July 18, 1961 F. H. J. FIGGE 2,992,647

THERMOSTATICALLY CONTROLLED CIGARETTE
AND METHOD OF MAKING THE SAME
Filed Nov. 5, 1958

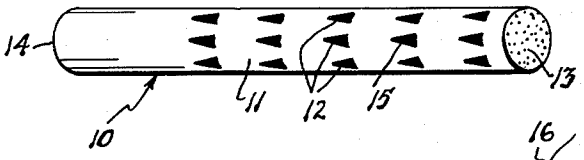

FIG. 1.

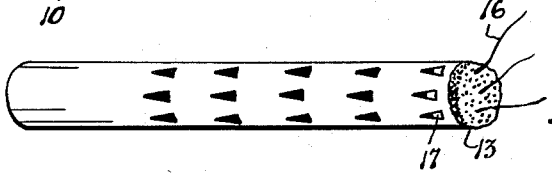

FIG. 2.

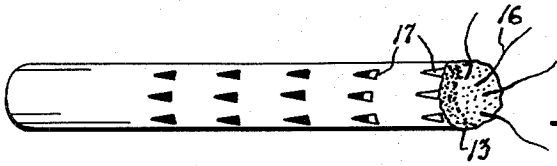

FIG. 3.

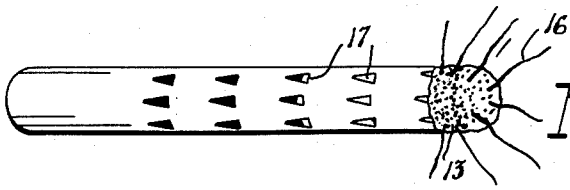

FIG. 4.

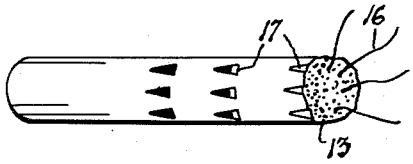

FIG. 5.

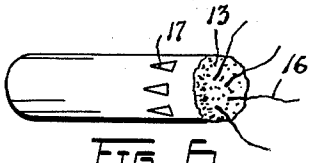

FIG. 6.

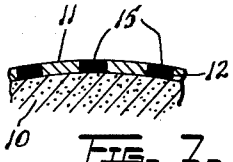

FIG. 7.

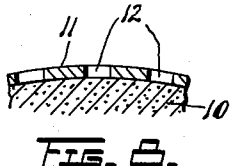

FIG. 8.

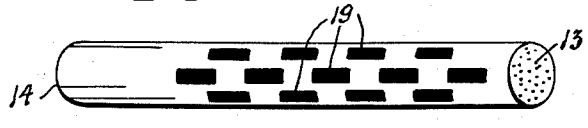

FIG. 9.

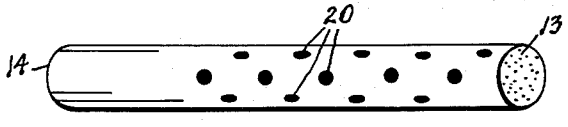

FIG. 10.

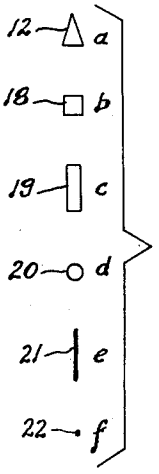

FIG. 11.

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THERMOSTATICALLY CONTROLLED CIGARETTE AND METHOD OF MAKING THE SAME

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4 Claims. (Cl. 131—9)

The invention relates to cigarettes and more specifically to a cigarette provided with a cigarette paper which will prevent the combustion temperature of the cigarette from going above a certain temperature no matter how vigorously the smoker attempts to draw air through the cigarette. It is, thus, a thermostatically controlled cigarette. The invention relates to cigarettes and to the method of making the same with a paper wrapper with openings which may be referred to as perforations, holes, pores, slits or the like that have been filled with a material of low melting or vaporizing point that will melt out or sublime as the cigarette is smoked. The melting or vaporizing point of the material filling the holes or pores is such that the holes, pores or slits open up for some distance in advance of the combustion area, and admit air which does not pass through the burning area of the cigarette. The air admitted in this way does not contribute to, or support the combustion of the burning tobacco. In this manner the percentage of the puff which comes through the burning area is regulated and it is impossible to puff or to draw so hard that the combustion temperature goes above about 650–700° C. The low melting or vaporizing point material which fills the perforations thus acts as a governor or thermostatic arrangement that compensates for the variation in the power of the individual smoker to draw air through the burning area. In the case of the smoker who draws lightly, the gases, vapors and smoke from the combustion areas will not be so hot and will not so readily melt out or cause the disappearance or dissipation of the material which closes the perforations or holes in the paper, so far in advance as will be the case where a smoker draws strongly on a cigarette. In the case of a smoker who draws lightly a greater percentage of the air would come through the combustion area for fewer holes would open up in back of the combustion area than would be the case with a smoker who draws very hard, in which event there will be a tendency to raise the temperature of the combustion area and the gases, and the smoke passing through the cigarette in advance of the combustion area would be hotter. This tendency in the case of the hard drawing smoker would, therefore, melt the material in the perforations, more of them would open up and a higher percentage of the puff would be diverted from the burning area because more air would enter the burning cigarette in advance of the burning area. I have found that a vigorous long, hard drawing puff thus does not increase the burning temperature above the critical level of 650 degrees C.

The primary object of this invention is to provide a cigarette in which combustion temperature may be regulated in order to control the types and quantities of materials formed during the combustion process; or in other words, the type and amounts of various materials that constitute the smoke. The production of certain cancer producing chemicals which are formed during the high temperature combustion of any organic material can thus be minimized, since the combustion temperature controls the amounts and kinds of chemicals that are formed. The smoke combustion temperature also controls flavor as well as other physiological and biological properties of the smoke. In particular it is thus possible to prevent the formation of such cancer producing agents at the combustion area and also to control the flavor of the smoke. These are the primary objects of the invention and are the reasons for the design of this new type of cigarette.

It has been found that certain cancer forming products, particularly aromatic tars and the like are produced where combustion temperatures substantially above the level of 650–700° C. are attained in the smoking of a cigarette or the like, and it is accordingly the object of the present invention to design a cigarette in which these temperatures will not be exceeded regardless of whether the smoker is a vigorous puffer or a gentle puffer.

This I accomplish by a predetermined arrangement of holes or perforations of any suitable size and shape formed in the cigarette paper and filled with a suitable low melting point or sublimable material which will dissipate, melt, vaporize or sublime during the course of smoking as the combustion point of the cigarette moves progressively from the burning end of the cigarette toward the portion held in the mouth of the smoker.

The reasons for the effectiveness of my invention for the reduction of aromatic cancer forming tars as well as the practical details of my process and product will now be more fully described.

I have found that the combustion temperature of a cigarette or cigar is dependent on the rate of passage of air through the burning area. I have also found that if only a small percentage of the air drawn through a cigar or cigarette traverses the burning area, the combustion temperature is lowered. My invention involves using perforated cigarette paper or cigar wrappers with the perforations or pores filled with a material that melts or sublimes at such a temperature that the perforations or openings or holes will open up a short distance in advance of the burning area to regulate the amount of air or the percentage of the puff coming through the burning area. It will be therefore impossible to draw or puff hard enough to raise the burning temperature of the smoking device above 650 to 700° C. The low melting point material which fills the perforations thus acts as a governor or thermostat arrangement to compensate for the variation in the potentialities of the smokers or puffers to draw air through the combustion area. The vigorous puffers have a tendency to cause tobacco to burn rapidly and the combustion temperature to go high. The combustion temperature will, however, never rise above 650–700° C. because the filling material in the perforations dissipates out of the holes or pores just in advance of the burning area. This allows a part of the puff to be diverted by air entering the smoking device in advance of the burning area. A vigorous long hard puff would thus not increase the burning rate very much or increase the temperature above a given level (650–700° C.).

It will be apparent that holes in the paper or wrapper or binder, may be round, rectangular, slits or small pores, or in fact of any shape or size. They will vary in size to compensate for variation in the melting point of the material filling the holes. The melting point of the material which fills the perforations, holes, or pores may also be adjusted by selection so as to effectively regulate the temperature of the combustion area. That is, materials that melt or sublime at low temperatures are used in these cases where it is desirable to keep the burning temperatures very low, i.e., between 450 and 500° C. Materials with higher melting points may be used in case it is desirable to prevent the temperature from going above 650 to 700° C. Materials which dissipate at temperatures between 35 to 250° C. are found desirable. Any one of a number of substances may be used as long as the melting points are appropriate and the odor or taste of the smoke is not objectionable. For example, polyethylene or cellulose compounds with softening and melting points between about 50° and 100° C. are believed to be most effective and are preferred. Monosodium phosphate ($NaH_2PO_4.H_2O$) which dissipates at about 48° C. is also found to be effective. These substances serve to effec-

tively close the holes, perforations, pores, etc., in the areas of the paper or wrapper toward the smoker, but they tend to melt and open up holes just in advance of the burning area to admit cooling air. As has been pointed out more holes will open up in the case of smokers who attempt to puff vigorously than in the case of smokers who puff very lightly. The temperature of the combustion area is thus automatically controlled. Since the combustion temperature controls the amounts and kinds of chemicals that are formed in or constitute the smoke, this temperature also controls flavor as well as the physiological and biological properties of the smoke. In particular, it is thus possible to minimize the formation of cancer producing chemicals at the combustion area, this being the object of the invention.

As previously pointed out the temperature at the combustion area preferably should not rise materially above 650° C. and in any event should not equal or exceed 700° C., at which temperatures certain aromatic or cancer producing chemicals have been found to form in the course of cigarette smoking.

The temperature at the center of the combustion area of an average or normal cigarette may fluctuate between 500° C. and 900° C. A maximum of 900° C. is reached near the end of a fairly vigorous puff. I have measured the temperatures of the paper at various distances from the combustion area. These temperatures were determined by actually placing materials with definite melting points on the cigarette paper, smoking the cigarette in the usual manner, and measuring the distance that the material melted in advance of the combustion area. Substances melting at 52° C. melt for a distance of 12 to 20 mm. in advance of the combustion area, substances which melt at 93° C. melt for a distance of 5 to 6 mm.; substances that melt at 150° C. melt for a distance of 4 to 5 mm.; substances that melt at 200° C. melt for a distance of only 3 mm.; materials that melt at 260° C. melt for a distance of 2 to 3 mm.; substances with melting points as high as 316° C. melt for a distance of only 1 mm. Thus an important temperature gradient exists with a maximum at the combustion area and a practical minimum about 2 cm. toward the end where the cigarette is held in the mouth. While there may be some rise in temperature of the tobacco in the cigarette or the paper near the butt end, this part of the cigarette barely rises above 50° C.

Permissible temperature range of sealing material

The temperature range within which the sealing material should melt, soften, sublime, or undergo any physical change which would leave an opening where the material formerly existed, should be approximately 35°–250° C. This means that it will melt or soften or holes will thereby be created in the cigarette paper for a distance of approximately 5 mm. (4–6) in advance of the combustion area during the process of smoking.

Examples of suitable sealing materials and method application

I have found that certain cellulose plastics are very effective. The cellulose compounds are essentially the same chemically as found in cigarette paper and other types of material which are burned in smoking devices. Accordingly they are less likely to add additional flavor, and the vapors, and combustion products, are not toxic. Ethyl cellulose is preferred and has a softening point range of 93° to 135° C. Cellulose acetate with a softening point of 60° to 130° C. and very thin films of polyethylene may also be used as well as other plastic materials of many varieties. It should be stated, however, that other non-plastic chemicals melting within the range of 35°–250° C. may be utilized for the purposes above set out. For example, monosodium phosphate ($NaH_2PO_4.H_2O$) has been successfully used.

Size and arrangement of perforations

The dimensions and the arrangements of the perforations may vary according to the melting and softening point of the material used to fill the perforations. The perforations may be a series of small round pin-hole-like perforations (0.1–1.5 mm.) that are arranged in a spiral fashion, so that there are approximately four pin holes per cm. length of the paper. If there are three spiral rows of pin holes, four to a centimeter, approximately 6 of these would be open during normal puffing of the cigarette. These 6 openings allow a considerable amount of air to enter the cigarette just in advance of the combustion area. In place of circular pin holes the openings may be small long triangles with the base directed toward the non-burning end of the cigarette. Small narrow rectangular or even square holes may also be utilized. The exact size of the holes must be adjusted so that the holes are the right size for the melting or softening point of the material which fills them. For example, materials which would melt at a lower temperature would open more holes and the holes should therefore be relatively smaller and less numerous than is the case where the filler melts at a higher temperature. It is therefore possible to use a wide variety of substances to seal the holes and a correspondingly wide variety of sizes of openings that would open up to allow air to bypass the combustion area. Thus the combustion temperature may be accurately regulated. Individuals who have a tendency to puff vigorously tend to raise the temperature of the paper back of the combustion area. However, this opens up more holes and prevents their drawing such large quantities of air through the combustion area and thus prevent the temperature of the combustion area from going above 700° C. in a thermostatic controlled cigarette or below the temperature at which aromatic and cancer producing chemicals begin to form.

The temperature of the combustion area of various cigarettes with conventional cigarette wrappers varies between 500° and 900° C. With this improved wrapper with the perforations closed by materials which melt, sublime, or evaporate out of the holes at a certain temperature, the temperature ranges of the combustion area would be accurately controlled and never rise above 700° C. It is at temperatures above 700° C. that the major quantities of cancer producing agents are formed in the combustion area, though some may be formed as low as 650° C.

Chemicals that will sublime may be used for sealing the holes in cigarette paper as well as those that melt at low temperatures. As an example there may be used substances such as menthol. This melts and sublimes at relatively low temperatures, 36° to 42° C. In addition, it serves to flavor the cigarette.

Temperature control operation

The principle of the production of thermostatic controlled cigarettes has been tested by perforating the wrapper of a cigarette and determining the combustion temperature of the cigarette. In the test the cigarette paper was punctured with an instrument to produce holes of various sizes and shapes. These holes were then filled by painting the cigarette paper with materials that melt at low temperatures or at the temperature of the paper in advance of the combustion area during a puff. Among the substances tested was monosodium phosphate

($NaH_2PO_4.H_2O$)

with a melting point near 48° C. worked efficiently. Ethyl cellulose and monosodium phosphate

($NaH_2PO_4.H_2O$)

mixed with menthol were also tested and found to work efficiently. The maximum combustion temperature that could be achieved with normal cigarettes without puncture holes and with the holes filled with material with low melting points was then determined.

This was determined by inserting capillary glass tubes containing a powder (Tempilaq—a high melting point material manufactured by the Temple Stix Co.) that would melt at a critical temperature (677° C.) The cigarettes were puffed by a human subject in as normal a way as possible. In these tests the powdered material in the capillary tubing melted in the untreated cigarettes whereas it did not melt where the holes were open to allow influx of air, thus proving conclusively that the combustion temperature can be regulated and kept below a certain level by the principle of having holes which open up to allow air to enter the cigarette in advance of the combustion area.

While in the aforesaid test the apertures were provided in a finished cigarette, and thereafter filled with material which may be dissipated at a relatively low temperature, it will be apparent that the perforations may be provided in the cigarette paper itself and these perforations filled with a low melting material prior to forming the cigarette, or else could be formed in the cigarette paper and filled after the cigarette has been formed.

In the foregoing tests the particular low melting point materials tested are given merely by way of illustration and not by way of limitation, as many other such materials may be employed within the scope of the invention, the important feature being that such materials may be dissipated at relatively low temperatures.

The invention may be more readily understood by reference to the accompanying drawing and the following detailed description in which specific embodiments of the invention are set forth by way of illustration rather than by way of limitation.

In the drawings:

FIG. 1 shows an unlit cigarette with a combustible wrapper **11** having openings **12** extending from end **13** to be lit toward mouth end **14**, the openings containing filler material **15**.

FIG. 2 shows the same cigarette lit at end **13**, producing fumes **16** under a "mild" draw or puff, also showing a relatively small accumulation of ash and dissipation of a small amount of the filler material to uncover a small portion of the openings as indicated at **17**.

FIG. 3 shows same condition as FIG. 2 but under a "medium" draw or puff, producing a larger accumulation of ash and exposing more of the openings indicated at **17**.

FIG. 4 shows the same condition as FIGS. 2 and 3, but under a "heavy" draw or puff, producing a still larger accumulation of ash and exposing even more of the openings indicated at **17**.

FIG. 5 shows the cigarette of FIG. 3 (under a "medium" draw) after several puffs so that almost a half of the cigarette is consumed.

FIG. 6 shows the same cigarette as FIG. 5 after several additional puffs so that almost the entire cigarette is consumed.

FIG. 7 shows a fragmentary cross-section of the cigarette greatly magnified to show the thickness of the wrapper with the filler material **15** in the openings **12**.

FIG. 8 is the same as FIG. 7 but with the filler material dissipated from the openings.

FIG. 9 is a view of an unlit cigarette (as in FIG. 1) but showing a modified form employing oblong openings **19** in staggered relation.

FIG. 10 is a view of an unlit cigarette (as in FIGS. 1 and 9), but showing another modified form employing circular openings **20** in a spiral arrangement.

FIG. 11 is a diagrammatical illustration, showing at *a, b, c, d, e, f,* various forms of openings **12, 18, 19, 20, 21** and **22**, respectively.

The foregoing drawings are largely diagrammatic in character and are intended as merely illustrative of the inventive thought. In the drawings the holes are shown opened up somewhat further toward the mouth end than they ordinarily would be with normal smoking. In the experimental tests previously described, in which the holes

are opened up in advance of the burning area, the testing powder (M.P. 677° C.) in the capillary tube did not melt in the exact area where the holes were punctured, but did melt after the combustion zone had passed the area where the puncture holes had been made.

The drawings will now be more fully described.

In FIGS. 1 to 6 the reference numeral **10** denotes a cigarette embodying my invention and having a cigarette wrapper **11** of any suitable combustible material, ordinarily cigarette paper, provided with spaced triangular holes **12** extending circumferentially around the cigarette and from a portion near the smoking end **13** of the cigarette toward the rear or mouth end **14**, but terminating short of the latter. The triangular apertures are filled with a suitable low melting point substance **15** such as sodium monophosphate or ethyl cellulose, which may be mixed with menthol if desired.

In FIGS. 2–6 the wavy lines **16** represent fumes and are intended to indicate that the cigarette is lighted. In these figures the numerals **10** to **14** indicate the same elements as in FIG. 1, and the unshaded portions **17** of the holes **12** indicate that the filler material has been melted out of these portions.

In FIG. 3 the unshaded portions extend further back than in FIG. 2 and indicate that the smoker is using a stronger puff than is indicated in FIG. 2, while FIG. 4 indicates a still stronger puff than in FIG. 3.

FIG. 9 is similar to FIG. 1 except that rectangular openings **19** filled with meltable material have been substituted for the triangular openings **12** of FIG. 1.

In FIG. 10 the filled openings **20** are shown as circular.

The sizes as well as the shapes of the openings may be widely varied, as for example, 1–3 mm., 0.1–0.3 mm., and 0.01–0.05 mm. The above sizes are intended as illustrative only, and not as in any way limiting the invention.

It will be understood that in the foregoing description where reference is made to melting of the filling material "in advance" of the combustion zone, the melting or dissipation actually takes place between the combustion zone and the mouth end of the cigarette.

I claim:

1. A cigarette wrapper or the like of combustible material having spaced apertures therein, and non-toxic filling material normally closing said apertures, which filling material is dissipated in advance of the combustion zone at temperatures within the range of 35°–250° C.

2. A cigarette or the like having its combustion temperature thermostatically regulated to prevent formation of aromatic tars, said cigarette including a combustible wrapper having perforations filled with a non-toxic material which is dissipated at relatively low temperatures within the approximate range of 35 to 250° C., in advance of the combustion zone, whereby cooling air drawn into the cigarette through said apertures by-passes the combustion zone.

3. A cigarette or the like as set forth in claim 1, wherein the combustion temperature of the cigarette is below 700° C.

4. A method of making a combustible cigarette or the like having built-in means for regulating the combustion temperature, which comprises providing a perforated combustible wrapper and filling the perforations with non-toxic material which will be dissipated at a relatively low temperature within the approximate range of 35 to 250° C., in advance of the combustion zone during the smoking operation.

References Cited in the file of this patent

UNITED STATES PATENTS

439,004	Harris	Oct. 21, 1890
1,711,487	Caldwell	May 7, 1929
1,770,616	Kean	July 15, 1930
2,694,399	Parker et al.	Nov. 16, 1954
2,754,828	Swain	July 17, 1956
2,854,010	Stamm	Sept. 30, 1958