Aug. 6, 1968 W. KAHANE 3,395,714

CIGARETTE HAVING PLASTIC SHEET LINED WRAPPER

Filed June 15, 1964

FIG. 1

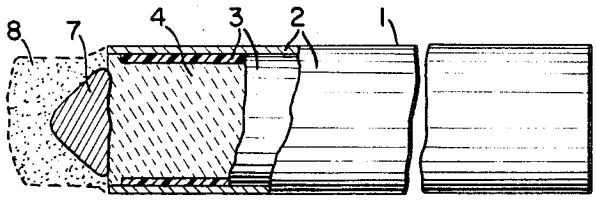
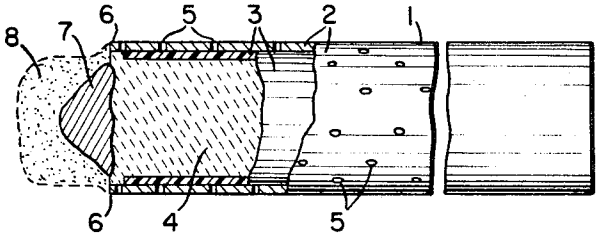


FIG. 2



INVENTOR.
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CIGARETTE HAVING PLASTIC SHEET LINED WRAPPER

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The specification first outlines a theory about the factors responsible for the ill effect of cigarette smoking on health; and then describes an invention aiming at its circumvention by imparting to the cigarette a characteristic feature of cigars and pipes, their quite long low-temperature distillation zone whose length exceeds by far that in conventional cigarettes. The theory starts from the statistical fact that the mortality ratio among cigarette smokers is much higher than among cigar-, or pipe-smokers, and points out at the following two factors as responsible for those differences: (1) The smoke's main-stream-formation burning temperature exceeding a critical which may allow the carcinogen, which I believe to be the radioactive element polonium, to enter in larger amounts into the smoke of cigarettes than into the cigar- or pipe-smoke. (2) the shortness of the cigarette's low-temperature distillation zone, and the smoke's subsequent poverty in "low-temperature tars," which I hold responsible for: (a) inciting to inhaling, due to the insufficient "kick" available from its smoke; (b) for its permitting deep inhaling, due to its easy pattern of puffing; (c) and for being a cause of the cigarette's higher burning temperature. The invention circumvents the above causes by a decrease of the wrapper's transversal heat conductivity, that lengthens the cigarette's low-temperature distillation zone, increasing the "kick" and flavor of the smoke, thus discouraging inhaling, while also indirectly decreasing the cigarette's burning temperature.

Until now, the fight against the cigarette's ill effect on health was based upon the aim of lowering the smoke's so-called "tar" content. The thought behind the present invention is quite its opposite. It is based upon the assumption that non-pyrolytic low-temperature-distillation "tars," which are the very reason for smoking, are not responsible for the cigarette-smokers' high mortality. The said assumption is backed by the statistics evidencing a much lower risk in smoking cigars or pipes, whose content in low-temperature-distillation tars is higher than in cigarettes. It is substantiated further by the recent discovery of dangerous amount of polonium in the cigarette smoke. The aim of the present invention is a cigarette as safe as a cigar or pipe; and, in fact, the proposed cigarette's smoke and behaviour, as evidenced by simple experiments, appear similar to those of cigars and pipes.

FIG. 1 is an enlarged longitudinal cross-section and view of a burning cigarette, which is a typical embodiment of my invention, while FIG. 2 is a similar view through a cigarette used in the experiments quoted in this description, but not covered by the claims.

My previous invention, Ser. No. 337,538, now abandoned proposing the replacement of the conventional paper-wrapper in cigarettes with a metallic foil, was based upon the assumption that the paper was largely responsible for the cigarette smoke's carcinogenity. However

two more factors, whose magnitude is greater in cigarettes than in cigars than in pipes, namely the percentage of inhalers in these three categories of smoking devices and the higher burning zone's temperature, appear to be more important. Nevertheless, the idea that the large difference in the percentage of inhalers among cigarette-, cigar-, and pipe-smokers might alone account for the excessive mortality of cigarette-smokers is invalidated by the statistics. I hold that wrong idea as largely responsible for the current approach with palliatives, such as filters, to the problem of combating the terrible danger presented by cigarette smoking, instead of changing the cigarette's burning and distillation conditions, to make them the same as in cigars or pipes.

I hold the view that, beside the differences in the tobacco and its curing, the difference in design between cigarette, cigar and pipe, viewed as combustion-distillation ovens, together with the presence of the paper in cigarettes, or alone, must be responsible for their differences in their effect on health. Their operational difference stems largely from the differences in diameter and heat-insulation. In spite of the great difference in form and size between cigarette, cigar and pipe, the volume of air aspirated per puff, which is a human datum, is largely the same for all three. This means that the air velocity in cigarettes is about twice that in cigars and about four times that in pipes. We may define these three tobacco smoking devices as intermittently-aspirated combustion-distillation ovens, with a cone-shaped self-forming coal obturator in the ash. The higher aspirated air velocity in cigarettes than in cigars than in pipes suggests that the combustion temperature too should be higher in cigarettes than in cigars than in pipes.

Temperatures as high or higher than 1200° C. have been reported at the conical surface of the coal (2). But these high temperatures, which are due to the combustion going on there to CO_2, are practically irrelevant to us as only a negligible part of the air forming the smoke's main stream is a part in that combustion. From the point of view of health, only the maximum temperatures of the gas flow inside the burning zone, i.e. the maximum particulate temperatures, are important. These were found by Egerton, Gugan and Weinberg (Combustion and Flame, March 1963), by X-raying metallic specimens of known melting points which were added to the tobacco, to exceed 900° C. in a ring surrounding the cone's base.

This is however counteracted by the tobacco's poorer preheat due to the lower heat-insulation of the tobacco in cigarettes than in cigars than in pipes, which means a shorter low-temperature distillation zone in the cigarette, i.e. less distillation and more combustion, which in turn increases the cigarette's burning temperature in comparision with cigars and pipes. Therefore, only comparative measurements can tell which of these three smoking devices gives rise to the highest burning zone temperatures. Controversities have been aroused by this subject (Green, Charles R., Science 122,514, 1955 and Harlow, E.S., Science 123,226, 1956).

Besides the above mentioned measurements done by Egerton, Gugan and Weinberg, among the most careful measurements of the burning zone's temperatures are those of Lam (Acta Path. and Microb. Scand., 36, 502, 1955) for cigarettes, cigars and pipes, and those of Touey

and Mumpower (Tobacco, 144, Feb. 22, 1957) for cigarettes only. The following table condenses the results.

Author	Combustion zone temperatures			
	Thermocouple inserted—			
	Through the mouth end ¼–⅓ from mouth end	Through the ash		
		tip	middle	butt
Lam, Cigarette blended	865–950	775–885	810–890	800–910
Lam, Cigarette Virginia	800–935	735–880	785–875	760–875
Lam, Cigarette Turkish	780–870	760–875	740–830	760–850
Lam, Cigar, machine spun	765–865	765–835	765–820	790–830
Lam, Cigar, hand spun	705–895	730–810	760–820	720–890
Lam, Pipe, finely cut tobacco			550–660	
Lam, Pipe, coarse cut tobacco			530–655	
Touey, Cigarette, 15 mm. from tip, intermittent puffing			860–913	
Touey, Cigarette, 15 mm. from tip continous puff 17.5 ml./s			846–934	
Touey, Cigarette, 15 mm. from tip continuous puff 17.5 ml./s			817–942	
Egerton Cigarette			>900	

The author explains the lower figures obtained with the thermocouple inserted through the ash, instead through the mouth end, by the insertion points being probably injured by burning, with formation of air canals along the wires.

The above table, which contains the most reliable data I found published about temperatures in cigarettes, cigars and pipes, not only shows higher temperatures in cigarettes than in cigars than in pipes, but evidences only a relatively small margin between the cigar's and the cigarette's temperatures. Based upon the deduction from statistical evidence that the unknown carcinogen most probably passes from tobacco in larger amounts into the cigarette smoke than in that of the cigar, we may suspect that a temperature situated inside that relatively narrow range must be critical for the appearance of the main carcinogen in the smoke. Therefore, the above table may be questioned for indications as to the agent which is responsible for the high mortality ratio of cigarette smokers, in the following way:

No non-radioactive carcinogen has been found in cigarette smoke, which is not in cigar and pipe smoke as well. Moreover, the amount of the most potent non-radioactive alleged carcinogen increases sharply from cigarette- to cigar- to pipe-smoke, as shown in the following Table 3, at p. 58 of the quoted report (Public Health Service Publication No. 1103):

POLYCYCLIC HYDROCARBONS ISOLATED FROM TOBACCO SMOKE

[μg. per 1,000 g. of tobacco consumed]

Hydrocarbon	Cigarettes	Cigars	Pipes
Benzo(a)pyrene	9	34	85
Acenaphtylene	50	16	291
Anthracene	109	119	1,100
Pyrene	125	175	755

Considerations based upon the difference in temperatures, as supplied by the above table of temperatures cannot therefore lead to the detection of a decisive carcinogen in the cigarette smoke unless one would look for those radioactive compounds which, due to the higher temperature in cigarettes, might enter into the smoke while a slightly lower temperature, as in cigars, would prevent their entrance. As due to the excess air, the combustion zone is highly oxidizing, and as the ratio of the surface to weight of the eventual radioactive elements in the tobacco is very high due to their extreme tenuity, no radioactive element can enter into the smoke except as an oxide. The problem therefore is that, based on the above table, to find out which radioactive oxide volatilizes substantially at the cigarette's maximum temperature and ceases practically to be volatile at that of the cigar.

The sublimation temperature of the polonium oxide, PoO_2, which is 885° C. (7, 8), is exceeded in cigarettes, but not in cigars and pipes. This would mean, should polonium, which is an extremely potent carcinogen to man, be found to pass from tobacco into cigarette smoke in higher ratios than into the smoke of cigars and pipes, that 885° C. is a critical temperature of the cigarette, which should not be exceeded. Recently, Radford and Hunt (Science, 143, Jan. 17, 1964) have found polonium both in the cigarette's tobacco as well as in its smoke in the following amounts:

POLONIUM CONTENT OF AMERICAN CIGARETTES AND SMOKE

	(Po^{210} content (pc.)					Ratio Po^{210} of mainstream to Po^{210} in total smoke, percent
	Ash	Butt	Total smoke	Total recovered (pc.)	Total recovered Percent	
Whole cigarette: 0.39–0.48	.031–.053	.094–.15	.17–.26	.32–.43	81–90	41–52

As the ratios of Po in the ash to those in the whole cigarette were 0.09–0.11, it appears that about 90% of the polonium contained in the tobacco was volatilized during smoking. The quoted authors have not yet investigated smoke from cigars or pipes. From their investigation, they estimate that the radiation dose delivered by polonium inhaled from cigarettes would be seven times the background exposure, if both the slowing effect of smoke on ciliary action as well as the effect of local concentrations of the smoke particulates in various regions of the bronchial tree are neglected. By taking into account these two effects, their estimate is that local intake radiation doses may range from several hundred rem. to more than 1000 rem., in the case of an individual smoking two packs a day over a 25-year period, while the normal background dose amounts to only 5 rem. per 25 years. They take the view that a dose of 100 to 200 rem. to the bronchial epithelium may be highly significant when taking into account the presence of strong cocarcinogens in cigarette smoke. The said authors' present conclusion was that polonium inhaled in cigarette smoke may act as an important initiator in the production of bronchogenic carcinoma.

In view of the above, a first object of my invention is a cigarette whose maximum burning temperature of the zone which generates the smoke's main stream is safely lower than the above said critical of 885° C.

While a burning temperature in excess of that critical should be considered only as the acting factor that makes cigarette bad for health, inhaling would appear to be an aggravating factor, as evidenced by the above quoted statistics. It is said that about 90% of cigarette smokers are inhalers while only 15–20% of the cigar- or pipe-smokers inhale the smoke. In my view, this may be a

consequence of the very short low-temperature distillation-zone of the cigarette as compared with cigars and pipes (Ermala P. and Holsti L. R., Cancer Research, 16, 490, 1956), which makes that a lower percentage of the so-called "low-temperature tars," contained in the tobacco, are able to pass into the cigarette-smoke than in the cigar- than in the pipe-smoke. As they contain the "kick" and flavor the smoker is looking for, the unsatisfied cigarette smoker is incited to inhale the smoke in order to offer a larger and more efficient absorption surface and so compensate for the weaker smoke. It should be noted that, though varying to a large extent, the nicotine content of the cigarette's tobacco, as an average, equals that of the cigar- and pipe-tobaccos. Lieb (Lieb, Clarence W. Safer Smoking, 19, 1953) gives the following figures for the nicotine contents:

	Percent
Pipe tobaccos	1.45–2.84
Cigar tobaccos	0.91–1.8
Cigarette tobaccos	1.06–3.11

Thus, the main cause of the cigarette smoker's poverty must lie primarily with the cigarette's very short low-temperature distillation zone, this cause in my view exceeding in importance the influence of tobacco's variety and that of its curing.

On the other hand, the high perfection of the cigarette as a mere combustion over, permitting puffing at wide intervals without fearing the fire going out, and not requiring any attention or need for preliminary short puffs or careful puffing as with cigars and so much more with pipes, leaves plenty of time and energy to the smoker to perform a deep inhaling before feeling the normal urge to expire. Thus the cigarette not only invites inhaling but facilitates it as well.

Another bad consequence of the cigarette's short low-temperature distillation zone, as already mentioned, is that the low amount of distillation causes a higher temperature due to less absorbed latent heat of vaporization and more fuel left in the burning zone. It results that, conversely, a lengthening of the low-temperature distillation zone, such as that achieved in this invention, will cause a reduction of the burning zone temperature.

In accord with the above, a second objective of my invention is a cigarette which has a longer low-temperature distillation zone than the conventional cigarette. A third objective is a cigarette which invites to a smoking pattern similar to that of a cigar or to that of a pipe and thus opposes deep inhaling.

It can be seen from the above that the present invention represents a departure from the current trend of combating the ill effects of cigarette smoking with improvements tending to impoverish the smoke. The general aim of this invention is to make the cigarette relatively as safe as a cigar or a pipe, not by emasculating its smoke, but by correcting the cigarette's structure so as to operate as a cigar or a pipe.

The shorter length of the cigarette's low-temperature distillation zone, as compared with that of a cigar or pipe, is partially due to the negligible radial heat-insulation of that zone in a conventional cigarette as contrasting with the excellent insulation in the cigar or pipe. As it will be further explained and substantiated by my experiments, though paradoxical, heat insulation seems to lower the burning temperature rather than to increase it as one would expect. A fifth object of my invention is a cigarette whose wrapper provides a better heat-insulation than the conventional cigarette's paper. The increased heat insulation of the invented wrapper will thus cause an increase in the length of the low-temperature distillation zone and indirectly will decrease the cigarette's burning zone temperature.

In some of the modified cigarettes I have used in the experiments described in this specification, a direct lowering of the burning zone's temperature was sought to be achieved by means of a wrapper that contains a perforated sheet of paper, which allows a stream of cool secondary air to enter into the fire zone. But in the cigarettes claimed in this invention, whose paper is unperforated, the decrease of the burning temperature is achieved indirectly, through the lengthening of the low-temperature distillation zone, by means of an increase in the wrapper's transversal heat-insulation. This is accomplished, in one alternate of the invented wrapper, by including in it "plastic films," as these ready-made plastic sheets are called by manufacturers; and in another alternate by including in it other heat-insulating materials.

The consequence of the said lengthening of the cigarette's low-temperature distillation zone is an increase of the nicotine and flavor content of the smoke, reducing the need for inhaling, as well as a modification of the smoking pattern, discouraging inhaling, as already explained.

It is to be noted that, even if no secondary air is being admitted, as in both alternates of the invention, there will still be a drop in the burning temperature due to the action of the above mentioned dependent parameter, the lengthening of the low-temperature distillation zone.

My invention can be viewed as an attempt to make the cigarette operating as a cigar or a pipe by adding to it elements which are present in cigars and pipes, but are lacking in the conventional cigarettes.

A typical embodiment of the invention, as represented schematically in FIG. 1, comprises a composite wrapper **1**, consisting of the assembly of two main components, in sheet form. The first one **2** is made of paper and is located at the outside of the cigarette, while the second one **3**, that contacts the tobacco **4** is made of a low-temperature melting-point heat-insulating plastic material. The melting point of the latter can be any one lower than 440° C.

The paper of the cigarette represented by FIG. 1 is conventional cigarette paper without increased porosity or perforations. Its liner **3** consists either of a commercial ready-made "plastic film" or is obtained by lining or smearing said paper **2** with a heat insulating material deposited from its solution, such as ethylcellulose dissolved in alcohol, the carbon from India ink, etc.

The plastic sheet **3** can be made out of any commercially available product which does not emit toxic or unpleasant fumes when heated or burning. In my experiments I used Du Pont Mylar polyester "films" with M.P. of 250° C. The fluor-type plastics, like Teflon, with M.P. of 290° or 327° C., have the advantage of not burning, but their fumes are known to be toxic and therefore fluor-type plastics cannot be used in the invented wrapper.

The thickness of the plastic sheet **3** should be kept as low as practical. In my experiments with commercial ready-made plastic "films" I used the current commercial size of 0.0005 inch.

The two sheets **2** and **3** may or may not be glued together, as their assembly may travel safely through the cigarette-making machine because the pull is resisted by the paper.

In the composite wrapper **1** it does not matter, principally, which of the sheets is the cover and which is the liner, the improved smoke being identical in both arrangements. There are, however, several advantages in using the plastic sheet **3** as the liner, as shown in FIG. 1 which represents both alternates of this invention, so that the cigarette and its ash should have the same aspect as those of the conventional cigarette.

A decrease in the proposed cigarette's burning temperature is due to the increased amount of low-temperature distillation, which consumes more latent heat of vaporization and supplies less fuel for combustion.

In conventional cigarettes the low-temperature distillation zone is only 1–2 mm. long. Its increase up to 5–10 mm., as the dissection of the proposed cigarette seems to indicate, changes substantially its smoke and smoking pattern toward those of a cigar or a pipe. The result is

a smoke richer in nicotine and flavor than that of the conventional cigarette filled with the same tobacco.

Very important is the fact that, in spite of its higher nicotine content, the smoke is less irritating than that from a conventional cigarette filled with the same tobacco. This is probably a consequence of the lower burning temperature causing the evolution of a smaller amount of pyrolytic products. It is an indication that, for the same reason, the proposed cigarette's smoke would probably contain less ciliary-activity inhibition agents.

It is to be noted that all my experiments have shown that the cigarettes provided with the proposed wrapper emit a much smaller amount of side stream smoke and have thus a much longer burning rate in the intervals between puffs. This allows a higher number of puffs per cigarette resulting in more economical smoking.

My experiments have also shown that both alternates of the proposed invention require, and thus invites the smoker to, a short puff before the regular one, or to start with a weak draft and continue it stronger, in both cases, requiring a longer time than the conventional cigarette, thus resulting in no disposition or time for a deep inhaling.

In accord with the content of the above paragraph, the expression "wrapper" used in the present description and claims means that part of the cigarette which surrounds its tobacco which is to be burned during smoking.

I claim:

1. A cigarette whose wrapper is a composite one, said wrapper being composed of two thin sheets: one of them, that which is located at the outside of the cigarette, being a sheet of unperforated conventional cigarette paper; while the other sheet, that which is located in the wrapper toward the inside of the cigarette, as a liner beneath the former, is made of a heat-insulating plastic material whose melting-point is lower than 440° C. and which, when heated, does not emit fumes that are toxic or unpleasant.

2. A cigarette whose wrapper is a composite one, said wrapper being composed of two thin sheets: one of them, that which is located at the outside of the cigarette, being a sheet of unperforated conventional cigarette paper; while the other sheet, that which is located in the wrapper toward the inside of the cigarette, as a liner beneath the former, is a self sufficient plastic film, that is made of a heat-insulating plastic material whose melting-point is lower than 440° C. and which, when heated, does not emit fumes that are toxic or unpleasant.

3. A cigarette whose wrapper is a composite one, said wrapper being composed of two thin sheets: one of them, that which is located at the outside of the cigarette, being a sheet of unperforated conventional cigarette paper; while the other sheet, that which is located in the wrapper toward the inside of the cigarette, as a liner beneath the former, is made of a heat-insulating plastic material whose melting-point is lower than 440° C. and which, when heated, does not emit fumes that are toxic or unpleasant; the above described plastic sheet being made by depositing said plastic material from a solution upon the sheet of cigarette paper to form a plastic liner beneath that paper.

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