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McArthur

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[54] **APPARATUS FOR ELECTRICALLY PERFORATING SHEET MATERIAL**

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[52] **U.S. Cl.** ..... **219/384,** 83/16, 93/1 R, 204/325, 219/121 EB, 264/154, 346/74

[51] **Int. Cl.** **H05b 7/18**

[58] **Field of Search** ..... 219/121 EB, 383, 219/384; 93/1 R; 83/16, 170, 171, 365; 156/272; 175/265; 204/323, 325, 168; 264/154; 346/74

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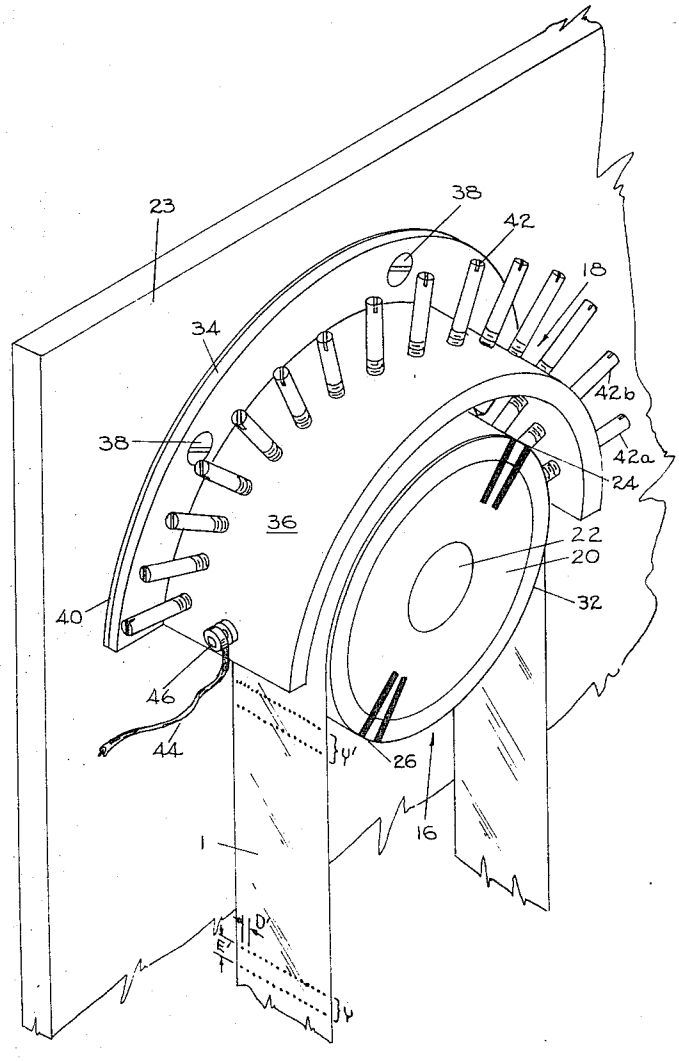
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[57] **ABSTRACT**

A web perforating apparatus for making rows of holes in a moving web, the rows being perpendicular to the direction of movement of the web and spaced longitudinally along the length of the web.

6 Claims, 3 Drawing Figures



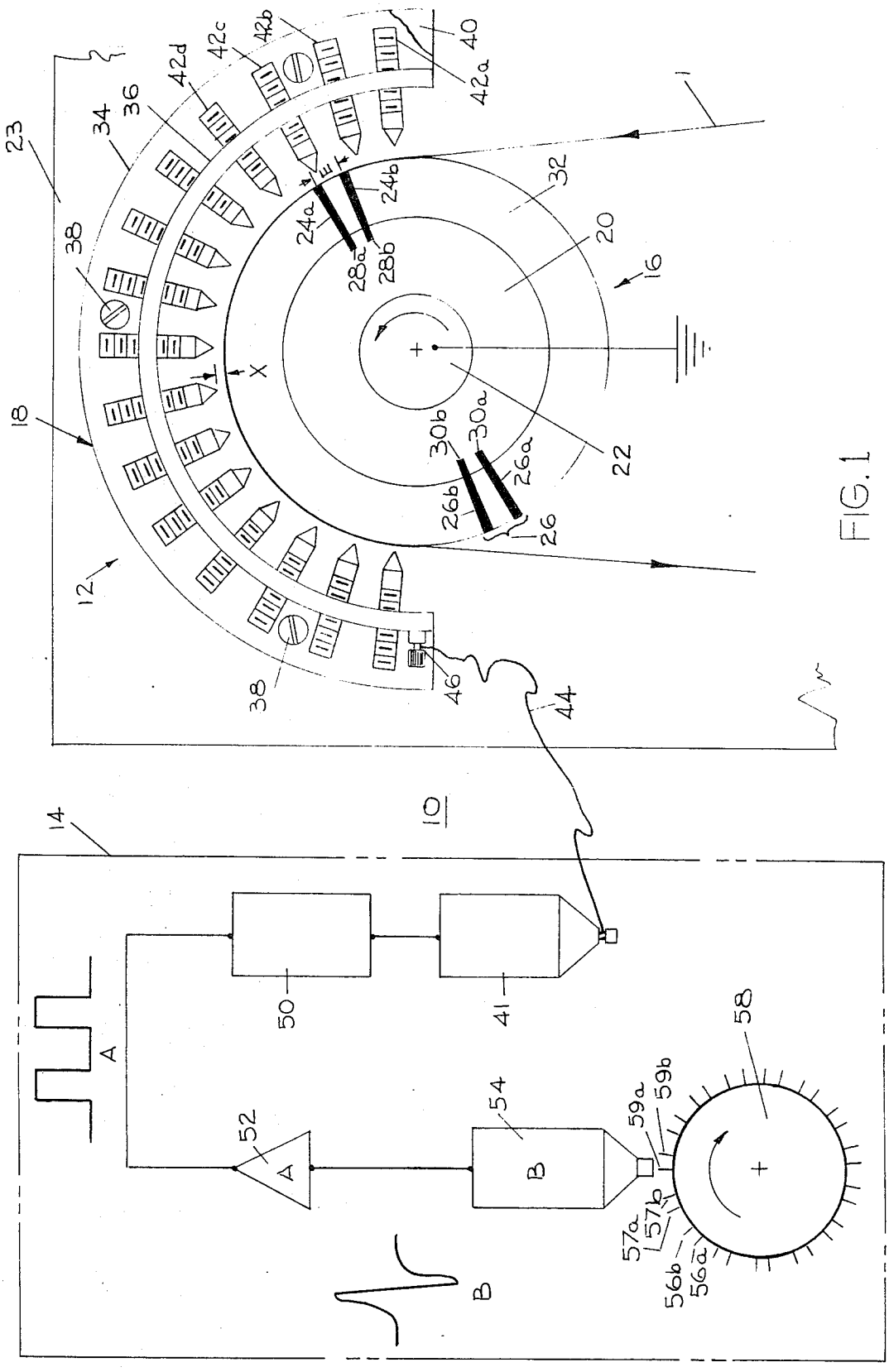

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FIG. 1

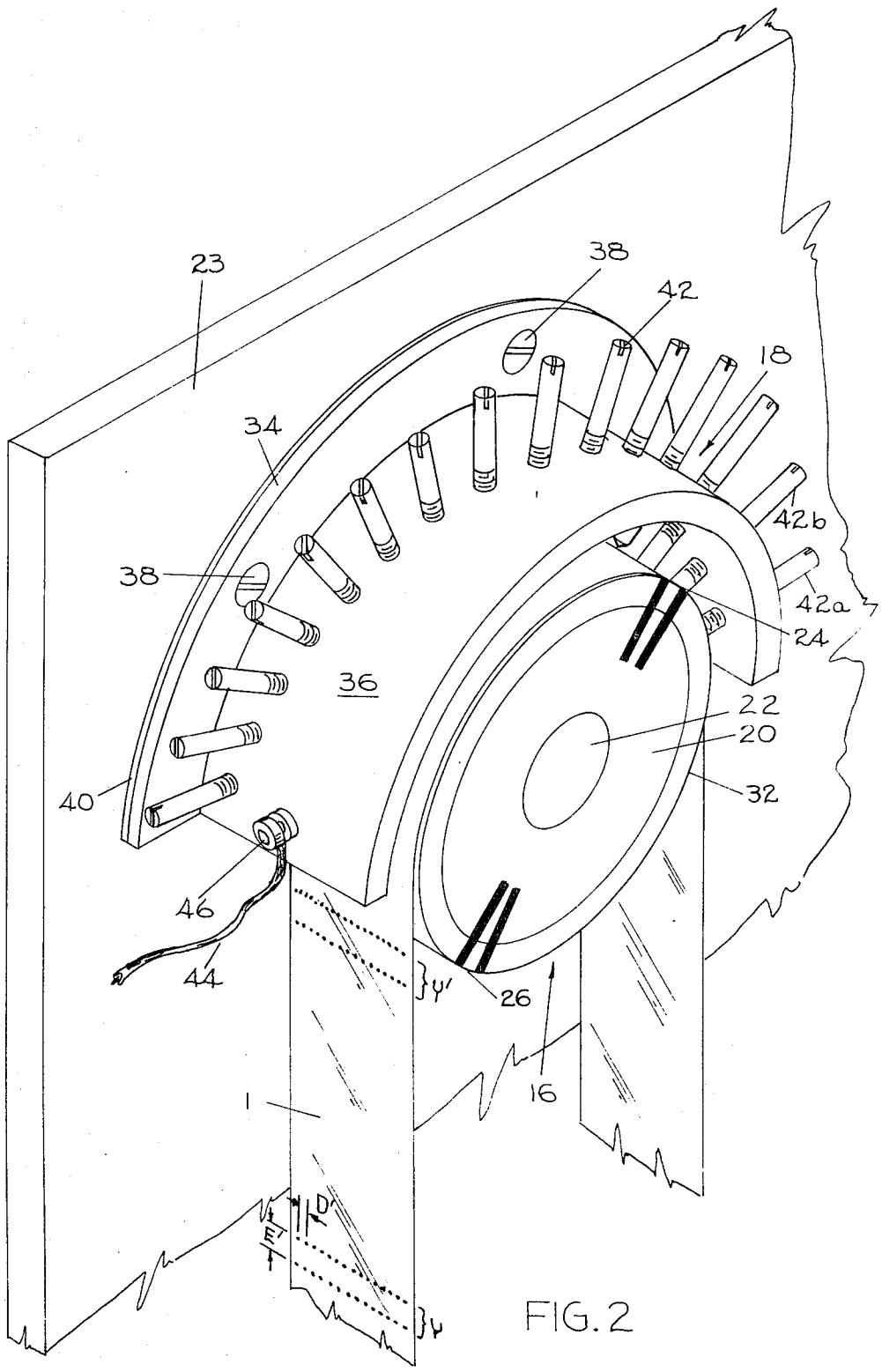


FIG. 2

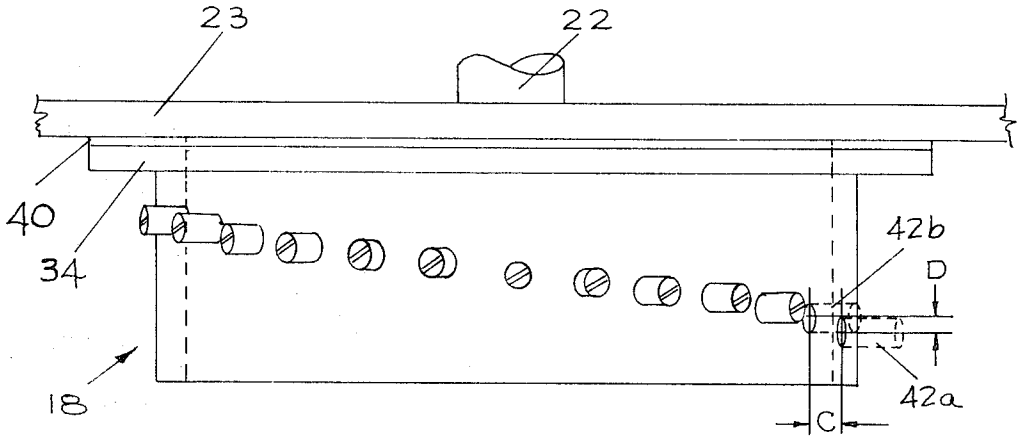


FIG. 3

APPARATUS FOR ELECTRICALLY PERFORATING SHEET MATERIAL

BACKGROUND OF THE INVENTION

This invention relates to an apparatus for use in perforating a web, more particularly, the invention relates to an apparatus which is adapted to perforate rows of minute holes in a cigarette paper web when the rows of holes are perpendicular to the direction of movement of the web and are spaced longitudinally along the length of the web.

There has been much effort in the field of cigarette research directed to the elimination or reduction of the amount of undesirable products or substances in cigarette smoke. A common approach to this objective has been the use of minute holes in the cigarette paper. these minute holes in the cigarette paper appear to produce two results. The first result is the dilution of the smoke when the air is permitted to enter the smoke stream through the holes, thus the concentration of particles in the smoke is not as great. Secondly, it has been discovered that the introduction of air into a filter cigarette causes turbulent flow in the smoke stream whereby the particles in the smoke coalesce and become larger which, of course, will increase the likelihood that these particles will be filtered out of the smoke.

In the past, several apparatuses have been developed by perforating minute holes through webs or sheets. Some of these apparatuses mechanically perforate the web by passing the web between mating rollers, one of which has pins and the other having a cooperating groove into which the pins are inserted. Another apparatus for perforating webs is the electric discharge or sparking device.

These web perforating devices have been used extensively in two industries; namely, the cigarette making and packaging industries. As mentioned above, in the cigarette industry, the cigarette paper is perforated to produce dilution of the smoke. In the packaging industry, the materials used for packaging products are perforated to permit the package to breathe so that it will not explode during storage. When packaging meats, the perforations permt oxygen to enter the package to prevent the meats from darkening.

Most of the presently known devices will produce perforations in the direction of movement of the web; however, there have been a few recently developed devices which will perforate a web so that the row of holes is transverse to the direction of the movement of the web. Some examples of these devices are disclosed in U.S. Pat. Nos. 3,435,190; 3,475,591; and 3,622,751. One disadvantage of the device disclosed in these patents is the high voltage required to perforate each row of holes. This high voltage is required because in each of these devices all of the holes in a particular row are made at the same time. As will be recognized, this requires a great deal more energy than when making a single perforation. The present invention eliminates the high voltages required when perforating the rows of holes in the moving web since only one hole is perforated at a time.

As mentioned above, the introductin of air into a smoke stream as a cigarette is being smoked produces turbulence which causes particles within the smoke stream to coalesce. Although the introduction of air into the smoke stream will cause turbulence no matter

where the holes are located along the length of the cigarette, it has been discovered that a better result occurs in a filter cigarette when the holes are located contiguous to the filter plug of the cigarette. It would appear that the closer the turbulence is to the filter, the greater likelihood that the coalescing particles will be moving in various directions and thus contacting the filter material. For this reason, there is a need for a device which will make rows of holes which are perpendicular to the direction of movement of the web and which are longitudinally spaced along the length of the cigarette paper whereby the holes can be located adjacent to the filter of the finished cigarette unit.

SUMMARY OF THE INVENTION

It is, therefore, an object of the present invention to provide an apparatus which will perforate a row of minute holes in a web which are perpendicular to the direction of movement of the web.

Another object of this invention is to provide an apparatus which will perforate a row of holes perpendicular to the direction of movement of a web and control the longitudinal spacing between the rows of perforations.

Still another object of this invention is to provide an apparatus which will perforate rows of minute holes in cigarette paper and space these rows of holes longitudinally along the length of the web.

These and other objects of the present invention are accomplished by a web perforating device which has a hole-making section and a high-voltage system. The device is slaved to a cigarette paper printer, and the hole-making section is synchronized with the high-voltage system. The hole-making section includes an insulated drum which is mounted for rotation on a shaft which in turn is mounted on a support frame, the drum being grounded through its shaft. At least one electrode blade is inserted in the periphery of the drum and extends radially therefrom. The blade is grounded through the drum and the drum shaft. The drum surface is partially surrounded by an electrode mounting element which is secured to the support frame. The electrode mounting element comprises an arc-shaped member located contiguous to the surface of the drum. A plurality of radially disposed electrodes are carried in the arc-shaped member and are progressively displaced along a helical or spiral path from one end of the arc-shaped member to the other. A roller guide arrangement directs the cigarette paper into the portion of the drum which is surrounded by the arc-shaped member, and the paper rotates with the drum.

The arc-shaped member is connected to the high-voltage system which produces a high-voltage potential on each of the electrodes at preselected intervals. As the blade in the drum passes beneath each electrode, the high-voltage system is pulsed, thus causing an arc between the blade and the closest electrode in the arc-shaped member. The arc produces a perforation in the cigarette paper.

The spiral arrangement of electrodes causes the holes to be produced in a line or row which is perpendicular to the movement of the web. Longitudinal spacing of the row of holes is a product of the location and number of the blades on the drum and the diameter of the drum.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and additional objects, features and advantages of the invention will be apparent to those skilled in the art from the following detailed description of a preferred embodiment taken with the accompanying drawings, in which:

FIG. 1 is a diagrammatic illustration of the web perforating apparatus according to the present invention;

FIG. 2 is a detailed perspective of the drum and electrode mounting element of the web perforating apparatus according to the present invention; and

FIG. 3 is the top view of the electrode mounting element used in the web perforating device of the present invention illustrating the spiral path of electrodes.

DESCRIPTION OF THE PREFERRED EMBODIMENT

When making cigarettes, a paper or web **1** is fed from a reel through suitable aligning devices to a printer where the brand name of the cigarette is printed on the web. Next, the paper is fed through a garniture section where tabacco or tobacco and a filter are applied to the paper whereby the cigarette rod is formed. In most instances, the printer prints the brand name across the web at between 1 and 1½ inches from a given end of the cigarette or, in the case of filter cigarettes, the name is usually printed at a point which will be near the juncture of the filter plug and the tabacco rod of the finished unit. In the preferred embodiment of the present invention, a web perforator apparatus deignated by **10, FIG. 1,** is synchronously geared to the printer in a cigarette making machine so that each row of holes produced by the perforator will be located at a fixed point on the cigarette unit at or near the location of the brand name printed on the cigarette paper.

The web perforator unit **10** includes a hole-making or sparking section **12** and a control and power section **14.** The two sections are slaved together for synchronous movement which will be explained hereinafter.

The hole-making section **12** includes a grounded drum or roller **16** and an electrode mounting element **18.** In this embodiment, the drum has an enlarged cylindrical portion or core **20** with a shaft **22** formed integrally therewith. The shaft is mounted for rotation by any suitable means on a support plate or frame **23** (see FIG. 2). It is necessary to insulate the drum shaft from the frame since the drum serves as the discharge electrode for the perforator device, and the drum is grounded through the shaft **22.** The drum is, of course, made of a suitable conductive material, such as copper, steel, etc.

This preferred embodiment of the web perforator is constructed so that a group Y (see FIG. 2) consisting of two rows of holes which are perpendicular to the side edges of the web will be made in each section of the cigarette paper or web which will be used to make a single cigarette unit. As can be seen in FIGS. **1** and **2,** two sets **24** and **26** of two blades **24*a***, **24*b***, **26*a***, and **26*b*** are mounted 180° out of phase in grooves **28*a***, **28*b***, **30*a*** and **30*b*** on the peripheral surface of the enlarged cylindrical portion **20** of the drum. The blades in each set are parallel to one another and extend outwardly from the surface of the enlarged portion **20.** An insulator covering **32** surrounds the enlarged portion of the drum except for the area where the blades are located, and thus the blades extend through the insulator covering. The blades are made of a suitable conductive material, thus the only portion of the drum surface which will accept the electrical discharge will be the exposed outer edges of each blade.

The electrode mounting element **18** is secured to frame **23** and partially surrounds the peripheral surface of the drum **16.** The electrode mounting element includes a securing flange **34** and an arc-shaped member or shoe **36** which is secured to the securing flange **34** by bolting, welding or other suitable means. The securing flange is secured to the frame **24** by a plurality of bolts **38.** The arc-shaped member is made of a suitable conductive material and thus will carry current. Thus, either the electrode mounting element **18** must be insulated from the frame **24** with a suitable insulating pad **40** or the arc-shaped member **36** must be insulated from the flange **34.**

A plurality of electrode screws or points **42** made of tungsten or other durable material are carried in the arc-shaped member in a spiral or helical pattern (see FIGS. **2** and **3**). The longitudinal spacing between the electrodes **42** is designated by the letter C while the offset spacing is designated by the letter D. The electrodes have threaded shanks which are threaded through the arc-shaped member to permit the gaps X (see FIG. **1**) between the tip of the electrodes and the surface of the drum to be adjusted. For best results, the gap should be approximately 0.020 inches; however, this gap will depend on the voltage produced by the high-voltage system used in the device.

The hole-making section **12** of the perforator is connected to the control and power section **14** of the perforator by a line **44** extending between a connector **46** on the electrode mounting element **18** and an automotive type ignition coil **48** in the control and power section. The coil **48** is energized by an SCR capacitor discharge circuit **50** or other suitable circuitry which receives its triggering pulse A from an amplifier **52.** The input pulse B to the amplifier **52** comes from a magnetic pickup **54** or other suitable means, such as a photoelectric or contacting pickup. In this preferred embodiment, the magnetic pickup senses the presence of one tooth **56*a*** in a set of teeth **56** on a wheel **58.** The wheel **58** is mounted for rotation adjacent to the magnetic pickup **54.** The control and power section of the perforator is designed so that the time interval between pulses can be varied, which will be explained hereinafter. This variation can be accomplished in many ways known in the art, but one method would be to increase the number of teeth in each seat on the wheel **58.**

The rotation of the wheel **58** is synchronized with the printer and web feeding mechanism of the cigarette making machine, as well as with the rotation of the drum **16** of the hole-making section of the perforator. Various methods of synchronizing the elements of the perforator unit to the cigarette making machine can be used, such as gearing, electrical circuits, etc.

In operation, the web perforator **10** receives the cigarette paper **1** as it leaves the printer mechanism of the cigarette making machine. The paper **1** is passed over the rotating drum **16** by suitable guide rolls (not shown). One surface of the paper **1** is in contact with the drum periphery while the other surface of the paper is exposed to the electrodes carried in the arc-shaped member.

As mentioned above, the movement of the wheel **58** and the drum **16** is synchronized with each other and

the printer unit; therefore, it can be understood that as the cigarette paper 1 is passing between the drum 16 and the arc-shaped member 36, the control and power section will be pulsed by the magnetic pickup 54. Teeth 56*a* and 56*b*, 57*a* and 57*b*, etc., of the wheel 58 correspond to the electrodes 42*a*, 42*b*, etc., respectively, on the arc-shaped member. As each tooth, for example — 56*a*, on the wheel 58 passes under the magnetic pickup 54, an output pulse B is generated and passes through an amplifier 52 which increases the amplitude of the pulse. The output pulse A of the amplifier passes into and triggers an SCR capacitor discharge circuit 50 which produces a high-voltage charge. The high-voltage charge produced by the capacitor discharge circuit 50 energizes an ignition coil 48, whereby a voltage is applied to the arc-shaped member 36. As blade 24*a* passes beneath the electrode 42*a*, an arc occurs between the tip of electrode 42*a* and blade 24*a* because of the high-voltage potential on electrode 42*a* and the low-voltage potential of blade 24*a* which is grounded. The cigarette paper 1 being disposed between the two electrodes, the arc perforates the paper.

In this preferred embodiment, the spacing C between electrodes 42*a* and 42*b*, 42*b* and 42*c*, etc., see FIG. 3, and the spacing E between blades 24*a* and 24*b*, see FIG. 1, are such that when the high-voltage system is designed to pulse twice, as in this preferred embodiment, arcs will occur progressively between electrode 42*a* and blades 24*a* and 24*b* before an arc occurs between electrode 42*b* and blade 24*a;* thereby, the longitudinal spacing E′ (see FIG. 2) between the two rows of holes in group Y is obtained. This spacing E′ corresponds to the spacing E between blades 24*a* and 24*b*. Since the electrodes are in a spiral or helical pattern, the electrical discharge occurring between electrode 42*b* and subsequent electrodes 42*c*, 42*d*, etc., and the blades 24*a* will perforate the web perpendicularly to the direction of movement of the web, and the perpendicular spacing D′ (see FIG. 2) between the holes in each row is produced and correspond to the transverse offset spacing D (see FIG. 3) between electrode 42*a* and 42*b*, etc.

The diameter of the drum 16 and the longitudinal spacing C between electrodes 42*a* and 42*b*, etc., are correlated so that the perforations which are made in the paper are in a row or line which is perpendicular to the edge of the paper, and this is approximately perpendicular to the direction of movement of the web.

As the drum 16 continues to rotate and carry the paper 1 beneath the arc-shaped member 36, the second set 26 of blades 26*a* and 26*b* will pass beneath the electrodes 42 whereby another group Y′ consisting of two transverse rows of holes is formed in the paper. Longitudinal spacing between each group of perforations will be equal to the circumferential distance between blades 24*b* and 26*a* on the drum 16.

It should be understood that the number of rows of perforations in each group can be varied by increasing or decreasing the number of blades in each set of blades and by pulsing the high-voltage system more often. The spacing between the rows of perforations in each group can be changed by varying the circumferential spacing between the blades in each set or by varying the speed of rotation of the drum. As far as the longitudinal spacing between two groups of perforations is concerned, the spacing can be changed in a variety of ways — for example, the diameter of the drum can be increased, or additional sets of blades can be added to the drum at various locations. Only one set of blades can be under the arc-shaped member at any one time; however, since the perforation is a single discharge system, if more than one set of blades is under the arc-shaped member at the same time, the blade closest to one of the electrodes 42 will be the blade to receive the arc. The perpendicular spacing between each perforation in a single row can be varied by varying the transverse spacing D between the electrodes on the arc-shaped member.

It can be seen from the above description and drawings that the web perforator unit of the present invention provides a device which will produce rows of holes which are perpendicular to the edges of a web and which will reduce the energy required to make the rows of holes by requiring only one arc to be made through the paper at any give time. It also provides for an easy and simple way to longitudinally space the rows of holes along the length of a web.

The above-described preferred embodiment of the present invention can be modified in numerous ways, as will be apparent from the foregoing; for example, the number of electrodes 42 in the arc-shaped member 36 can be increased to increase the number of perforations in each row, various types of pickups can be utilized for pulsing the high-voltage system, etc. Such changes would normally be determined by the specifications of the particular product which is to be produced by the perforation. However, these and other variations and changes can be made in the invention as above described and illustrated without departing from the true spirit and scope thereof as defined in the following claims.

I claim:

1. An apparatus for perforating rows of holes in a moving web, each row being perpendicular to the direction of movement of said web comprising:

a. a frame;

b. a ground shaft mounted for rotation on said frame, said shaft being insulated from said frame;

c. a drum secured to said shaft, the axis of said drum being perpendicular to the direction of movement of said web, said moving web contacting the surface of said drum, said drum including an internal core of a conductive material surrounded by an insulative cover and at least one blade of conductive material contacting said core and extending outwardly therefrom so that the edge of said blade is exposed on the peripheral surface of said drum, said edge being parallel to the axis of said drum;

d. a plurality of electrodes positioned around a portion of said drum, said electrodes being arranged in a spiral pattern transverse to the direction of said web and the tips of said electrodes forming the outline of an arc surrounding said portion of said drum;

e. means for mounting said electrodes on said frame; and,

f. means for applying a pulsing voltage to said electrodes, said means for applying said pulsing voltage being synchronized with the rotation of said drum so that the voltages are applied to said electrodes as said blade passes each electrode, whereby a single, electrical discharge arc occurs between said blade and said electrode closest to said blade to perforate the web and from form row of holes in

the web which is perpendicular to the edge of the web.

2. The apparatus of claim **1,** wherein said means for mounting said electrodes comprising:

a. an arc-shaped shoe of the conductive material which partially surrounds the surface of said drum and is connected to said pulsing voltage means, said shoe being secured to said frame; and

b. means for insulating said shoe from said frame.

3. The apparatus of claim **2,** wherein said electrodes are threaded through said arc-shaped shoe so that the gaps between the tips of said electrodes and the surfaces of said drum can be adjusted.

4. An apparatus for perforating groups of holes in a moving web, each group having two rows of holes which are perpendicular to the direction of movement of said web, said groups being spaced longitudinally along the length of said web, comprising:

a. a frame;

b. a grounded shaft mounted for rotation on said frame, said shaft being insulated from said frame;

c. a drum secured to said grounded shaft, the axis of said drum being perpendicular to the direction of movement of said web, said moving web contacting this surface of said drum, said drum including an internal core of conductive material surrounded by an insulative cover and at least two sets of two blades of conductive material contacting said core and extending outwardly therefrom so that the edges of said blades are exposed on the peripheral surface of said drum;

d. a plurality of electrodes positioned around a portion of said drum, said electrodes being arranged in a spiral pattern transverse to the direction of movement of said web and the tips of said electrodes forming the outline of an arc surrounding a portion of said drum, said web passing between said drum surface and said tips of said electrodes and the transverse offset space between adjacent electrodes corresponding to the perpendicular space between adjacent holes in a row on said web and the longitudinal spacing between said rows of holes on said web corresponding to the circumferential spacing between said blades on said drum;

e. means for mounting said electrodes on said frame; and

f. means for applying a pulsing high voltage charge to said electrodes, said pulsing voltage means being synchronized with the rotation of said drum so that at least two high voltage charges are applied to said electrodes as each set of blades passes each electrode, whereby a single electrical discharge will occur between each blade in the set and each electrode to perforate the web.

5. The apparatus of claim **4,** wherein said means for mounting said electrodes comprises:

a. an arc-shaped shoe of conductive material which partially surrounds the surface of said drum and is connected to the pulsing voltage means, said shoe being secured to said frame; and

b. means for insulating said shoe from said frame.

6. The apparatus of claim **5** wherein said electrodes are threaded through said arc-shaped shoe so that the gaps between the tips of said electrodes and the surface of said drum can be adjusted.

* * * * *