June 18, 1968 W. HARRIS 3,388,707

TOBACCO SMOKE FILTER

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Fig. 1

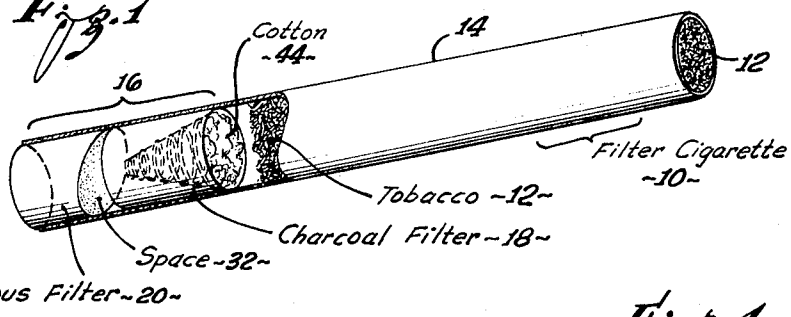


Fig. 2

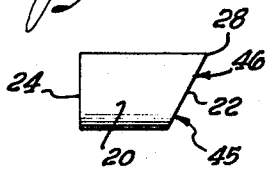


Fig. 3

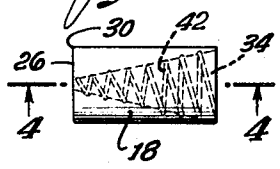


Fig. 4

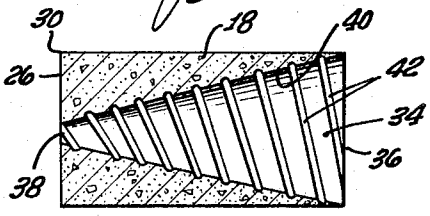


Fig. 5

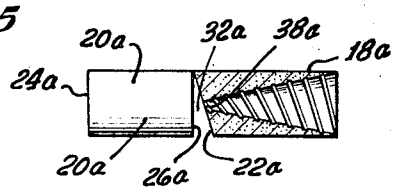


Fig. 10

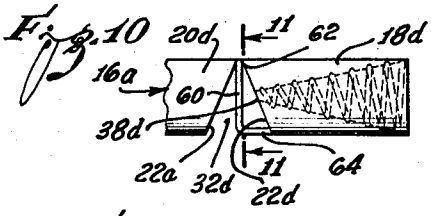


Fig. 6

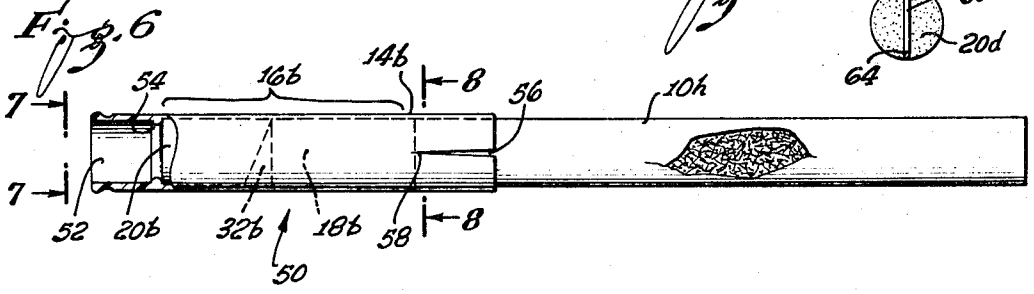


Fig. 11

Fig. 7

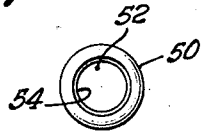
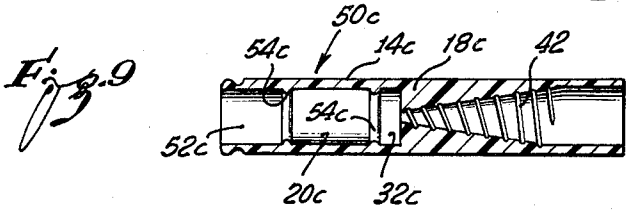


Fig. 8



Fig. 9



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TOBACCO SMOKE FILTER

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Fig. 12

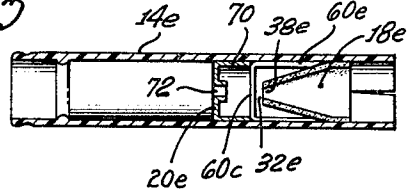


Fig. 13.

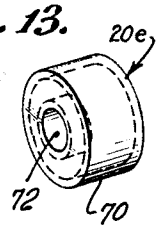


Fig. 14

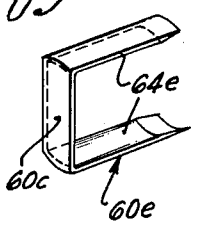


Fig. 15

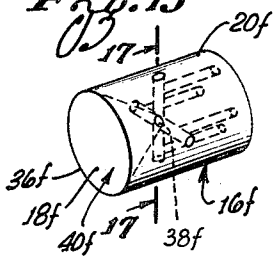


Fig. 16.

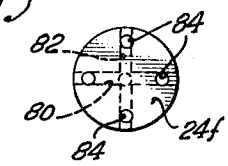


Fig. 17

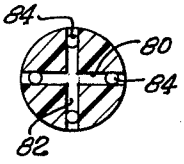


Fig. 18.

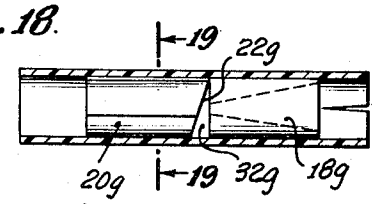


Fig. 20

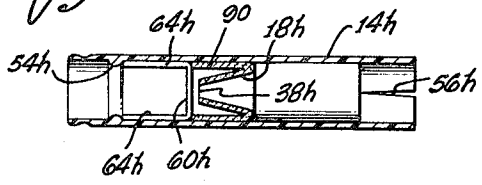


Fig. 19

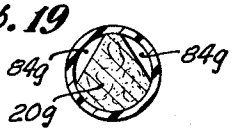


Fig. 22

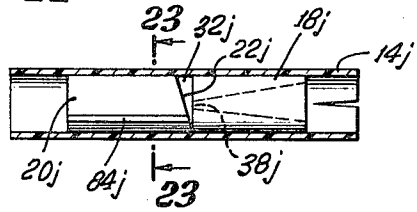


Fig. 21.

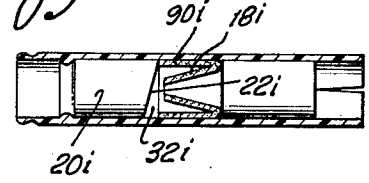
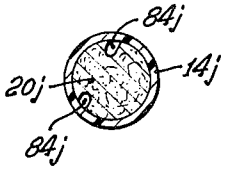


Fig. 23.



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United States Patent Office 3,388,707 Patented June 18, 1968

3,388,707

TOBACCO SMOKE FILTER

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Filed May 17, 1965, Ser. No. 456,285
3 Claims. (Cl. 131—261)

ABSTRACT OF THE DISCLOSURE

This disclosure describes a filter for filtering tobacco smoke which includes a first filter and a second filter. The two filters have disaligned filter passages extending therethrough and a radial passage is provided for connecting the two smoke passages.

This invention relates to a tobacco filter having an improved construction which more efficiently filters extraneous and harmful material from tobacco smoke such as tar, nicotine, oils and dust, and is an improvement over the invention of my previous Patent No. 3,103,221 entitled "Cigarette Filter" which issued Sept. 10, 1963.

In that patent, to form a filter a conical filtering element was incorporated into a sleeve or wrapper and then placed into the mouth end of a cigarette but at a distance therefrom and then hermetically sealed within the cigarette wrapper. The cone of this conical filtering element was open at its apical and base portions and disposed so that the base portion was located adjacent to the tobacco while the apical portion was located a predetermined distance from the mouth end of the cigarette so that additional filtering material could be placed between the conical element and the mouth end of the cigarette. Thus, smoke drawn through the cigarette entered the base opening of the cone, moved along the axis of the cone and simultaneously deflected off its inner converging walls. This funnelling action of the smoke within the cone gradually increased the density of the smoke so that, upon leaving the apical opening of the cone, the smoke reached the succeeding filtering material downstream of the conical element under optimum conditions conducive for effective filtration.

It has been found, however, that a tobacco filter of the type disclosed in my previous patent could be still further improved in a number of ways.

One difficulty in that filter and all prior art filters has been the problem of air lock which prevents the free and easy draft of a cigarette by a blockage or stoppage of air and smoke traveling through the filters and the solution to this problem has been found in the provision of a space or gap between the succeeding filter elements, which gap permits the smoke and air to travel from one filter element to another filter element without resistance. This invention teaches how this air lock can be prevented in various embodiments of the filter elements at the same time each of the filter elements are themselves improved in performance and function.

One embodiment of this invention utilizes a conical filtering element and an additional or succeeding filter element. This succeeding filter element can be of conventional fibrous material which permits smoke to filter through or can be of a solid body such as plastic, but provided with one or more apertures to allow the smoke to travel therethrough. In this embodiment, the space which prevents air lock is defined between the conical filtering element and the filter element by the provision of an oblique surface on either the end surface of the conical filter element containing the apex of the cone, or on the surface of the succeeding filter element facing the apex surface, or the oblique surface can be on both such facing surfaces. The uniformity of this air lock

preventing space or gap is assured in this construction by placing one edge of the oblique surface in contact with the end surface of the other filter element while the diametrically opposite edge of the oblique surface is spaced from the end of the filter element. These two filter elements—the conical filtering element and the succeeding filter element may then be disposed in the sleeve or wrapper of a cigarette to perform the filtering function therein.

Another embodiment of this invention utilizes a smoke diverter in connection with the conical filtering element and which is placed a distance downstream from the apical opening of the conical device. This smoke diverter can take several forms. It can be either a relatively thin, narrow strip of smoke impervious material separate and apart from any succeeding element with the air lock preventing space determined by legs or extensions which hold the narrow strip in place in connection with the conical filtering element or the smoke diverter may form part of the next succeeding element, whether this element comprises filtering material or is impervious to smoke. In this latter type of filter element, however, specifically defined passages are cut in this element in such a way that a diverter is formed on the end surface of the filter element facing the apical opening of the conical filtering element. These passages in forming the diverter impede the smoke in its path of travel as it leaves the conical filter element, causing the smoke to swirl and form eddies before entering the passages.

When the tobacco filter comprising this invention is to be used in a cigarette holder as distinguished from forming part of the cigarette itself, it is especially desirable, it has been found, to provide a reservoir in the cigarette holder to collect tar or nicotine therein. This invention teaches that this reservoir may be a separate collecting body located downstream of the diverter, if the diverter type filtering element is used, or it can be part of the aforesaid air lock prevention space with the diverter arranged so that this reservoir traps the tar and nicotine therein. If desirable, of course, a reservoir can be incorporated into the filter comprising this invention when part of a cigarette; however, it has been found that the diverter or the filter, or both, in combination with the space therebetween, form a sufficient reservoir for any tar or nicotine which can be accumulated during the smoking of any one cigarette.

In addition to the above, it has also been found that the tobacco filter of the type disclosed in my previous patent can be still further improved by constructing the conical filtering element more rigidly, thus avoiding the flexibility of the construction of my prior invention and avoiding leakage problems which may occur in the manufacture therefor by reasons of folds and creases forming the sleeve.

This latter improvement is accomplished by forming the frustum of the cone in a rigid, cylindrical block of smoke impervious material, or by providing a bracing for the conical element if the latter is formed in accordance with the teaching of my aforesaid patent, to prevent possible collapse when the filter is grasped by the smoker, and as will be clear in the more detailed description thereof, this bracing may form part of the aforesaid smoke diverter.

In still another embodiment, which is the preferred form of this invention because of its simplicity, this invention teaches how all of the above improvements can be incorporated into one integral filter unit made of an impervious material such as plastic. This is accomplished by forming a cylindrical plastic body of a size that may be incorporated into a sleeve such as the wrapper of a cigarette or into a cigarette holder and by providing the body with a frustum of a cone in one end to form the

conical filtering element thereof. The axis of this cone is coextensive with the axis of the cylindrical body and formed to a depth substantially midway of the cylindrical body. Both the apical opening and the air space or gap are formed in one operation in this filter body by forming a passage directed radially through the cylindrical body near the end of the cone so that the side walls of this passage intersect the side walls of the cone at the apex thereof. This cylindrical body is also provided with two or more passages formed in the end opposite the conical filtering element and longitudinally of the cylindrical body, but eccentric with respect to the axis thereof. These passages are formed to meet the radial passage and are eccentric with respect to the axis of the cylindrical body from a diverter within the cylindrical body. With the apical opening concentric with axis of the cylindrical body and with the longitudinal passages eccentric, smoke leaving the apical opening will travel first through the radial passage and thence through the longitudinal passages. This diversion of the smoke functions to filter the smoke and to collect tar and nicotine in the radial opening in the same manner as the other diverters and filter elements function in the previous embodiments.

Still another problem in filters of all types is the distance that the smoke travels to provide proper filtering action. Obviously, the greater the distance of travel through the filter, the better the filtering action; yet all filters heretofore had no means of increasing the distance of travel to accomplish the better filtering action. The present invention teaches a solution to this problem and which may be incorporated in any of the above embodiments by providing within the filtering device itself a means in the form of a spiral which increases the length of travel of the smoke therethrough. In the embodiment teaching this solution to the problem, this spiral is cut into the sides of the rigid impervious material forming a frustum of a cone in the aforesaid rigid cylindrical block.

As hereinabove referred to, and as will be more clear from the more detailed description herein, the filter forming this invention may be incorporated in any cylindrical body or sleeve such as the paper forming the mount end of a cigarette or in a sleeve such as a plastic sleeve for forming a cigarette holder. If the filter is used as part of a cigarette holder, it may be made separately and inserted in the cylindrical sleeve or all of the elements of the filter may be formed as an integral part of the cylindrical sleeve.

Also, as will be apparent hereinafter, the filter construction is such that it is economical to manufacture and is practical and efficient for safer smoking and better health.

Other and additional advantages and features of the present invention will become apparent from a more detailed description of the drawings, wherein:

FIGURE 1 is a perspective view of a filter cigarette partially broken away to illustrate to advantage one embodiment of the filter constructed in accordance with the teachings of this invention;

FIGURE 2 is a side elevational view of the fibrous filter shown in FIGURE 1 but illustrating the oblique surface cut in one end thereof;

FIGURE 3 is an elevational view illustrating the internal construction of the conical filtering element illustrated in FIGURE 1;

FIGURE 4 is an enlarged elevational cross-sectional view illustrating to advantage the conical filtering element illustrated in FIGURE 3, taken along line **4—4** of FIGURE 3 and looking in the direction of the arrows;

FIGURE 5 is an elevational view illustrating to advantage the air space defined by the oblique surface on the concial filtering element as distinguished from the disclosure of FIGURES 1 and 2;

FIGURE 6 is an elevational view illustrating the cigarette holder of FIGURE 5 with a cigarette inserted therein;

FIGURE 7 is an end view of the cigarette holder of FIGURE 6 illustrated at line **7—7** of FIGURE 6 and looking in the direction of the arrows;

FIGURE 8 is an end view of the cigarette holder of FIGURE 5 taken along line **8—8** of FIGURE 6 and looking in the direction of the arrows;

FIGURE 9 is an elevational view partly in section illustrating the filter incorporated in a cigarette holder where the conical filtering element is made integral with the sleeve of the cigarette holder;

FIGURE 10 is an elevational view illustrating the air lock preventing space defined by two oblique surfaces with a smoke diverter therebetween;

FIGURE 11 is a view taken along line **11—11** of FIGURE 10 and looking in the direction of the arrows;

FIGURE 12 is an elevational view in section illustrating a conical filtering element formed of paper in accordance with the teachings of my prior patent, but with a smoke diverter and a reservoir incorporated therein;

FIGURE 13 is an enlarged perspective view of the smoke diverter utilized in the embodiment shown in FIGURE 12;

FIGURE 14 is an enlarged view of the smoke diverter utilized in the invention shown in FIGURE 12;

FIGURE 15 is the preferred form of this invention showing the filter constructed of one integral body;

FIGURE 16 is an end view of the filter body opposite the end having the conical filter showing the longitudinal apertures formed in the cylindrical body;

FIGURE 17 is a cross-sectional view taken along lines **17—17** of FIGURE 15 and looking in the direction of the arrows;

FIGURE 18 is an elevational sectional view showing a conical filtering element and a fibrous filtering element incorporated in a cigarette holder with longitudinal openings for the passage of smoke;

FIGURE 19 is a cross-sectional view taken along line **19—19** of FIGURE 18 and looking in the direction of the arrows;

FIGURE 20 is an elevational sectional view of a cigarette holder having a conical filtering element formed in accordance with the teachings of my previous patent and with a smoke diverter incorporated therein, but without a reservoir;

FIGURE 21 is an elevational sectional view illustrating a cigarette holder constructed with a conical filtering element constructed in accordance with the teachings of my previous patent and with a succeeding filtering element defining an air space therebetween;

FIGURE 22 illustrates still another form of a cigarette holder showing the air space defined by a succeeding filtering element and with passages formed in the succeeding filtering element for the flow of smoke therethrough; and

FIGURE 23 is a cross-sectional view taken along line **23—23** of FIGURE 22 and looking in the direction of the arrows.

Turning now to the drawings, the invention will first be described in connection with FIGURES 1–14, inclusive, to describe the various components as they cooperate with one another to accomplish the desired function and then the invention will be described in connection with FIGURES 15–17, inclusive, the preferred form of the invention showing how all of the elements and their function as a combination may be incorporated in one unitary body. Thereafter, the remaining FIGURES 19–23, inclusive, will be described since they show the invention with the elements such as those disclosed in FIGURES 1–14, inclusive, in combination with some of the embodiments of the preferred form of the invention shown in FIGURES 15–17, inclusive.

In FIGURE 1, the filter cigarette incorporating one embodiment of this invention and constructed in accordance with the teachings thereof is designated as **10** having tobacco **12** and a conventional cylindrical paper sleeve or wrapper **14** throughout its length. The filter comprising

this embodiment is designated in its entirety as **16** and comprises a cylindrical element **18** forming the conical filtering element and a next or succeeding filtering element which in this illustration is a cylindrical element **20** of filtering material. Both cylindrical elements have outer diameters such that they may be suitably hermetically sealed in the cigarette wrapper **14** as shown.

As can be seen in FIGURE 2, the second or succeeding filter element **18** is provided with an oblique surface **22**, that is, a surface disposed at an angle to the longitudinal axis of the cylindrical element **18** as distinguished from the surface **24** disposed normal to the longitudinal axis of the cylindrical element. Surface **24** in the embodiment illustrated constitutes the mouth end of the filter cigarette as clearly illustrated in FIGURE 1, while the oblique surface **22** faces the end surface **26** of the cylindrical element **18**. When incorporated in the filter cigarette as illustrated in FIGURE 1, the upper edge **28** of surface **22** touches the upper edge **30** of the surface **26** for the purpose of providing the space **32** between the two cylindrical filter elements. The material of which the cylindrical filter element **20** is formed may be of any suitable fibrous or paper material commonly used for filtering cigarette smoke such as those which provide numerous fine passages for the travel of the smoke and which may be also provided with the oblique surface **22** as aforesaid.

In FIGURES 3 and 4, it can be seen that the cylindrical filter element **18** is suitably formed, as by boring, with the frustum of the cone indicated as **34**, said cone having its longitudinal axis concentric with the longitudinal axis of the cylindrical element **18** and having a base opening **36** and an apical opening **38** to provide the conical wall **40** which tapers in a typical conical configuration from the opening **36** to the apical opening **38**. The conical wall **40** is also formed with a spiral groove **42** preferably during the cutting or boring of the cone. Spiral groove **42** serves to increase the distance that the smoke travels from the base opening **36** to the apical opening **38** to increase the filtering action of the conical filtering element **18**.

The base opening may be of a size commensurate with the diameter of the paper sleeve or wrapper **14** of a cigarette and the apical opening **38** may be between 0.001 and 0.02 in diameter. The length of the cylindrical element **18** is that of about 0.02 to 0.05, but may be shorter or longer as desired. The material of the cylindrical element **18** may be charcoal, wood, plastic or cardboard, or any other material suitable for the purpose.

From the above description, it can be seen that the cigarette filter **16** comprises the conical filtering element **18** and a succeeding or second filtering element **20** with the oblique surface **22** placed adjacent the apical portion of the cone so that the edge **28** is in contact with the edge **30**. This oblique surface provides a permanent and uniform space **32** between the apical opening **38** and the filtering surface **22** and prevents air lock therebetween which as aforementioned has been found to be a common defect in the prior art filtering devices. If desired, this space may be filled with an amorphous form of carbon such as activated charcoal granules or silica gel to serve as a denicotinizer. This space, in accordance with the teachings of this invention, also acts as a reservoir for nicotine and tar and is especially important if the filtering device is to be incorporated in a cigarette holder where the latter is used for more than one cigarette. The purpose of this reservoir is not as important, it has been found, where the filtering device is incorporated in a single sigarette such as illustrated in FIGURE 1, since the amount of tar and nicotine collected in any one cigarette is not sufficient to require a reservoir, in which case the function of the space or gap **32** is primarily to prevent air lock.

Turning now to FIGURE 5, it can be seen that the air lock preventing space designated in this illustration is **32***a* and is formed by providing the oblique surface **22***a* on the conical filtering element **18***a* which faces the surface end **26***a* of the fibrous filtering element **20***a*, which end is normal to the longitudinal axis of the fibrous body **20***a*. It has been noted that inasmuch as the elements of the filter device illustrated in this figure perform the identical function as described in connection with the FIGURES 1–4, inclusive, the same reference numerals are used but with the suffix *a*. For example, surface **22***a* while used in connection with the fibrous filter element **20** in FIGURES 1–4 illustrates the oblique surface on the cylindrical filtering element **18***a* where it performs the same function as described in connection with FIGURES 1–4.

The operative properties and function of this filtering device will be explained as follows in connection with the embodiment illustrated in FIGURES 1–4, inclusive.

As the smoke (more correctly, smoke entrained air) is drawn through the cigarette, smoke enters the conical filtering element **18** at the base opening **36**, the material of element **18** being of the type which will inhibit smoke passing through it and thus forces the smoke to enter the cone. The smoke then moves along the conical surface **40** with the smoke engaging and spiraling throught the spiral groove **42** as it passes from the base opening **36** to the apical opening **38**. If the conical filtering element is made of a material which has fibers there is a possibility that additional filtering action on the smoke will be accomplished as it travels through this spiral groove **42**.

If desired, a wad of cotton **44** (FIGURE 1) may be inserted in the cone **34** to direct the smoke toward the spiral groove **42** to insure a spiral configuration of the smoke traveling through the conical filtering element and thus insure an increase in the distance of travel of the smoke and providing more filtering action. The fibers in the cotton, in addition to directing the smoke through the spiral groove **42** will also serve to filter the smoke simultaneously, of course, as the smoke moves toward the small opening **38**, there is a resulting funneling action which gradually increases the density of the smoke.

As the smoke leaves the apical opening **38** of the cone, the smoke enters the air lock preventing space **32** downstream of the conical filtering element in which the thicker and heavier smoke passes through that portion of the surface **22** furthest from the apical opening **38**, that is, in the vicinity of the arrow **45** while the thinner, lighter and finer smoke passes through that portion of the surface **22** closest to the opening, that is, in the vicinity of arrow **46**. This space, of course, as mentioned previously, may be filled with an activated charcoal or silica gel to act as a denicotinizer. It is to be noted that with the cylindrical element of filtering material **20** firmly mounted and united against the face of the conical filtering element **18**, this space is always uniform. This configuration has the additional advantage of preventing collapse as the cigarette is being handled and, as mentioned previously, this space has the all important function of preventing air lock between the filtering elements, which air lock has been found to be a major contributor in the inability of previous filtering elements to operate satisfactorily.

The above description of the operation and function of the filter as explained in connection with FIGURES 1–4 applies equally well to the filter illustrated in FIGURE 5 except, of course, the smoke leaving the apical opening **38***a* will enter the vertical or conical surface **26***a*. The space **32***a*, of course, performs the same function as explained in connection with the embodiment shown in FIGURES 1–4, inclusive.

As previously mentioned, the filter comprising this invention may not only be incorporated in a filter type cigarette, as illustrated in FIGURE 1, but may equally well be incorporated in a cigarette holder **50**, as illustrated in FIGURES 6–8, inclusive.

In these figures, it will be noted that where like elements perform the same function in the cigarette holder **50** as performed in the filter cigarette **10**, they are given the same reference numerals with the addition of the

suffix *b*. Thus, the filter **16***b* is incorporated into a sleeve **14***b* which forms part of the cigarette holder so that the cigarette **10***b* may be inserted into the sleeve **14***b*, as illustrated in FIGURE 6, and when in that position, the conical filtering element **18***b*, space **32***b* and filter element **20***b* function identically with that described in connection with the previous figures. Smoke leaving the conical filtering element **18***b* and the succeeding filtering element **20***b* passes out the mouth end **52** of the holder **50**. The sleeve may be provided with an inwardly extending ridge or protuberance **54** to position the filter body **20***b* as well as all other parts of the filter **16***b*. In this embodiment, too, the cigarette receiving end of the sleeve **14***b* is provided with a slot **56** to permit the cigarette **10***b* to be inserted into the end so as to lodge against the conical filtering element **18***b*. The slot **56** terminates only a short distance as indicated at **58** from the end of the conical filtering element to permit the cigarette to be squeezed slightly at this point, yet in no way affect the shape or the easy draft of the cigarette through the filter.

If desired, the mouth end of the cigarette holder may be coated or roughened such as by forming or machining a tester on the surface thereof for the purpose of making the holder easier to use, thus preventing it from being slippery when used, as might be the case in some plastics used to make up the holder. As pointed out in connection with this filtering device, the air space **32***b* while performing the function of an air space to prevent air lock also functions as a reservoir for nicotine and tar filtered out of the smoke by the filter; and, as previously mentioned, this reservoir aspect of this invention is important in connection with a holder inasmuch as this holder may be used for holding several cigarettes before discarding same.

Turning now to FIGURE 9, it can be seen that there is illustrated still another cigarette holder **50***c* which functions identically with the previously described cigarette holder **50** except that in this embodiment, the conical filtering element **18***c* is made an integral part of the sleeve **14***c*; such conical filtering element being molded or otherwise formed to be a part of the sleeve. This filter is functionally the same as the holder described in connection with FIGURES 6–8, inclusive, except that in the event the succeeding filter (not shown in this figure) does not have an oblique surface, then the sleeve **14***c* may be provided with a pair of ridges or protuberances **54***c* to properly position the succeeding filter element therein to provide the air lock preventing space **32***c* to prevent air lock and to provide a reservoir which functions the same as the reservoir **32***b*, previously described.

FIGURES 10 and 11 illustrate another embodiment of the invention wherein the oblique surfaces **22***d* are formed on both the conical filtering element **18***d* and on the succeeding filter element **20***d*. Inasmuch as this filter is otherwise functionally the same as the filter described in connection with the previous figures, no further description thereof is deemed necessary. These figures do show, however, another embodiment of the invention and that is that in addition to the air lock preventing space **32***d*, a smoke diverter **60** in the form of a rod or thin strip is placed diagonally of the filter through the space **32***d* and attached to the top of the conical filtering element as at **62** and at the bottom end to the sleeve or to the conical filtering element by a leg **64** as illustrated. The smoke diverter **60** is in line with the apical opening **38***d* so that the smoke leaving the opening **38***d* will strike the rod and will be caused to swirl and form eddies and be diverted before entering the succeeding filter **20***d*. This rod or strip is of any suitable smoke impervious material and may be of the same material as the conical element and formed as an integral part of the conical filtering element or as a separate piece of material suitably attached within the filter. This diverter may also be formed directly on the normal surface such as **26***a* in FIGURE 5, and in line with the apical opening **30***a* so as to be struck by the smoke leaving the apical opening before the smoke through the surface **26***a*. The important feature to the operation of this diverter is that it be in line with but spaced from the apical opening to form eddies and swirls. This rod has the additional advantage of collecting tar and nicotine more effectively and thus improving the filtering action of the invention and may be placed in the space illustrated at **32***a*, **32***b* or **32***c* in FIGURES 1–9, inclusive, as well as in the filters illustrated in FIGURES 10 and 11. In these latter figures, this diverter has the additional advantage of providing a more rigid construction to prevent the collapse of the sleeve at the air space when the same is incorporated in a cigarette such as shown in FIGURE 1.

Further, in connection with these figures, it should be remembered that a wad of cotton **44** will function in the embodiments shown in FIGURES 5–11, inclusive, the same as previously described in connection with FIGURES 1–4, inclusive.

Turning now to FIGURES 12–14, inclusive, it can be seen that the filtering element **18***e* is formed of paper in a manner taught in my previous patent, above identified, and is provided, of course, with an apical opening **38***e* and with a space **32***e* for preventing air lock in the operation of the filter. This embodiment is also provided with a diverter **60***e* which functions in the same manner as that explained in connection with the diverter shown in FIGURES 10 and 11. This diverter, however, is provided with a pair of legs **64***e* which are interconnected by a web **60***c*. The legs **64***e* perform the function of spacing the diverter **60***e* from the conical element so that the air gap is always maintained between the two and serves to brace and protect the conical element against crushing if the filter is incorporated in a sleeve of cigarette paper. FIGURE 14 shows the construction of this diverter and legs **64***e* prior to its insertion into the sleeve **14***e*. In addition to the diverter, this embodiment of the invention is provided with a succeeding filter element **20***e* which comprises a hollow cup-shaped element more clearly depicted in FIGURE 13. This element **20***e* is provided with cylindrical outer walls **70** to fit into the sleeve **14***e* and with an opening **72** centrally thereof which permits the smoke entering the filtering element to travel therethrough and out the sleeve **14***e*. This filtering element functions as a reservoir in this embodiment and the walls **70** serve to space the opening **72** from the diverter **60***e* so that the tar and nicotine may be suitably collected therein. This embodiment of the invention is particularly useful in cigarette holders where reservoirs are required and this embodiment teaches how the air lock preventing gap or space **32***e* may be accomplished through the use of material such as paper when used in connection with a paper type conical filtering element **18***e* formed in accordance with the teachings of my previous patent.

Once having understood the functions and operations of the various elements comprising the filter of this invention, attention is now directed to FIGURES 15, 16 and 17 which depict the preferred embodiment of my invention which will function in a manner taught by the previous embodiments, but is preferred because of its simplicity which makes it less expensive to manufacture. In FIGURE 15, it can be seen that the filtering element **16***f* is provided with a conical filtering element **18***f* and a succeeding filtering element **20***f*, all formed as one integral unit in a plastic body. The tobacco facing end of the cylindrical element is provided with a frustum of a cone **36***f* in a manner taught in the previous embodiments and with an apical opening **38***f* which performs exactly the same function as previously described. However, in this embodiment, the apical opening and an air space are formed simply by providing radial passages **80** and **82** in the cylindrical element which communicate with the wall **40***f* of the cone.

FIGURES 16 and 17 show how the mouth end **24***f* of the cylindrical element is provided with longitudinal

passages **84** (four shown) which intersect the radial passages **80** and **82**. These longitudinal passages are eccentric to the axis of the cylindrical element and thus smoke leaving the apical opening **38***f* will be forced to travel radially until it can enter the longitudinal passages **84**. It can be appreciated that the side walls of these radial passages **80** and **82** perform the function of the diverter, previously described, since smoke leaving the apical opening strikes these walls, at the same time, these passages perform the function of the air lock preventing space, also previously described, in this embodiment of the invention. Thus, it can be appreciated from this disclosure that this embodiment of the invention incorporates all of the functions of the previously described embodiments in one integral filter which may be incorporated as a unit either in a paper sleeve such as **14** in FIGURE 1, or in the plastic sleeves **14***b*–**14***e*, as previously described. Likewise, the conical filtering element **18***f* may also be formed with grooves **42***f* to induce the spiraling action into the traveling smoke and with a cotton wad such as **44**, if desired. This latter will function as it does in the previous embodiments.

FIGURES 18 and 19 show still another form of the invention with the conical filtering element **18***g* incorporated in a sleeve adjacent to a succeeding filter element **20***g*. The air lock preventing space **32***g* in this embodiment is the same as that described in connection with FIGURES 1–11 and is formed by the oblique surface **22***g* except that in this case the filtering element **20***g* is impervious to smoke but is provided with longitudinal passages **84***g* to permit the smoke to pass therebetween. It can be appreciated that this embodiment incorporates the advantages of the smoke diverter and the air space, but shows how the succeeding filter may be made of impervious material, if desired.

FIGURE 20 shows a conical filtering element **18***h* formed in accordance with the teachings of my prior patent, but with the diverter **60***h* and its legs **64***h* disposed in the opposite direction from that described in connection with FIGURES 12–14, inclusive. This figure shows another variation of the invention shown in FIGURES 12–14, but without the reservoir. In this embodiment, the conical filtering device is provided with a sleeve **90** of a length sufficient to space the diverter **60***h* from the apical opening **38***h* in accordance with the teachings of this invention, and the sleeve **14***h* is provided with protuberances **54***h* to properly space the diverter and the filtering element within the sleeve.

FIGURES 21 and 22 show additional filtering elements embodying this invention. For example, the filtering device **18***i* is the same as the filtering device **18***h* shown in FIGURE 20, but the sleeve **90***i* is utilized to space a fibrous type filtering body **20***i* therefrom. It is to be noted that the fibraus filtering body **20***i* is provided with an oblique surface **22***i* which performs the function of providing the air space **32***i* to prevent air lock in this embodiment.

Similarly, FIGURES 22 and 23 show a conical filtering element **18***j* incorporated in a plastic sleeve **14***j* with an impervious second or succeeding filtering element **20***j* with outlet passages **84***j* which has an oblique surface **22***j* to provide the air space **32***j* between the apical opening **38***j* to perform the function of preventing air lock and collecting tar and nicotine as previously described. The wall **22***j* between passages **84***j* also acts as a diverter for the smoke leaving apical opening **38***j*.

The above description of this invention shows that once having understood the defects and problems in the prior art filters, many combinations of the various elements may be utilized to obtain the desired solution, the embodiment shown in FIGURES 15, 16 and 17 being the preferred embodiment, since all of the function and operation of the filter comprising this invention is incorporated into a single unit. It may also be appreciated that while the invention was described in connection with a cigarette, the same could be made part of a cigar or a cigar holder or the stem of a pipe.

It is also readily apparent to persons skilled in the art that numerous other changes and modifications may be made without departing from the scope of the invention and, accordingly, the foregoing disclosure and description thereof are for illustrative purposes only and do not in any way limit the invention which is defined only by the claims which follow.

What is claimed is:

1. In a filter for filtering the smoke from a burning mass of tobacco, the combination of:

first filter means having an axially elongated frustoconical inlet passage extending therethrough, said first filter means being made of a material to inhibit the passage of smoke through the material;

said frustoconical inlet passage having a base opening for facing a mass of tobacco and having an apical opening whereby the frustoconical inlet passage gradually increases the density of the smoke as the smoke flows from the base opening toward the apical opening;

second filter means disposed downstream of said apical opening in said first filter means for filtering the smoke leaving said apical opening, said second filtering means being of a material which at least substantially prevents the flow of tobacco smoke therethrough and defining an axially elongated outlet passage for conducting the smoke away from said apical opening, said outlet passage having an inlet, said inlet of said outlet passage being axially disaligned from said apical opening;

means defining a generally radially extending intermediate passage joining said apical opening of said inlet passage and the inlet of said outlet passage to prevent air lock of the filter to cause abrupt changes of direction of the smoke as the smoke travels through the filter; and

said first and second filter means having confronting faces with said faces being spaced over at least a portion of the areas thereof to at least partially define said intermediate passage, at least one of said faces being inclined relative to the axis of said inlet passage.

2. A combination as defined in claim **1** wherein said one face is the face of said second filter means and said one face is inclined from the inlet of said outlet passage away from said base opening whereby at least some of the smoke must traverse at least two turns of more than 90° in flowing from said apical opening through the inlet of said outlet passage.

3. In a filter for filtering the smoke from a burning mass of tobacco, the combination of:

a first filter element having an inner face and an axially elongated frustoconical inlet passage extending therethrough, said first filter element being made of a material to inhibit the passage of smoke through the material;

said frustoconical inlet passage having a base opening for facing a mass of tobacco and having an apical opening at said inner face whereby the frustoconical inlet passage gradually increases the density of the smoke as the smoke flows from the base opening toward the apical opening;

a second filter element disposed downstream of said apical opening in said first filter element for filtering the smoke leaving said apical opening, said second filtering element being of a material which at least substantially prevents the flow of tobacco smoke therethrough and defining an axially elongated outlet passage for conducting the smoke away from said apical opening, said second filter element having an inner face and said outlet passage having an inlet opening at said inner face of said second filter ele-

ment, said inlet of said outlet passage being axially disaligned from said apical opening;

a sleeve surrounding said filter elements and retaining said filter elements with the inner faces thereof in generally confronting relationship; and

said inner faces being spaced over at least a portion of the areas thereof to at least partially define a generally radially extending intermediate passage joining said apical opening of said inlet passage and the inlet of said outlet passage to prevent air lock of the filter and to cause abrupt changes of direction of the smoke as the smoke travels through the filter, at least one of said inner faces being inclined relative to the axis of the inlet of the outlet passage to provide at least one turn of greater than 90° for the smoke to traverse as the smoke passes through the filter.

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