bell shape or a cone shape.

5. A smoking article according to any one of claims 1 to 4, wherein the filter is coupled with the rod of smokeable material via a web wrapping material, which surrounds the outer surface of the join between the filter and the rod of smokeable material.

6. A smoking article according to any one of claims 1 to 4, wherein the filter is coupled with the rod of smokeable material via a moulded coupling extrusion, which surrounds the outer surface of the join between the filter and the rod of smokeable material.

7. A smoking article according to any one of claims 1 to 4, wherein the rod of smokeable material has a plurality of wraps of tipping paper around the filter end of the rod.

8. A smoking article according to any one of claims 1 to 4, wherein the filter is joined to the rod of smokeable material via a cavity in the filter.

9. A smoking article according to any one of claims 1 to 4, wherein the filter is joined to the rod of smokeable material via an annular extension to the filter.
10. A smoking article according to any previous claim, wherein the filter contains a carbon additive.

11. A smoking article according to claim 10, wherein the carbon additive is arranged as an annular band in the filter.

12. A smoking article according to any one of the preceding claims, wherein the filter material is selected so as to have an affinity to phenols and phenol-based derivatives.

13. A method of forming a smoking article, comprising:
   providing a rod of smokeable material and an elongate filter; and
   coupling the filter adjacent to the rod of smokeable material;
   wherein the diameter of the whole, or a portion of the filter adjacent to the rod of smokeable material, is formed to be greater than the diameter of the rod of smokeable material.

14. A method according to claim 13 comprising reducing the diameter of a portion of the filter to match that of the rod of smokeable material through compressing fibres of the filter, and coupling the filter and the rod of smokeable material using tipping paper.

15. A method according to claim 14 wherein a tapered profile is applied to a plurality of portions of an extrusion rod and the extrusion rod is cut so as to be divided into a plurality of filters each having a tapered profile.

16. A method according to claim 13 comprising forming a plurality of sheets of tipping paper on the rod of smokeable material so as to match the effective diameter of the rod to the diameter of the filter.

17. A method according to claim 13 comprising coupling the filter to the rod of smokeable material via a cavity in the filter or using a moulded coupling extrusion.
18. A method according to claim 13 comprising forming an annular extension on the filter and coupling the filter to the rod of smokeable material by coupling the rod to the annular extension.
Reduction in Hoffmann analytes of test smoking article compared with conventional smoking articles, normalised to tar.

Figure 12

[Diagram showing bar graphs for different analytes such as p-cresols, o-cresols, m-cresols, and Phenol, with percentage change on the x-axis and analyte levels on the y-axis.]
Reduction in Hoffmann analytes of test smoking article compared with conventional smoking articles, normalised to nicotine

Figure 13