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Hammersmith et al.

[11] **3,910,288**

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[54] **PROGRAMMED FILTER**

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[73] Assignee: **Brown and Williamson Tobacco Corporation,** Louisville, Ky.

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[21] Appl. No.: **486,021**

Related U.S. Application Data

[63] Continuation of Ser. No. 336,277, Feb. 27, 1973, abandoned.

[52] **U.S. Cl.** ..... **131/10.5;** 131/10.3; 131/261 B

[51] **Int. Cl.²** **A24D 01/04;** A24F 07/04

[58] **Field of Search** ..... 131/10.5, 10.3, 10 A, 10.7, 131/201, 261 B, 15 B, 10.9, 210, 10 R

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[57] **ABSTRACT**

A filter is provided for a smoking tobacco product, the filter having one or more channels which by-pass the main body of filtering material such that a portion of the smoke is caused to flow through the channel and a relatively short portion of the filter in the earlier puffs, while essentially all of the smoke flows through the main body of the filtering material in later puffs. Through the gradual change from a portion of the smoke flowing through the channel to all of the smoke flowing through the main filter body, the filter accomplishes a nearly uniform per puff delivery of total particulate matter, through a relatively steady increase in filter efficiency.

12 Claims, 11 Drawing Figures

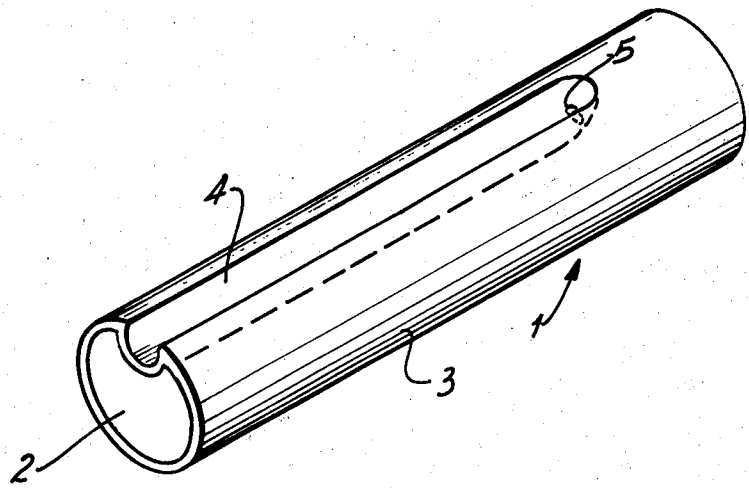


FIG.1

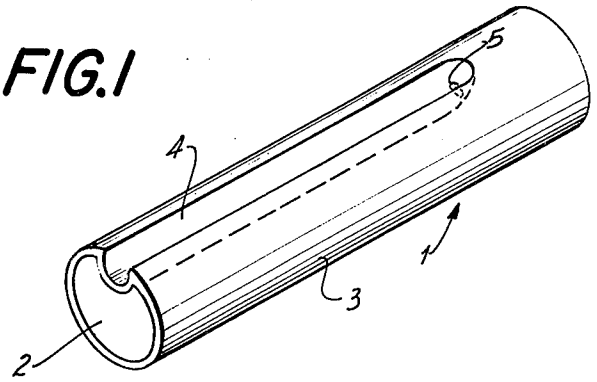


FIG.2

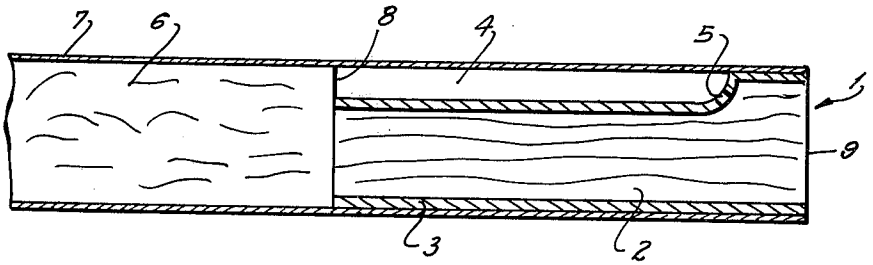


FIG.3

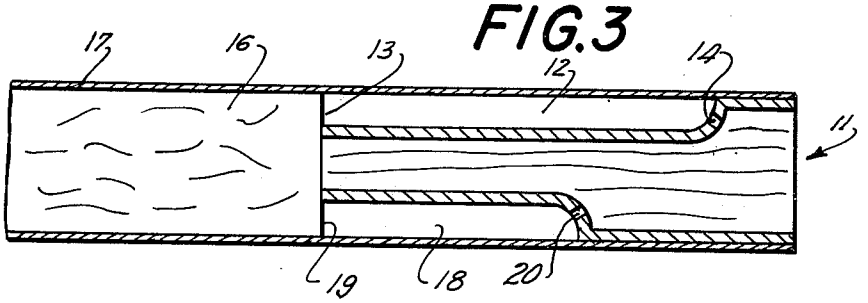


FIG.4

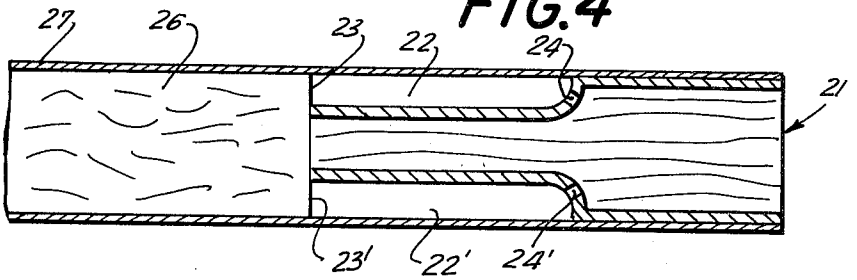


FIG.5

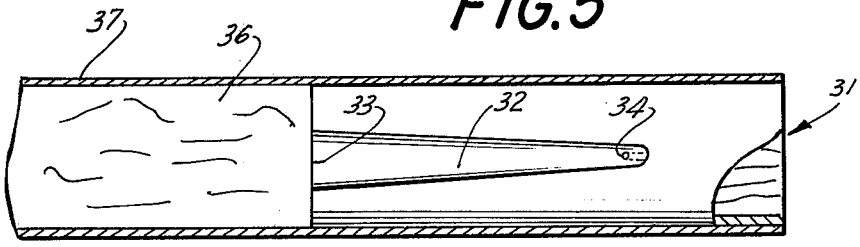
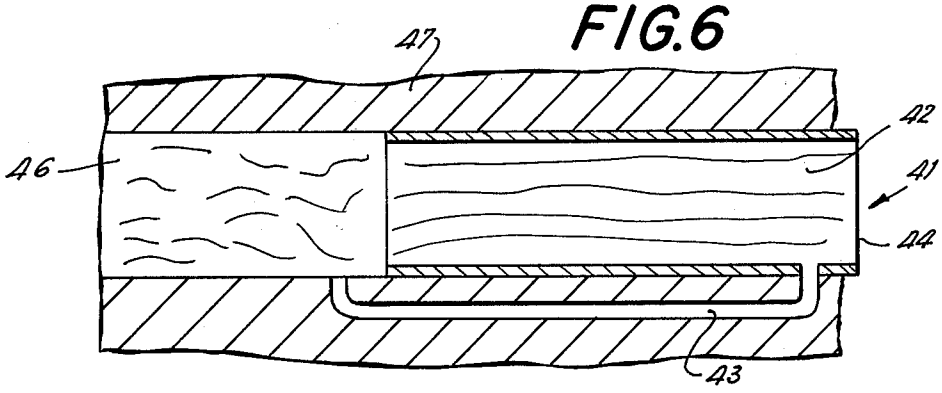


FIG.6



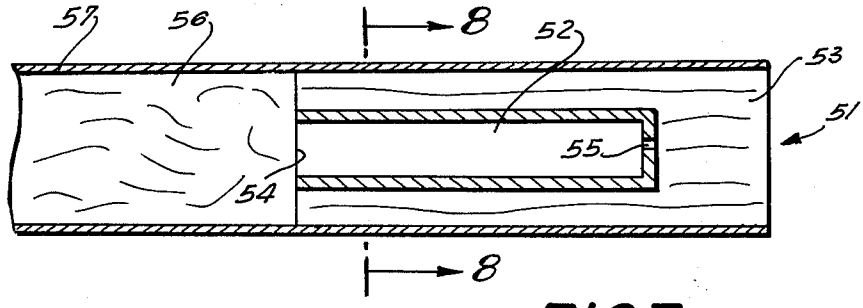
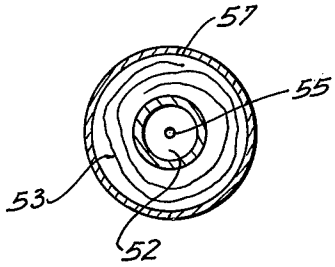


FIG.7

FIG.8



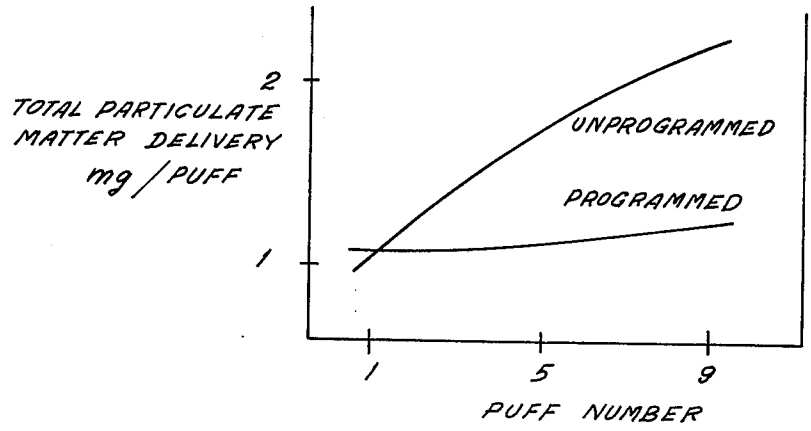


FIG.9

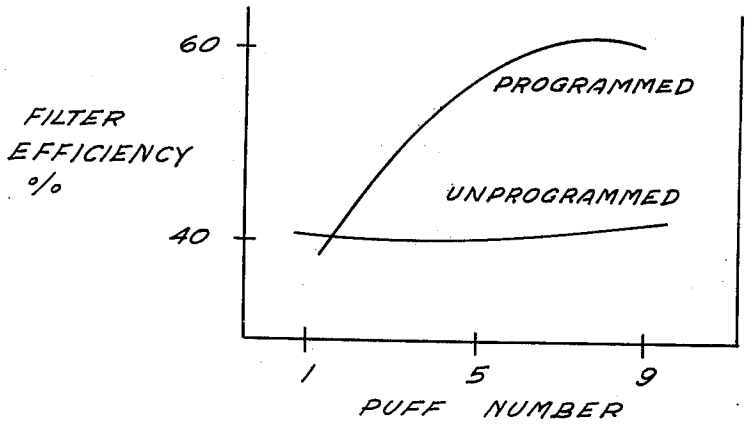
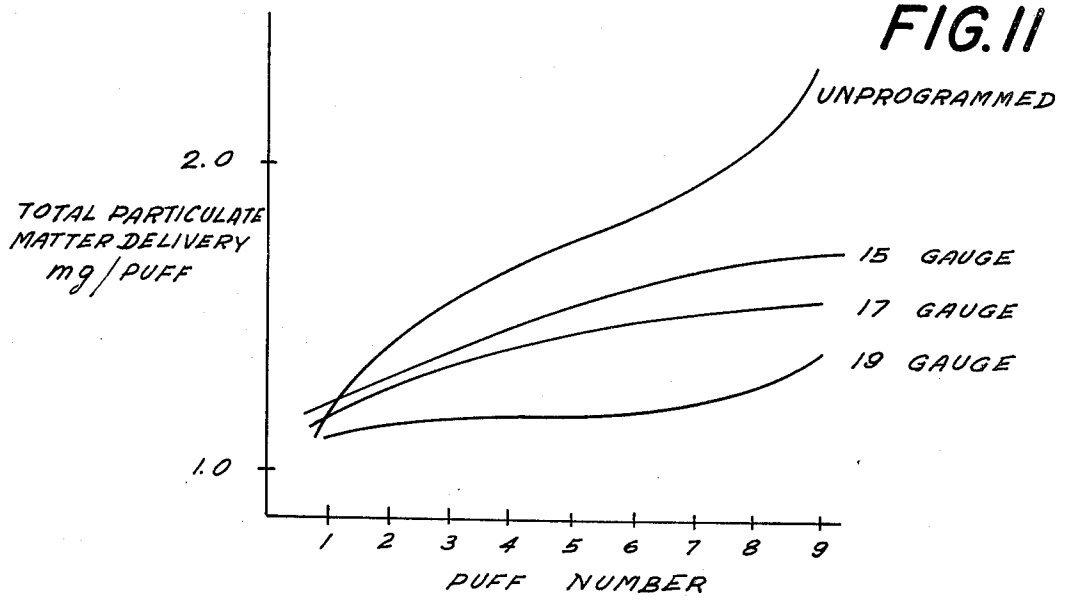


FIG. 10

FIG. 11



PROGRAMMED FILTER

RELATED APPLICATIONS

This is a continuation of U.S. Ser. No. 336,277 filed Feb. 27, 1973, now abandoned.

BACKGROUND OF THE INVENTION

In recent years there has been a tendency in the tobacco industry to use filtering materials for smoking tobacco products, particularly cigarettes, having greater and greater efficiencies. Efficiencies, in this sense, are defined as the amount of total particulate matter removed from the smoke created by the burning tobacco before it reaches the smoker.

While the increased efficiency is frequently desirable, the first few puffs of a smoking tobacco product employing such a high efficiency filter generally have no taste or impact for the smoker. For these first few puffs, not only does the high efficiency filter act to remove a significant portion of the total particulate matter, but the effect of the entire tobacco column is added to the effect of the filter. The combination is such as to remove almost all of the total particulate matter so that the smoker receives no satisfaction from these first few puffs.

While not directed to the same problem, the provision of channels in a filter for a smoking tobacco product is described in U.S. Pat. No. 3,270,750—Campbell. Various locations and configurations for the channel are provided, the channel running the entire length of the filter section. It will be noted that with each of these locations and configurations, however, the channel is closed before the cigarette is used through application of digital pressure. The filtering element is specifically formed in such a manner as to be crushable.

BRIEF DESCRIPTION OF THE INVENTION

In accordance with the present invention one or more channels are formed on or within a filtering element for a smoking tobacco product, such as a cigarette, where the filtering element is formed in such a manner or provided with protection so as to prevent crushing and leave the channel member generally open throughout smoking of the product. While the beginning of the channel is contiguous with the tobacco section of the smoking product, the channel terminates short of the mouthpiece end. At the termination of the channel, a small orifice leading to the filter material is provided.

The filtering element is so formed that it is generally resistant to crushing, so that the channel may remain open during the entire course of smoking the smoking product.

In the initial stages of smoking, because of the sizing of the channel and hole taken together with the efficiency of the filtering element, at least some of the smoke generated by burning the tobacco product passes through the channel and orifice and then through a shortened portion of the filtering element. The walls of the channel, except for the orifice, are essentially impervious to the smoke, so that there is no filtration through these walls. During the course of smoking, the area of the filtration element adjacent the orifice gradually becomes plugged due to the accumulation of solid material. As the plugging continues, there is increased resistance to smoke passing through this shortened portion of the filter so that, gradually,

all, or essentially all, of the smoke generated by the burning tobacco product will pass directly through the main filter section. In this manner, there is a general leveling of delivery of total particulate matter.

Additionally, though a high efficiency filter is employed, because of the shortened path of the first few puffs through the filtering element, the puffs provide a generally full taste. As is known, in general, the first few puffs of a cigarette have a generally low total particulate matter content, in any event. In large part, this is due to the filtration effect of the tobacco column so that maximum filtration by the filtering element is not required, in any event.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. **1** is a perspective view of a preferred programmed filter of the present invention having a single channel on the periphery;

FIG. **2** is a plan view of the filtering element of FIG. **1** incorporated into a smoking product;

FIG. **3** is a plan view of a filtering element according to the present invention having two channels, where the channels are of unequal length;

FIG. **4** is a plan view of a filtering element according to the present invention, incorporated in a smoking tobacco product, where the channels formed in the filtering element are of equal length;

FIG. **5** is a plan view of a filtering element according to the present invention where the channel formed in the periphery of the filtering element is tapered;

FIG. **6** is a plan view of a filtering element according to the present invention incorporated in a smoking product, where the channel is external to the filtering element;

FIG. **7** is a plan view of a filtering element according to the present invention incorporated in a smoking product where the channel is formed within the body of the filtering element, rather than along the periphery;

FIG. **8** is a sectional view along the line **8—8** of FIG. **7**;

FIG. **9** is a plot showing the milligrams of total particulate matter delivered on a per puff basis for programmed and unprogrammed filters;

FIG. **10** is a plot showing the efficiency, on a per puff basis, of programmed and unprogrammed cigarette filters; and

FIG. **11** is a plot of total particulate matter delivery, on a per puff basis, illustrating the effect of varying orifice size.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the accompanying drawings, a filtering element **1** of the present invention is illustrated in FIG. **1.** The filtering element includes a high efficiency filtering material **2** encased in a stiff plastic casing **3** within which is formed a channel or groove **4.** An orifice **5** is formed at the terminus of the channel or groove. In FIG. **2** the filtering element **1** illustrated in FIG. **1** is shown incorporated in a cigarette including a tobacco section **6** and a wrapper **7** which encases both the tobacco section **6** and the filtering element **1.** It will be noted in FIG. **2** that the open end **8** of channel **4** is adjacent the tobacco section while no groove appears at the mouthpiece end **9** of the smoking tobacco product.

In FIG. 3 a filtering element 11 is incorporated in a smoking tobacco product including a tobacco section 16, both the filtering element and the tobacco section being encased in a wrapper 17. The filtering element 11 illustrated in FIG. 3 has a longer channel 12 with its open end 13 adjacent the tobacco section 16 and an orifice 14 at the end of the channel. A shorter channel 18 is also formed in the filtering element with the open end 19 of this channel also adjacent the tobacco section and an orifice 20 formed at the closed end of the channel. Again, the channels terminate short of the mouthpiece end of the cigarette.

In FIG. 4 a filtering element 21 is illustrated, similar to filtering element 11. The filtering element is incorporated with a tobacco section 26 by wrapper 27. The two channels 22 and 22' of filtering element 21 each have the open portions 23 and 23' of the channels adjacent the tobacco section while the closed portions of the channels are formed with orifices 24, 24'.

In FIG. 5, filtering element 31 is again incorporated with a tobacco section 36, the two portions being enrobed in wrapper 37. Filtering element 31 includes a single channel 32, the channel differing from the channels described in the previous figures by tapering, the largest portion of the channel being the open end 33 adjacent tobacco section 36. The channel gradually tapers to orifice 34 formed at the closed end of the channel. Again, the channel terminates short of the mouthpiece end of the cigarette.

In FIG. 6, a filtering element 41 is shown including high efficiency filtration material 42. The filtration material is adjacent a tobacco section 46 and the filtration material 42 and tobacco section 46 are held together by member 47 which may be a portion of a cigarette holder. Formed within member 47 is a channel 43 which connects the portion of the tobacco section closest the filtering element 42 to the filtering element 42 near, but not at, the mouthpiece end 44 of the smoking product.

In FIG. 7 a filtering element 51 is illustrated in combination with a tobacco section 56, the two sections being enrobed in a common wrapper 57. A channel 52 is formed within the high efficiency filtration material 53, rather than on the periphery of this material. The open end of the channel 54 is again adjacent the tobacco section 56 and an orifice 55 is formed in the closed end of the channel.

It will be appreciated that the filtering elements shown in each of the figures are not necessarily drawn to scale, but rather illustrate various embodiments possible within the concept of the present invention. In general, the channels are shown as having a length approximately 80 percent of the overall length of the filtering element. Generally, the channel or channels should have lengths of about 50 to 85 percent of the length of the filtering element. In each case, the channels and orifice sizes are generally shown larger than they would actually be formed in order to render the illustration clearer. The parameters for the various lengths and sizes will be given in more detail below.

In designing a workable filter of the type described herein, several factors are of particular importance. The overall efficiency of this type of filter is determined, to a great degree, by the particular type of filter element selected for the main body of the filter. As such, the normally important parameters including the type of tow, the weight of the rod, the circumference, and the fiber distribution are important.

With the programmed filter of the present invention, the additional factors of importance are the size of the orifice at the end of the channel, the non-porous walls lining the channel, and the initial relationship between the resistance of the smoke flow path through the channel and orifice compared with the initial resistance through the main body of the filtering element. Also of importance are the shape and placement of the orifice, the compression of the tow, the dimensions of the groove, and the orientation of the fibers within the main filtering element, particularly that part of it adjacent the orifice.

The initial resistivity ratio of the programmed filter is defined as the pressure drop of the main filter section divided by the pressure drop of the shortened flow path which includes the groove, orifice, and short section of the filter element. These values are obtained, independently, with a 17.5 cc./sec. air flow. The percentages of the initial smoke puff which flow through the groove and orifice, as compared with the flow through the main filter section, at varying resistivity ratios are shown below in Table 1:

TABLE 1

INITIAL RESISTIVITY RATIO COMPARED WITH SMOKE FLOW

Ratio	Percent of Puff Volume Through Groove - Orifice	Main Filter Element
0.1	10	90
0.5	33	67
1.0	50	50
3.0	75	25
5.0	83	17

In general, regardless of the main filter element employed, the programmed filter with the greatest resistivity ratio will give the lowest initial efficiency and the greatest rate of efficiency increase in later puffs. The initial resistivity ratios desired for the programmed filters of the present invention are from 0.5 to 5.0, preferably 1.0 to 3.0. When the initial resistivity ratio is below 0.5, the programming effect is not realized. Above a resistivity ratio of 5.0, there are problems of the orifice being too large to be effectively blocked during the initial puffs, or of blocks which are broken in the later puffs. In the preferred range of 1 to 3, the initial resistance through the groove - orifice in short filter section is obviously equal to or less than the resistance through the main filtering element. Consequently, during the first puff from 50 to 75 percent of the smoke passes through the lower efficiency groove - orifice. As this path becomes gradually blocked, more and more of the smoke passes through the main filter section. In general, by the fourth or fifth puff the resistance through the groove - orifice is greater than the resistance through the main filter element so that the largest part of the smoke passes through the main filter element. Normally, by the last puff, the orifice is almost totally blocked and essentially all of the smoke passes through the main filter element.

The effect of this programming can be seen in FIGS. 9 and 10. In FIG. 9, the total particulate matter delivery per puff is shown both for a standard cellulose acetate filter and for a programmed filter of the present invention. It can be seen that the milligrams delivered per

puff is essentially the same for the first as for ninth puff with the programmed filter, while with the normal cellulose acetate filter, the delivery of total particulate matter per puff has more than doubled within these puff ranges. The reason for this leveling of tar delivery per puff is seen in FIG. **10** where the efficiency of the filter for each puff is illustrated. Here, the efficiency of the standard cellulose acetate filter is changed very little between the first and ninth puffs, while the efficiency of the programmed filter increases from approximately 40 percent to 60 percent during this same period of smoking.

The optimum size of the orifice formed at the end of the channel, when a single channel and orifice are used, is from about 12 to 30 Birmingham or Stubs gauge or about 0.07 to 6.0 square millimeters in cross-sectional area. Preferably, the orifice size for such a filtering element is from 12 to 21 Birmingham or Stubs gauge or about 0.5 to 3.5 square millimeters in cross-sectional area. The size of the channel leading to the hole should be from about 1 to 3 millimeters diameter, and, generally, slightly greater than the orifice. While the channel size is expressed as a diameter, it is the cross-sectional area of the channel, and not its configuration or diameter which are the critical factors.

The area of the channel should not be too great or there is a danger that the area of the main body of the filtration material will be too small, the channel representing a portion of the main filtration volume being removed. The length of the channel is not critical and it is selected such that the relative resistance between the main body of the filtration material and the channel, orifice and short section of the filtration material are within the ranges recited above.

Some impaction is necessary to provide a buildup of the particulate material in the portion of the filtration material adjacent the orifice at the end of the channel. The proper velocity for this is provided through sizing of the channel as indicated above.

When more than one channel and orifice are employed, as illustrated, for example, in FIGS. **3** and **4**, the total area of the plurality of orifices should be slightly larger than the area of a single orifice to accomplish the same result. Because the buildup of particulate material around the orifice in the filtration material generally occupies an essentially hemispherical configuation, more particulate matter is required to block one orifice than a plurality of orifices having the same area. Thus, the size of the plurality of orifices is increased, relative to the single orifice, so that essentially the same amount of particulate matter is required to block the plurality of orifices as would be required for a single orifice and the same type of programming is obtained. With a plurality of orifices as illustrated in FIG. **3**, for example, where the channels are of unequal length, one channel, e.g., channel **12**, may be the channel through which smoke flows during the first few puffs of the cigarette, after which the smoke flow may shift to a second channel, as channel **18**, and finally through the main body of the filtration material. Of course, though only two channels are illustrated in FIG. **3**, a different number might be employed.

The effect of varying orifice size, within the stated range, is illustrated in FIG. **11**. With the same filter element material employed in each case, the total particulate matter delivery in milligrams per puff is plotted against puff numbers from 1 thru 9. It can be seen that as the orifice size becomes smaller, there is a greater leveling of particulate matter delivery, per puff, as other factors are unchanged. Again, the leveling of particulate matter deliveries compared to a control is easily seen.

If desired, the single channel of most of the illustrated embodiments, or one or more of the channels illustrated in FIGS. **3** and **4**, may be filled or partially filled with a material to accomplish a particular result. For example, a flavorant might be placed in the channel to flavor the earlier puffs of the smoke. When such a material is included in the channel, it should be of such a type and such an amount that the programming effect of the filter is not lost.

The main filtration element, e.g., **2** in FIG. **1**, may be formed of various filter materials. For example, it may be formed of paper or cellulose acetate. It is, in general, selected for its filtration efficiency and with a filtering element of the present invention, the filtration efficiency for particulate matter should be at least about 50 percent.

As illustrated in FIG. **1**, the main body of filtration material is surrounded by a plastic sleeve where the channel is formed in this sleeve and the orifice at the end of the channel is formed through the sleeve. The function of the plastic sleeve is twofold:

1. It prevents crushing of the filter which would destroy the channel.

2. It renders the walls of the channel impervious, so that filtration does not take place through these walls. The plastic sleeve is not a critical feature of the present invention, so long as its two functions are provided. Thus, for example, after formation of the channel in the filtration material, the periphery of the filtration material may be coated so as to provide the necessary seal and increase the mechanical strength. Depending upon the particular filtration material employed, heat sealing may also be used.

The effects of the various parameters mentioned above on operation of the programmed filter are illustrated in Table 2. The various parameters are set forth and the effect of an increase in any of these parameters is given with regard to the initial filter pressure drop, initial filter efficiency, amount of initial flow through the channel and orifice, final filter pressure drop, and final filter efficiency. An increase in any of these measured effects is shown as a "+", a decrease as a "—", and no change with a "0".

In order that those skilled in the art may be better enabled to practice the present invention, the following examples are given. These examples should be considered as illustrative, and not as limiting in any way the full scope of the present invention as covered in the appended claims.

EXAMPLES 1 – 3

In these examples the filter element was formed of cellulose acetate filters having a denier of 1.6 per fiber and 24,000 denier per filter and having an injected secondary crimp. Three filters were formed with this material having, respectively, orifice sizes of 19, 17 and 15 Stubs gauge or diameters of 1.1, 1.5 and 1.8 mm., respectively. The total particulate matter deliveries in milligrams per cigarette, initial pressure drops in inches of water gauge, initial resistance ratios, and filter efficiencies are shown in Table 3. It can thus be seen that with each of these filters there was a significant in-

crease in the filter efficiency from the first puff through the final puff.

EXAMPLE 4

In this example the cellulose acetate filter element had 1.6 denier per fiber and 48,000 total denier. The orifice diameter was 1.8 millimeters, a Stubs gauge of 15. The total particulate matter delivery was 12.2 milligrams per cigarette and the initial pressure drop in inches of water gauge was 3.7. The initial resistance ratio was 0.9. The cigarette showed a filter efficiency, overall of 50 percent including an initial efficiency of 34 percent and a final efficiency of 65 percent.

EXAMPLE 5

In this example a cellulose acetate filter element having 2.5 denier per fiber and a total denier of 44,000 was employed. The orifice diameter was 1.8 mm., a Stubs gauge of 15. The total particulate matter delivery for the cigarettes was 17.6 milligrams. The initial pressure drop was 2.2 inches water gauge and the initial resistivity ratio was 1.4. The cigarette showed an overall efficiency of 31 percent including an initial efficiency of 16 percent and a final efficiency of 47 percent.

While the invention has described with particular reference to the drawings and particular examples, it should not be considered as so limiting, but only as limited by the appended claims.

TABLE 2

Parameter Increased	Initial Filter Pressure Drop	Initial Filter Efficiency	Initial Flow Thru Channel and Orifice	Final Filter Pressure Drop	Final Filter Efficiency
				0	0
Orifice Size	−	−	+	−	−
Channel Area	+	−	+	+	0
Efficiency of Filter Element	+	+	+	+	+
Distance of Orifice From Suction End of Filter	+	+	−	0 +	0 +

TABLE 3

Hole Diameter Stubs Gauge	Initial Pressure Drop Inches Water Gauge	Initial Resistance Ratio	Filter Efficiency Percent		
			Overall	Initial	Final
19	3.6	1.4	58	38	71
17	3.0	1.7	49	34	65
15	2.6	2.2	47	33	61

We claim:

1. A filtering element for a smoking product comprising

a. a main filtration element, containing filtration material and having a mouthpiece end, for disposition in substantial alignment with a tobacco section and

b. channel filter means of an initial flow resistance equal to or lower than said main filtration element for causing predetermined proportion of the smoke from the tobacco section to initially by-pass a part of the filtration material and move through said channel filter means and further causing a predetermined increasing proportion of the smoke to pass through said filtration material as the tobacco section is smoked, due to increasing flow resistance through said channel filter means, whereby the total particulate matter per puff delivered to the smoker remains essentially constant during smoking of the tobacco section, said channel means including at least one channel having essentially smoke impervious walls, an open upstream end communicating with the tobacco section, and a single orifice at the downstream end of said channel adjacent said filtration material at a position short of the mouthpiece end of said main filtration element, the area of the orifice is from about 0.07 to 6.0mm^2.

2. The filtering element of claim **1** wherein said channel means is a single channel formed in said main filtration element.

3. The filtering element of claim **2** wherein said channel is formed on the periphery of said main filtration element.

4. The filtering element of claim **2** wherein said channel is formed axially within said main filtration element.

5. The filtering element of claim **2** wherein the area of the orifice is from 0.5 to 3.5mm^2.

6. The filtering element of claim **2** wherein said channel is tapered.

7. The filtering element of claim **1** wherein said channel means is a plurality of channels, each having an open end communicating with said tobacco section and an orifice adjacent the filtration material.

8. The filtering element of claim **7** wherein two channels are formed.

9. The filtering element of claim **7** wherein each of said channels is of the same length.

10. The filtering element of claim **7** wherein the channels are of different lengths.

11. The filtering element of claim **10** wherein the length of one channel is greater than the length of the other channel.

12. The filtering element of claim **1** wherein the channel filter means lies outside the main filtration element.

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