United States Patent [19]

Norman

[11] **3,860,011**

[45] **Jan. 14, 1975**

[54] **HOLLOW FILTER**

[75] Inventor: **Vello Norman,** Durham, N.C.

[73] Assignee: **Liggett & Myers,** New York, N.Y.

[22] Filed: **Aug. 27, 1973**

[21] Appl. No.: **391,834**

[52] **U.S. Cl.**..... **131/10.5,** 131/10 A, 131/198 A

[51] **Int. Cl.**.....**A24d 1/04,** A24f 5/04

[58] **Field of Search**..... 131/10 A, 11, 10 R, 10.3, 131/10.5, 15 B, 261 B, 10.7, 261 R, 198 A, 198 R

[56] **References Cited**

UNITED STATES PATENTS

3,045,680	7/1962	Smith	131/10.5
3,242,925	3/1966	Sterne	131/10 R
3,270,750	9/1966	Campbell	131/10 R
3,324,861	6/1967	Gaisman	131/10 A UX
3,324,862	6/1967	De Simone	131/10 A UX
3,396,733	8/1968	Allseits	131/10.5
3,428,050	2/1969	Kandel	131/10.3
3,490,461	1/1970	Osmalov	131/10.5
3,546,325	12/1970	Muller	131/10 R X

FOREIGN PATENTS OR APPLICATIONS

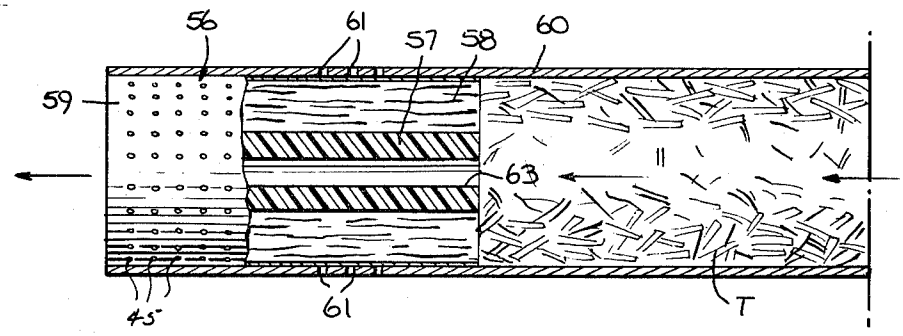
1,115,485	5/1968	Great Britain	131/10.5
635,110	1/1962	Canada	131/269

Primary Examiner—Robert W. Michell
Assistant Examiner—John F. Pitrelli
Attorney, Agent, or Firm—Kenyon & Kenyon

[57] **ABSTRACT**

The hollow filter includes a rigid non-deformable tube defining a smoke passage having a draw resistance to control the amount of unfiltered smoke, a concentric layer of filter material and a perforated outer wrap for passage of air into the layer of filter material.

9 Claims, 5 Drawing Figures



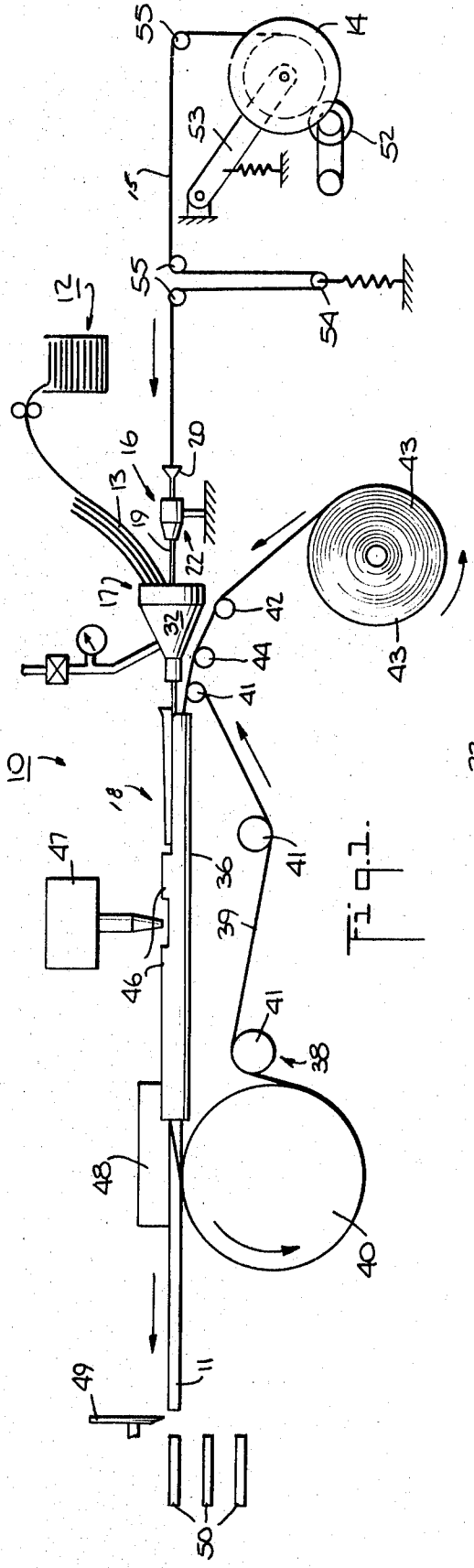


Fig. 1.

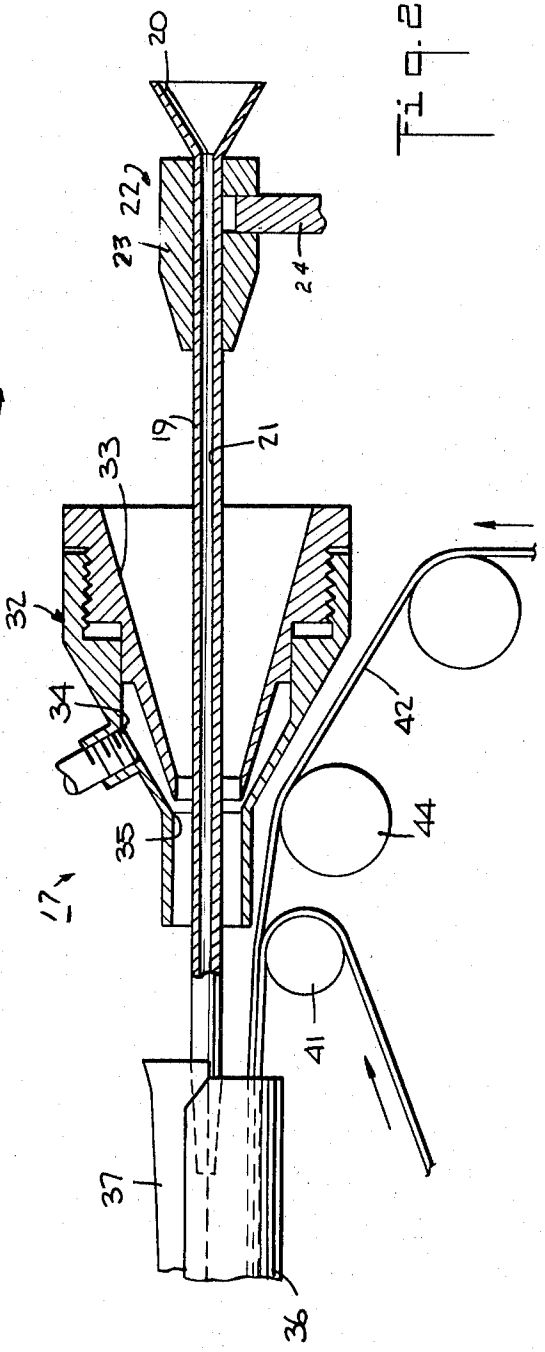


Fig. 2.

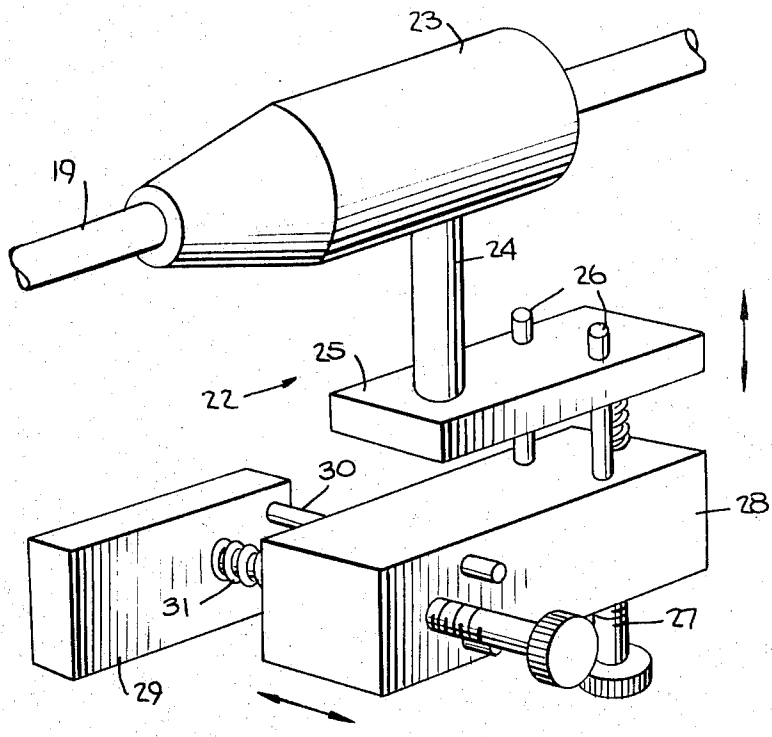


Fig. 3.

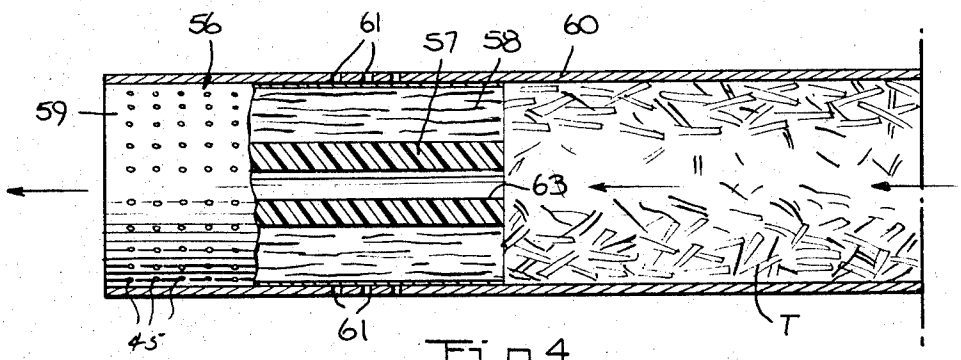


Fig. 4

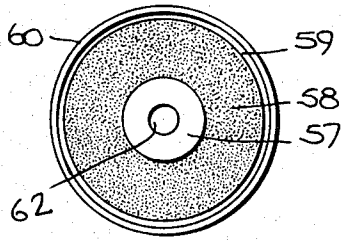


Fig. 5.

HOLLOW FILTER

This invention relates to a filter rod. More particularly, this invention relates to a hollow filter rod for use in making filters for cigarettes.

Heretofore, various types of filters have been devised for use in cigarettes in order to screen out various filterable materials in the smoke generated during smoking. For example, filters made up of fibrous materials, such as a cellulose acetate, have been known for filtering out particulate matter from the smoke generated during smoking. However, such a filtering medium between a smoker's mouth and the tobacco column of the cigarette generally required additional drawing or inhaling forces on the part of the smoker in order to draw the smoke through the filtering material. As a result, a practical limit has been imposed on the amount of particulate matter that can be filtered out by a particular filtering material due to the need to have a pressure drop across a filter that can be tolerated by a smoker without discomfort.

In more recent times, attempts have been made to dilute the smoke stream from a cigarette with ventilating air to reduce the quantity of particulate matter drawn into a smoker's mouth for each puff while allowing the taste to pass through. Some of these attempts have used bypass arrangements by which a greater or lesser proportion of the cigarette smoke can be bypassed around a filter medium and drawn into a smoker's mouth. In some cases, the filters have been provided with passageways through which a portion of unfiltered smoke can be passed directly to the smoker's mouth. Such passageways have usually been provided directly in the filter material and the filter material has been constructed so as to be collapsed manually about the passageway to constrict the size of the passageway and, thus, reduce the proportion of unfiltered smoke passing through to a smoker, for example, as described in U.S. Pat. Nos. 3,242,925 and 3,270,750.

One of the reasons for utilizing filters with bypass passages is that the flow of unfiltered smoke can be drawn through the filter at a greater speed than the filtered flow which passes through the filtered material so that the faster flow can impinge upon the tongue and taste buds of the smoker at a greater impact speed than the normal. This is believed to impart a greater taste to the smoke. At the same time, since only a smaller proportion of the smoke is directed into the smoker's mouth, a smaller proportion of particulate matter is drawn into the smoker's mouth.

However, it has been found that the exact size of the bypass passages are critical for controlling the amount of smoke delivery and cannot be effectively maintained by the use of collapsible or crushable means. Further, the relationship of the bypass passage to the air flow paths have not been accurately determined or maintained.

Accordingly, it is an object of the invention to provide a filter having a centered smoke bypass passage within a filter media to accurately direct a high velocity stream of smoke into a smoker's mouth.

It is another object of the invention to accurately regulate the amount of unfiltered smoke entering a smoker's mouth while simultaneously giving a pleasing taste.

Briefly, the invention provides a filter for a cigarette which allows a portion of unfiltered smoke to enter a smoker's mouth at high velocity while diluting the smoke with drawn-in air in the mouth.

The filter is used in combination with a cigarette tobacco section and is joined to the tobacco section by a cylinder or outer wrap of tipping paper. The filter is constructed of a rigid non-deformable tube, a layer of compacted filter material and a cylinder of perforated or inherently porous plugwrap paper. The tube defines a smoke passage of constant cross-sectional area throughout having a draw resistance for controlling the amount of unfiltered smoke entering a smoker's mouth for a given draw. The layer of filter material surrounds the tube and is formed e.g. of cellulose acetate. The plugwrap paper is porous, e.g. the paper is either inherently porous or has numerous perforations some of which are aligned with perforations in the tipping paper. In either case, the number and size of the perforations in the tipping paper define the air flow path through the tipping paper and the layer of filter material to a smoker's mouth. The flow path is of a draw resistance to complement the draw resistance of the smoke passage whereby for a given draw a desired amount of unfiltered smoke and ventilation air are drawn into the smoker's mouth. The draw resistance of smoke passage can be varied by varying the cross-sectional area of the tube, that is, the internal diameter of the tube can be changed.

The filter material which is used to make up the filter rod can be of any suitable material such as a cellulose acetate tow. The tubing is made of a self-supporting structure and is of a material, such as a plastic tube, of small diameter.

The means for enveloping the fibrous material about the mandrel and the forming means can be of known construction, as is conventionally used in forming filter rods of fibrous filter material of solid construction. For example, this means can be in the form of a nozzle having a Venturi-opening and an air supply as described in British Pat. No. 933,227.

These and other objects and advantages of the invention will become more apparent from the following detailed description and appended claims taken in conjunction with the accompanying drawings in which:

FIG. **1** illustrates a schematic view of an apparatus for making a hollow filter rod according to the invention;

FIG. **2** illustrates an enlarged partly cross-sectional view of the apparatus of FIG. **1**;

FIG. **3** illustrates a perspective view of the mandrel of FIG. **1**;

FIG. **4** illustrates a part cross-sectional view of a cigarette having a filter made in accordance with the invention; and

FIG. **5** illustrates an end view of the filter of FIG. **4**.

Referring to FIG. **1**, the apparatus **10** for making a hollow filter rod **11** includes a means **12** for supplying a stream of fibrous filter material **13** such as a cellulose acetate tow and a means such as a supply reel **14** for supplying a stream of tubing **15**, for example, of hollow plastic material. In addition, the apparatus **10** includes a guide means **16** positioning the stream of tubing **15** in a predetermined path, a means **17** for shaping the stream of fibrous filter material **13** about the tubing **15** and a rod former **18** of conventional construction for wrapping the streams of filter material and tubing into the filter rod **11**.

Referring to FIGS. 1 and 2, the guide means 16 for the tubing 15 is positioned downstream of the supply reel 14 and includes a hollow mandrel 19 of elongated length which passes through the shaping means 17 into the rod former 18. The mandrel 19 has a funnel shaped inlet 20 at the upstream end to guide the stream of tubing into an internal passageway 21. In addition, the mandrel 19 is mounted in cantilever manner on a support 22 for adjusting the mandrel 19 vertically and horizontally. As shown in FIG. 3, the mandrel support 22 includes a sleeve 23 mounted via a post 24 on a bracket 25 which in turn is mounted by means of two guide rods 26 and a spring-loaded adjustment screw 27 to a block 28. The bracket 25 can be adjusted vertically with respect to block 28 by means of the adjustment screw 27 which is captive but free to rotate in bracket 25 and threaded into block 28. The block 28 is similarly mounted to and horizontally adjustable with respect to a stationary bracket 29 via guide rod 30 (only one shown) and a spring-loaded adjustment screw 31. The passageway 21 of the mandrel 19 is of substantially uniform diameter throughout while the free end of the mandrel 19 is tapered for purposes as described below.

Referring to FIG. 2, the means 17 for shaping the stream of filter material 13 about the tubing 15 includes a nozzle 32 positioned about the mandrel 19 in coaxial fashion. This nozzle 32 is similar to that described in British Pat. No. 933,227 and U.S. Pat. No. 3,016,945. That is, the nozzle 32 includes an internal bore 23 of Venturi-shaped configuration, an annular air chamber 27 which receives air from a suitable air supply source (FIG. 1) and surrounds the Venturi-shaped bore 33, and a Venturi-opening 35 communicating the chamber 34 with the bore 33 to direct a flow of air in a direction towards the free end of the mandrel 19. The entrance end of the nozzle bore 33 is sized to receive the stream of filter material 13 with the material in a spread and decrimped manner from the filter material supply 12.

The rod former 18 is constructed with a forming block 36 and a tongue 37 mounted on the topside of the block 36. The block 36 and tongue 37 form a passageway (not shown) into which the mandrel 19 projects. This latter passageway is sized to receive the tubing 15 passing through the mandrel 19 and the fibrous filter material 13. The tongue 37 and the forming block 36 are also tapered internally to form an inwardly tapering surface for the passageway so that the passageway gradually diminishes in cross-section. In addition, the rod former 18 includes a conveyor 38 having a conveyor belt 39, such as a continuous fabric belt, which is driven by a belt drive wheel 40 over guide rolls 41 through the passageway formed by the block 36 and tongue 37. The belt 39 is used to move a stream of porous web 42 e.g. plugwrap paper from a suitable supply reel 43 into the passageway via guide rollers 44 as well as to convey the filter material and tubing streams 13, 15. The web 42 has a uniform pattern of perforations 45 (FIG. 4) throughout, or is inherently porous for purposes as explained below.

As shown in FIG. 1, the rod former 18 includes a pair of folding sections 46 as are known, a glue or adhesive applicator 47 and a sealer 48. The folding sections 46 serve to fold the edges of the delivered web 42 towards each other in enveloping relationship to the filter material and the tubing while the adhesive applicator 47 serves to apply a line of adhesive on the top surface of one edge so that the undersurface of the opposite edge can be sealed thereto by the subsequent folding section 46 and sealer 48 to form the filter rod 11. The web 42 may also be of the type which has a heat-activated resin pre-applied to the surface, in which case, the applicator 47 may be eliminated.

A suitable cutting mechanism utilizing a knife 49 is disposed downstream of the sealer 48, as is known, for cutting the filter rod 11 into predetermined lengths 50. Each length may thereafter be cut into a multiplicity of filters.

Referring to FIG. 1, in operation, a stream of filter material 13 is fed from the supply source 12, is spread out and decrimped in a conventional fashion as is known and delivered into the nozzle 32. In addition, a length of tubing 15 is taken from the supply reel 14 and passed into the mandrel 19. After the filter material stream 13 is passed into the nozzle 32, the air which is supplied to the nozzle 32 causes the material to bloom, for example, as described in U.S. Pat. No. 3,367,447. This allows the fibrous material to be pushed along the surface of the mandrel 19 into the rod former 18 rather than pulled. Thereafter, as the filter material 13 is passed into the rod former 18 between the folding block 36 and the tongue 37, the fibrous material is gradually reduced circumferentially due to a tapering of the tongue 37 relative to the forming block 36. The filter material 13 is then brought into direct contact with the tubing 15 which passes out of the mandrel 19 within the rod former 18 and is juxtaposed in enveloping circumferential relationship with the tubing 15. At the same time, the web of paper 42 is guided into the rod former 18 underneath the tubing 15 and filter material 13 and folded into a generally U-shape. Continued travel of the tubing and filter material causes the filter material to be constricted circumferentially about the tubing 15 to grasp or to frictionally engage the tubing 15 under a force sufficient to continuously pull the remaining tubing 15 supplied from the supply reel 14 through the mandrel 19.

The movement of the fibrous material 13 through the rod former 18 is facilitated by the conveyor belt 37 and the paper web 42 as is known. In addition, the paper web 42 is subsequently folded about the constructed filter material 13 and the engaged tubing 15 with the paper edges sealed together to form a filter rod 11 of continuous length. The filter rod 11 is then severed into predetermined lengths 50 by the knife 49. Referring to FIG. 1, the rotational speed of the tubing supply reel 14 and the take off speed of the tubing 15 is controlled by an elastic-faced roll 52 frictionally driven against the outer layer of tubing on the reel 14. The roll 52 is driven by either an auxiliary motor or a suitable connection with the belt drive wheel 40 such that the peripheral speed of roll 52 is matched to the linear speed of the conveyor belt 39. The rubing 15 is therefore fed from the reel 14 at a rate approximately equal to the rate of consumption. The reel 14 rotates on a shaft attached to a hinged arm 53, which is free to rotate and is suitably loaded by either a spring or weight so that a firm contact is always maintained between roll 42 and the outermost layer of tubing on the reel. A spring-loaded or weighted take-up roll 54, in cooperation with guide rollers 55, maintains a reservoir of tubing to accommodate small variations between the take off and consumption rates, such as will occur in the transition in the outermost layer of tubing on reel 14. The guide

rollers **55** further serve to guide the tubing **15** towards the mandrel **19.**

Referring to FIG. **4,** a filter **56** formed from the filter rod **11** includes a hollow cylindrical tube **57** surrounded by an annular layer of compacted filter material **58,** a wrapping of perforated plug wrap paper **59** and an outer wrap of tipping paper **60.** The filter **56** is mounted, as is known, by means of the outer wrap of tipping paper **60** on a tobacco column T to form a cigarette. The outer wrap of tipping paper **60** is provided with a number of circumferential rows of perforations **61** which are located at about the mid-section of the filter **56.**

As shown in FIG. **5,** the tube **57** is centered on the axis of the filter **56** and extends the length of the filter **56** to form a passageway **62** which serves as a bypass passage for unfiltered smoke.

As shown in FIG. **4,** as the smoker takes a puff of his normal puff volume, the smoke flow through the cigarette and the central tube **57** and the air flow through the perforations in the tipping and the filter material are proportional to the draw resistance of these two passageways. Since the draw resistance of the whole length of filter material is relatively high there is very little communication between the tobacco column and the smoker's mouth through the filter material.

The smoke generated in the burning cigarette cone during the puff upon reaching the filter **56** travels predominantly through the unencumbered passageway **62** in the tube **57** and reaches the smoker's mouth in an unfiltered and undiluted state and at a relatively high velocity. Even though the quantity of this smoke is reduced when compared to normal filter cigarettes, its unfiltered and undiluted state and its high impingement velocity have the effect of enhancing the taste of the cigarette to the smoker.

A relatively small amount of smoke generated in the cigarette cone passes into the compacted filter material **58** and becomes filtered almost completely.

The other part of the smoker's puff volume brings in air from the surrounding environment via the perforations **61** in the tipping paper, through the plugwrap paper **59** and the filter material **58** into the smoker's mouth. The air does not mingle with smoke until it is delivered into the smoker's mouth. This enhances the possibility of the smoker getting an increased flavor impression from the delivered smoke stream. In conventional cigarettes utilizing perforated tipping, diluting air and smoke mix within the filter with the delivered smokestream being prediluted before impinging in the smoker's mouth.

The amount and velocity of the smoke stream and of the air stream can be regulated by varying the respective draw resistances of the two passageways and the smoke yield of the cigarette can be varied over a wide range by choice of proper combinations of the two draw resistances.

Since it has been found that the diameter of the passageway **62** is critical it can only be maintained by rigid elements. Thus, the tube **57** is of such a material and/or construction to remain undeformed during use. The tube **57** may thus be characterized as a self-supporting, non-deformable rigid tube of sufficient strength to maintain the integrity of the passageway.

The apparatus and method have been used successfully to make 150mm long, 24.62mm filter rods on production machinery at a production rate of 500 rods per minute using 3.0 dpf 48,000 total denier cellulose acetate tow and low density polyethylene tubing. The maximum deviation of the tubing from an adjusted position was observed to be no more than 0.5mm. The particular tow and tubing used in this example have no particular significance as far as the method of the invention is concerned and a wide range of specifications should be tolerable. However, inordinate increases in the tubing diameter and thickness would eventually lead to a limiting condition where either the annular tow span is too restricted or the filter rod becomes too difficult to cut. The tubing material is not necessarily restrictive; however, low density materials are preferred from the standpoints of cost, filter weight and cutting.

Using the filter rods four 100mm sample cigarettes were fabricated and submitted to standard analytical smoking tests. The data listed in Table 1 below are typical of results that can be obtained with the filter of this invention. The yield reductions are calculated on the basis of the same tobacco column smoked without a filter.

Table 1

Sample No.	Analytical data for four sample cigarettes. 89 W	59 U	87 W	60 U
Pressure drop of perforations (cm H_2O)	16.3	17.2	9.0	7.8
Pressure drop of tubing (cm H_2O)	8.1	9.1	7.6	9.7
Tubing I.D. (mm)	0.982	0.955	1.002	0.945
Diluting air (%)	38.6	41.2	55.8	60.6
Yield reduction(%) per cigarette				
NFDS	46.6	57.4	58.0	69.8
Nicotine	41.3	46.2	51.1	58.6
HCN	57.5	67.8	76.3	83.0

Referring to FIG. **1,** since the filter material **13** is constrained and compressed between the self-supporting tubing **15** and the enveloping paper web **42,** the filter rod **11** is substantially rigid without the use of a plasticizer on the material **13** or the associated curing process that is used to achieve rigidity in filters of conventional construction. Furthermore, in reference to FIG. **4,** since a relatively small amount of the smoke follows the path through the filter material **58,** a plasticizer on material **58** would not serve in the usual capacity of selectively removing phenol from the smoke stream. Thus, the filter construction made according to this invention affords the option of eliminating the ap-

plication of a plasticizer and the associated curing process. As a result, the apparatus **12** can be of simple construction and the usual cure time between formation of the filter rod and its application to cigarettes can be eliminated.

As can be seen from FIG. **5**, the invention provides a cigarette filter in which a hollow tube is radially centered to achieve a symmetrical construction and an aesthetically pleasing appearance at the exposed end of a cigarette. Should any misalignment of the tube occur, the mandrel **19** (FIG. **1**) can then be adjusted in an appropriate manner to again align the tubing in the proper place and bring about a centering of the tubes in subsequently made filters.

What is claimed is:

1. The combination of

a cigarette tobacco section;

a filter immediately adjacent said tobacco section comprising a rigid tube extending the length of of said filter and defining a smoke passage aligned with said cigarette tobacco section for passage of an unfiltered portion of smoke said passage being of constant cross-sectional area throughout and being of a cross-sectional size to have a draw resistance for controlling the amount of unfiltered smoke entering a smoker's mouth for a given draw; a layer of compacted filter material circumferentially about said tube for receiving a second portion of smoke from said tobacco section for substantially complete filtration therein; and a cylinder of porous plugwrap paper about said layer of compacted filter material; and

a cylinder of tipping paper joining said tobacco section and said filter together, said tipping paper having a plurality of perforations communicating the surrounding air with said layer of compacted filter material via said porous plugwrap paper, said perforations and said layer of filter material defining an air flow path having a draw resistance to complement said draw resistance of said smoke passage whereby for a given draw a desired amount of ventilation air and unfiltered smoke enters the smoker's mouth.

2. The combination as set forth in claim **1** wherein said tube is of low density polyethylene.

3. The combination as set forth in claim **1** wherein said smoke passage has a diameter of from 0.90 to 1.20 millimeters.

4. The combination as set forth in claim **3** wherein said perforations in said tipping paper have a total cross-sectional area to permit an air flow of from 20 to 70 percent of the total flow through the cigarette to a smoker's mouth for each puff.

5. The combination as set forth in claim **1** wherein said layer of filter material is unplasticized cellulose acetate.

6. A filter for a cigarette comprising

a rigid non-deformable tube extending the length of said filter and defining a smoke passage of constant cross-sectional area throughout and being of a cross-sectional size to have a draw resistance for controlling the amount of unfiltered smoke to be drawn therethrough for a given draw,

a layer of compacted filter material circumferentially about said tube for substantially complete filtration of smoke therein, and

a cylinder of porous plugwrap paper about said layer of filter material holding said layer in a compacted state about said tube, said cylinder having perforations therein for passage of air into said layer of filter material, said perforations and said layer of filter material defining an air flow path having a draw resistance to complement said draw resistance of said smoke passage whereby for a given draw a desired amount of ventilation air and unfiltered smoke enters the smoker's mouth.

7. A filter as set forth in claim **6** wherein said tube is made of polyethylene.

8. A filter as set forth in claim **6** wherein said filter material is unplasticized cellulose acetate.

9. A filter as set forth in claim **6** wherein said passage is of a diameter in the range from 0.90 to 1.20 millimeters to deliver unfiltered smoke at a high velocity therethrough for said given draw.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,860,011 Dated January 14, 1975

Inventor(s) Vello Norman

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 20, change "3,367,447" to --3,637,447--.

Signed and sealed this 15th day of July 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks