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H. B. PARMELE ETAL

3,167,641

APPARATUS FOR PERFORATING SHEET MATERIAL

Original Filed Nov. 6, 1958

3 Sheets-Sheet 1

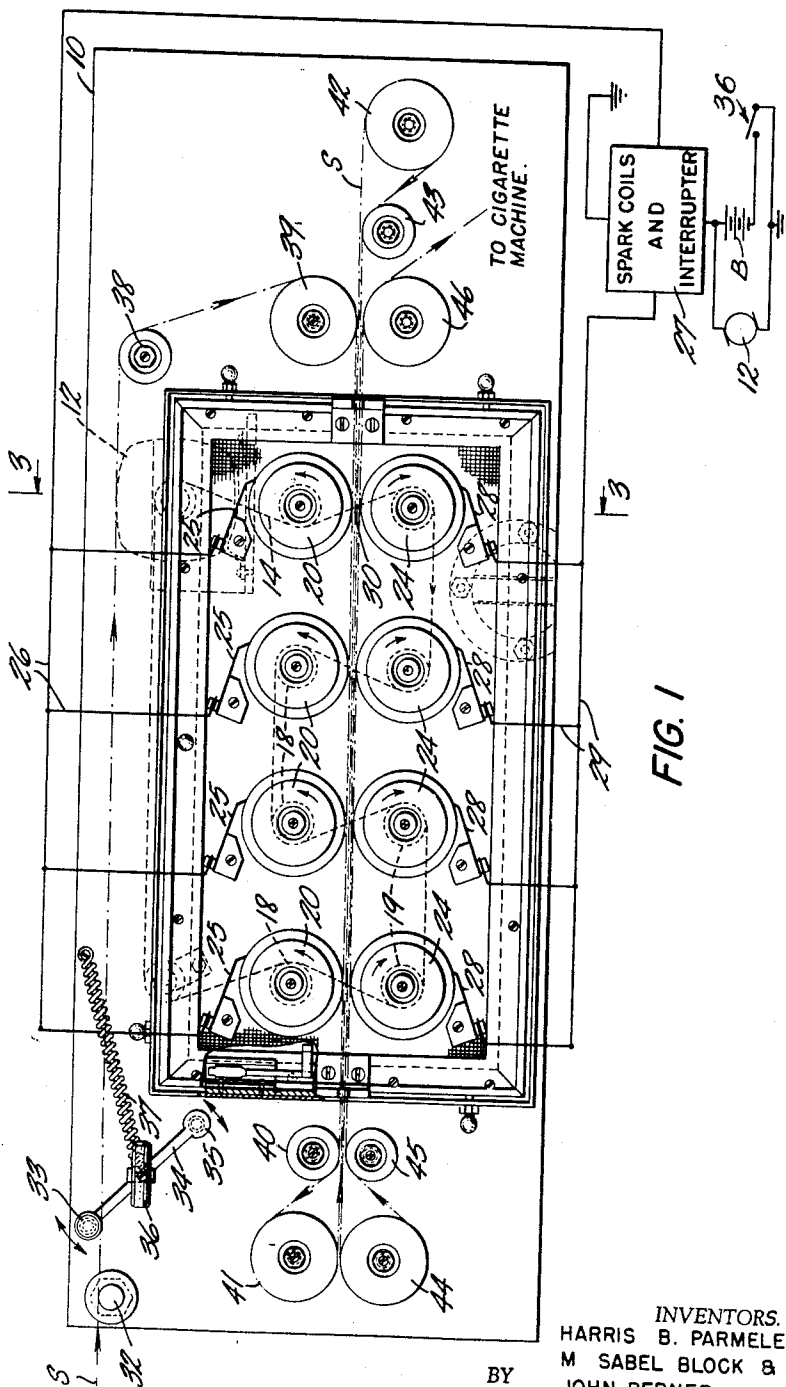


FIG. 1

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3 Sheets-Sheet 2

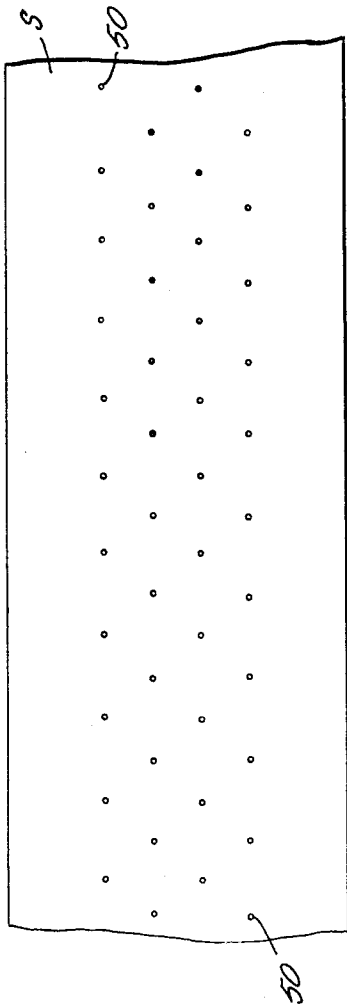


FIG. 4

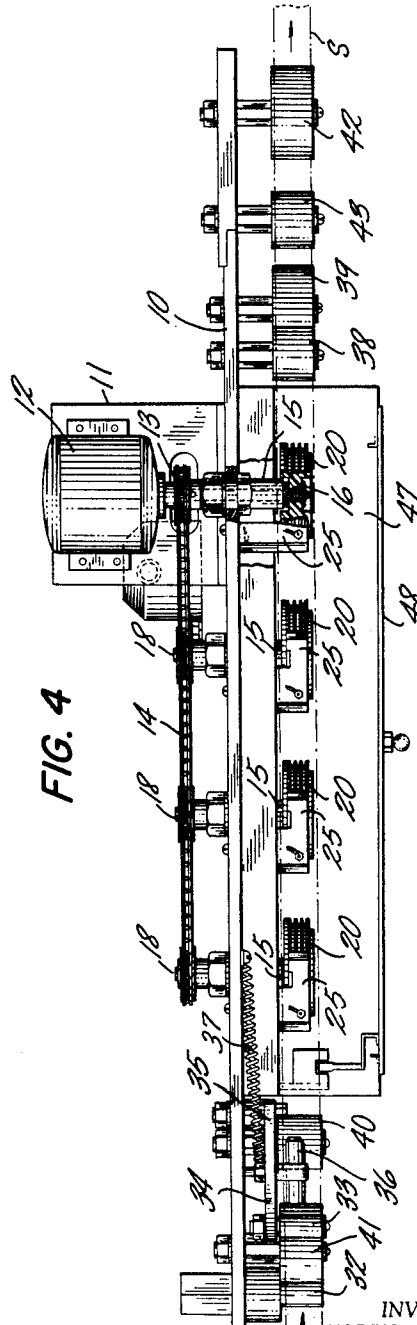


FIG. 2

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3 Sheets-Sheet 3

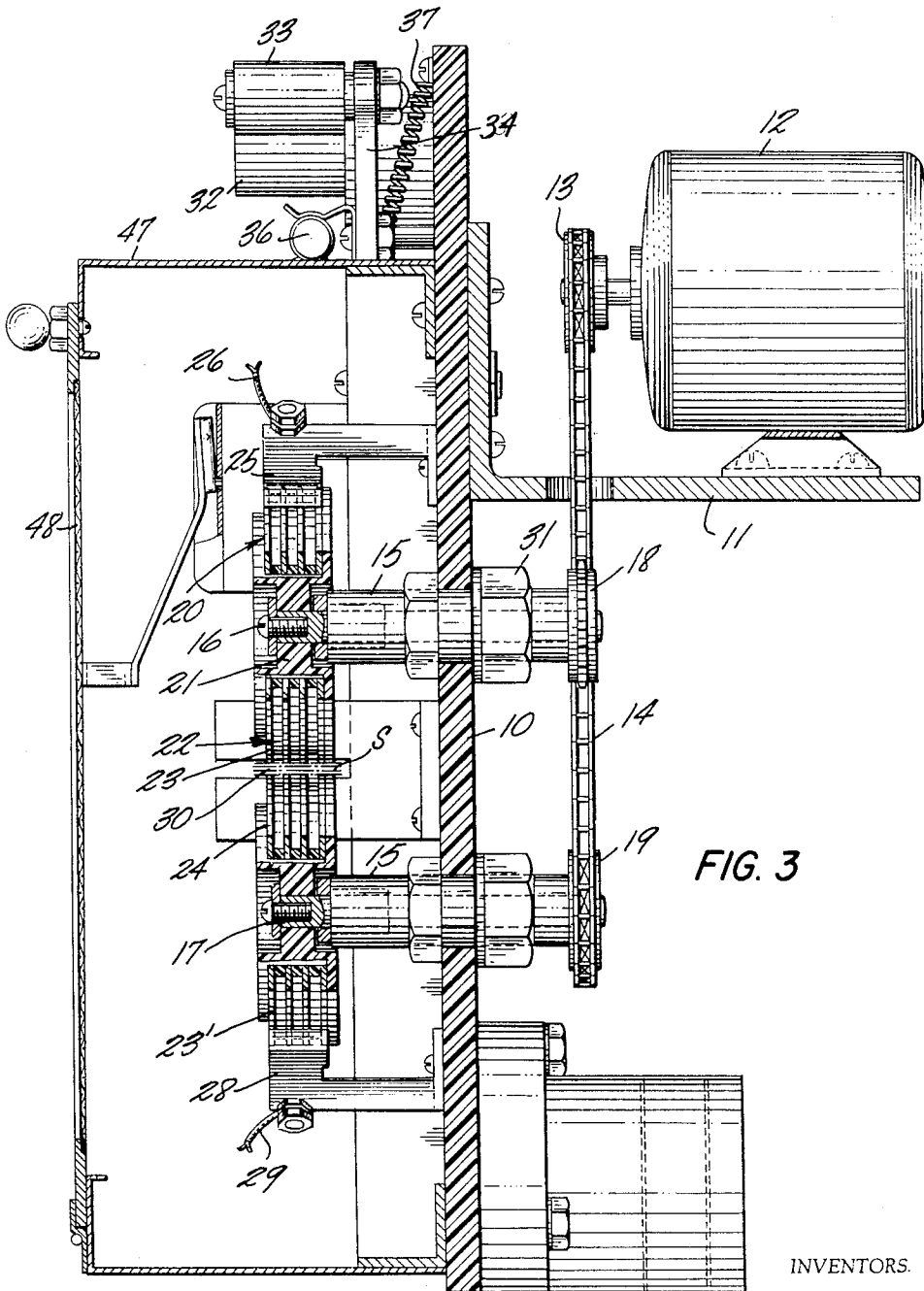


FIG. 3

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3,167,641 APPARATUS FOR PERFORATING SHEET MATERIAL

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Original application Nov. 6, 1958, Ser. No. 772,251.
Divided and this application Dec. 12, 1962, Ser. No.
260,089

2 Claims. (Cl. 219—384)

This invention relates to tobacco products, and has particular reference to methods and apparatus for making the same.

This is a division of United States application Serial No. 772,251 filed November 6, 1958, now abandoned.

In the search for methods of rendering inactive or impotent those distillation by-products of tobacco combustion believed by some investigators to be harmful to the smoker, it has been suggested that a greater flow of air through the cigarette with consequent dilution of the smoke would be beneficial in that such dilution would be accompanied by a volumetric decrease in the supposed harmful by-products of tobacco combustion. Accordingly, various proposals for achieving that end have been made, such as the provision of longitudinal separate air ducts through the cigar or cigarette, perforations in the wrapper through which air is drawn between the combustion zone and the smoke, and the like.

Although such arrangements for mixing additional air with the smoke probably are beneficial to the extent that the added air dilutes the smoke and therefore the combustion by-products, it has been found that it is not merely such dilution that measurably decreases the quantity of the supposedly harmful distillation components of tobacco combustion, but rather that the added air modifies such components by oxidizing upon their formation.

Considering that the distillation process proceeds at the temperature of combustion of the tobacco, which in a cigarette during a "draw" is on the order of 880° C., the oxidation effect must take place at the combustion point at that temperature. However, the supply of added air must be properly regulated in order that the harmful distillation products may be oxidized sufficiently to become effectively inert to the respiratory tract of the smoker. Thus if the supply of added air is too small, dilution and oxidation will be negligible or non-existent. On the other hand, if the added air is greater than that required for complete oxidation, smoke dilution will result but the excess air exerts too great a cooling effect and thus precludes oxidation of the distillation products by lowering the temperature below the oxidation temperature and also causes condensation of the distillation components behind the combustion zone, so that the latter including the harmful ingredients, are subsequently re-volatilized as the cigar or cigarette is progressively consumed.

Therefore, aside from the uncertain degree of benefit resulting from mere dilution of the tobacco smoke with added air, the prior arrangements of air conduits, indiscriminate wrapper perforations, and the like, have not resulted in any measurable decrease in the undesirable distillation components considered to be harmful, particularly the polynuclear or polycyclic hydrocarbons, because they have not provided properly regulated volumes of added air. An example is Muth Patent No. 2,304,009 of 1942, where perforations were provided in the cigarette wrapper and an attempt made to space them so as to maintain relatively uniform supply of added air as the cigarette was consumed for the asserted purpose of oxidizing carbon monoxide, without, however, any optimum

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regulation of the volume of added air to attain that desired end nor, since they were not mentioned, any decrease in the distillation hydrocarbons.

In accordance with the invention, methods and apparatus for making a smoking tobacco product such as a cigarette or a cigar are provided, wherein a carefully regulated amount of air is added during and in proportion to the degree of "draw" applied to the product by the smoker, whereby the distillation components are not merely diluted but are oxidized to a degree to render them inert to the respiratory tract of the smoker, all without material condensation of the same for subsequent redistillation as the product is progressively consumed.

The smoking tobacco product comprises a cigarette or cigar having substantially uniformly distributed throughout its length a plurality of apertures of diameters on the order of less than one hundred microns and in the optimum diameter range of between about thirty and about eighty microns, which, by reason of their size are not only invisible to the naked eye, but are so small that they act as one-way valves, admitting air during a "draw" in proportion to the degree of draw but not passing smoke outwardly when atmospheric pressure is restored after or between "draws" so that no "jetting" of smoke occurs. Also the distribution of the microscopic pores is such that volumetric regulation of the intake air precludes material cooling of the smoke below the condensation temperature of the distillation products.

A preferred method of this invention for production of the microscopic pores in the wrapper is by intermittent electric spark as the wrapper passes between electrodes across which the spark is drawn, the frequency of the spark and speed of the wrapping determining the spacing between the pores while the intensity of spark determines the sizes of the microscopic pores within the aforementioned diameter range.

The preferred apparatus for effecting the perforation of the tobacco product wrapper according to the invention comprises a series of pairs of opposed wheels which are driven in opposite directions and each pair of which is spaced so as to provide the spark gap between which the cigarette paper strip or other wrapper strip passes. Each wheel of each pair is engaged by a brush connected to opposite sides of the sparking circuit, so that when the circuit is intermittently completed a spark across the air gap and through the moving intervening strip "burns" a microscopic pore through the strip, the size of the pores being predetermined by the size of the spark and the spacing between them by the frequency of the spark and the speed of the moving strip, the optimum spacing being between about ten and about thirty per square inch, but the spacing is not critical.

It will be seen that it is not merely the provision of apertures, but the size thereof that provides the tobacco product of this invention and that the method and apparatus for making the same afford an extremely simple and inexpensive means for decreasing the supposedly harmful ingredients in tobacco smoke brought about by the distillation of the components of the tobacco at the combustion zone thereof, thereby affording a helpful adjunct to the conventional filter in the case of cigarettes or, in some cases, making a filter unnecessary.

For a more complete understanding of the invention, reference may be had to the accompanying drawings, in which

FIGURE 1 is an elevation of the preferred apparatus for forming the proper microscopic pores in the cigarette wrapping paper, more than one, preferably four, layers of the paper strips being perforated simultaneously;

FIG. 2 is a plan view thereof;

FIG. 3 is a vertical section therethrough as seen along the line 3—3 of FIG. 1; and

FIG. 4 shows a section of the perforated cigarette paper strip in which the size of the normally invisible microscopic pores is shown greatly exaggerated for the purpose of indicating the distribution thereof in the paper strip.

Referring to the drawings, numeral 10 designates the base or back plate, preferably made of steel or cast iron and arranged vertically on a suitable support, not shown.

Mounted on a bracket 11 on the rear face of plate 10 is the electric driving motor 12, which may be started by the usual switch, not shown. The shaft of the motor 12 carries a driving sprocket 13 over which passes the endless chain 14, to be further described.

Journalled on the base plate on suitable bearings 15 arranged in spaced pairs, such as the four pairs shown, are upper and lower shafts 16 and 17 each having fixed at one end the corresponding sprockets 18 and 19, which are aligned with drive sprocket 13 so that the chain 14 may pass over them in the same plane. As shown particularly by the dotted line in FIG. 1, the chain 14 passes over the sprocket pairs 18, 19 so that the sprockets of each pair rotate in opposite directions but the corresponding sprockets of all pairs rotate in the same direction, i.e., the upper sprockets 18 all rotate in a counterclockwise direction and the lower sprockets 19 all rotate in a clockwise direction.

Also mounted on each upper shaft 16 so as to rotate therewith is an upper electrode wheel 20 comprising an insulating hub 21 and rim 22 made of electrical conducting material, such as brass, and serrated circumferentially so as to provide four, more or less, contact or spark rings 23. The cooperating lower electrode wheel 24 of each pair is constructed in the same way with spark rings 23 and need not be further described.

Engaging the four spark rings 23 of each upper electrode wheel 20 is a corresponding brush 25 supported on the plate 10 and connected by wires 26 to one terminal of a conventional sparking device indicated by numeral 27 in FIG. 1 and comprising in one suitable form the spark coil and interrupter of a Ford automobile. The coil is energized by a suitable source of electrical energy such as the battery B. Similarly spanning the four spark rings 23' of each lower electrode wheel 24 is brush 28 mounted on the plate 10 and connected by wires 29 to the opposite terminal of the sparking device 27, as is indicated in FIG. 1.

The brushes 25 and 28 are of spring metal and in addition to their electrical connection function, they are shaped to serve as scrapers for cleaning and maintaining clean the edges of the spark rings 23 and 23' of the wheels 20 and 24 that the brushes 25 and 28 respectively engage.

The spark rings 23 and 23' of each pair of cooperating electrode wheels 20 and 24 are closely spaced to form a spark gap 30 best shown in FIG. 3. The gap 30 is adjustable by adjusting the corresponding shafts 16, 17 toward and away from each other on the base plate 10, which is accomplished by loosening and tightening the nuts 31 which hold the shaft journals in place. The width of the gap 30 is determined by the thickness of the strip S which passes between the wheels preferably in several layers, such as the four layers shown in FIGS. 1 and 3.

The strip S is drawn from supply, not shown, but located at the left of FIG. 1, over a guide 32, under the roller 33 on the upper end of a sensing lever 34 pivoted on the back plate 10 and having a counterbalance weight 35 at its lower end. The sensing lever 34 carries a normally closed mercury type switch 36 in the circuit of motor 12 and is so biased by spring 37 that its roller 33 lightly engages strip S and when the strip becomes slack as when broken, the spring 37 tilts the lever to open switch 36 and stop motor 12. It also performs the function of breaking the electrical circuit to stop the sparking; otherwise the paper would burn.

The strip S then passes horizontally to the right over

roller 38 journalled on base plate 10, downwardly and to the left over roller 39, between the successive pairs of electrode wheels 20, 24, under roller 40 at the left end of the machine, around roller 41 and back under roller 44 to the right as the second layer or pass between the successive pairs of electrode wheels 20, 24 to emerge at the left and pass around roller 44, over roller 45 as the fourth pass or layer between the successive pairs of electrode wheels 20, 24 to emerge from the machine over roller 46 to the conventional cigarette making machine, indicated in FIG. 1 but not further shown as well known in the art.

An electrical shield 47 encloses the moving parts just described and is mounted on the base plate 10 with a removable screen 48 for observation and servicing through the open front.

The operation of the apparatus of this invention, additional to the feeding of the strip S, which is preferably cigarette paper which usually has a width on the order of 25 millimeters, comprises the functioning of the electrode wheels 20 and 24 in cooperation with the sparking device 27. The latter is adjusted so as to draw a spark simultaneously through the spark gaps 30 of the several pairs of electrode wheels 20, 24 and thus through the several layers of paper strip S passing between them in alternate directions as described. The number of passes of strip S may be varied at will and in case the strip S is formed of reconstituted tobacco, one or two passes will suffice, considering that it is considerably thicker than cigarette paper.

The sparking current density determines the size of the spark and consequently the size of the hole or microscopic pore "burned" through the strip S, whereas the frequency of the spark as provided by the interrupter of sparking device 27 and the speed of the strip jointly determine the spacing between the holes or microscopic pores indicated by numeral 50 in FIG. 4. As there indicated, there are four rows of holes or microscopic pores 50 through the strip S, as determined by the four sets of spark rings 23, 23' between which the spark is intermittently drawn as described. At nine volts and 5 amperes with stock Ford automobile spark coils, the size ranges and percentage distribution of the specified microscopic pores throughout two grades, marked A and B, of cigarette paper strip were as follows:

Diameter Range (Microns)	A	Dist., percent	B	Dist., percent
0-30.....	189	55.8	162	51.1
31-40.....	85	25.0	20	6.7
41-50.....	33	9.6	85	28.9
51-60.....	13	3.9	26	8.9
61-70.....	13	3.9	7	2.2
71-80.....	7	1.9	7	2.2
Over 80.....	None	0.0	None	0.0
Total.....	340	-----	307	-----

SUMMARY

30 or less.....	189	55.6	162	52.7
31-80.....	151	44.4	145	47.3
Over 80.....	None	-----	None	-----

It will be observed that the optimum diameter range is between thirty and eighty microns and it has been found that the diameter should not be greater than one hundred microns. However, the spacing is not critical but satisfactory results are obtained when the microscopic pores 50 are spaced between about one-fourth and one-half inch in any direction or between about ten and about thirty per square inch of strip.

Inasmuch as the added air drawn into the combustion-distillation zone through the microscopic pores 50 during a "draw" on the cigarette performs its oxidizing function immediately at that zone, the longitudinal spacing of the pores behind the combustion zone is not critical since they act merely as diluting ports, providing the dilution is not too great to cause excessive cooling and therefore

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condensation of now harmless distillation components, having the effect of impairing the flavor of the smoke during the remainder of the smoking operation. Accordingly, the size and spacing of the pores 50 at the distillation zone is the important consideration and that is effected by the dimensions and distribution of the microscopic pores 50 as heretofore described, plus the added advantage of the one-way valve effect precluding "jetting" of smoke between draws. The same conditions apply to smoking articles bearing a wrapper of reconstituted tobacco.

Although preferred embodiments and operations of the new method and machine for making the smoking article have been illustrated and described herein, it is to be understood that the invention is not limited thereby except to the extent defined by the appended claims.

We claim:

1. In apparatus for perforating sheet material, the combination of a pair of wheels each having electrical conducting rims and mounted for rotation in substantial peripheral contact, driving means for rotating at least one of said wheels, means for feeding sheet material between said wheels in the direction of rotation thereof, electrical source means for creating an electrical tension across said wheel rims for drawing a spark between them, and intermittent make-and-break control means interposed between said source means and said wheel rims, a conducting brush engaging the rim of each of said wheels and

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interposed between said control means and the corresponding wheel rim for conducting the electrical sparking impulses thereto and simultaneously cleaning the same, whereby said sheet material is perforated by the spark drawn across said wheel rims as the material moves through the gap created thereby between said wheel rims.

2. The apparatus set forth in claim 1 in which said brushes comprise spring metal strips having scraping edges for cleaning said rims.

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