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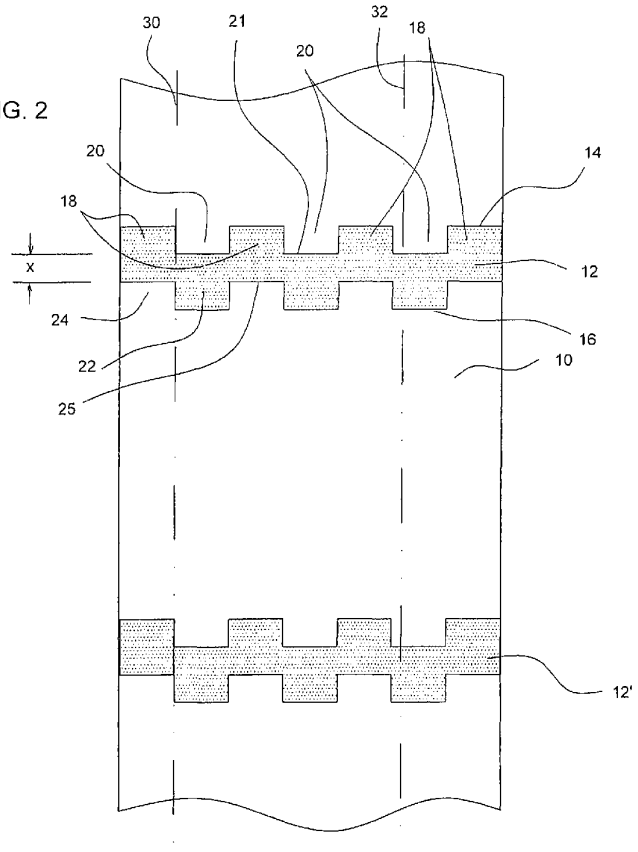
FIG. 2



(57) Abstract: A wrapper for a smoking article comprises a base web 10 having an banded region 12 the leading edge 14 of which is undulated. The wrapper preferably exhibits both low ignition propensity and reduced rates of self-extinguishment under free burn conditions.

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UNDULATED BANDED CIGARETTE PAPER

FIELD OF ART

There have been attempts to design smoking articles that extinguish when inadvertently left unattended on a substrate, and the tendency to do so is referenced herein as a smoking article having "low ignition propensity". Ideally, a low ignition propensity smoking article will continue to burn when freely suspended such as in the holder of an ashtray or when being held in the hand without puffing ("free burn"). The tendency for a cigarette to go out during free burn is referred to herein as "self extinguishment". Many prior cigarette designs that achieve low ignition propensity characteristics exhibit high rates of self-extinguishment under free burn conditions.

SUMMARY

A wrapper for a smoking article herein comprises a base web having a nominal permeability and a banded region with sufficient add-on material such that the wrapper has a permeability at the banded region less than the nominal permeability of the base web. A leading edge of the banded region as seen by an advancing coal is crenellated.

BRIEF DESCRIPTION OF THE DRAWINGS

Many objects and advantages of this disclosure will be apparent to those skilled in the art when this specification is read in conjunction with the attached drawings wherein like reference numerals are applied to like elements and wherein:

FIG. 1 is a perspective view of a smoking article according to this disclosure;

FIG. 2 is a schematic view of a wrapper paper having a first embodiment of a crenellated banded region;

FIG. 3 is a schematic view of a wrapper paper having a second embodiment of a crenellated banded region;

FIG 4 is a schematic view of a wrapper paper having a third embodiment of a crenellated banded region;

FIG. 5 is a schematic view of a wrapper paper having a fourth embodiment of a crenellated banded region;

FIG. 6 is a schematic view of a wrapper paper having a fifth embodiment of a crenellated banded region;

FIG. 7 is a schematic view of a wrapper paper having a sixth embodiment of a crenellated banded region;

FIG. 8 is a schematic view of a wrapper paper having a seventh embodiment of a crenellated banded region;

FIG. 9 is a schematic view of a wrapper paper having a eighth embodiment of a crenellated banded region; and

FIG. 10 is a schematic view of a wrapper paper having a ninth embodiment of a crenellated banded region.

DETAILED DESCRIPTION

In accordance with this description, a smoking article 1 includes a tobacco rod 2. The tobacco rod 2 may include a cut filler 3 of tobacco and is surrounded by wrapper paper 10. One end of the smoking article may include a suitable filter 4 surrounded by suitable filter tipping paper. The smoking article 1 typically may have a generally circular cross section over the length of the smoking article. Nevertheless, other cross-sectional shapes including, for example, oval, are within the scope of this description. The tobacco rod 2 has a nominal length measured from the tipping paper to the free end of the tobacco rod along a longitudinal axis of smoking article. By way of example, that nominal length may lie in the range of about 60mm to about 100mm.

The wrapper paper 10 includes a base web which typically is permeable to air. Permeability of wrapper paper is normally identified in Coresta units. A Coresta unit measures paper permeability in terms of volumetric flow rate (*i.e.*, cm^3/sec) per unit area (i.e., cm^2) per unit pressure drop (*i.e.*, cm of water). The base web for conventional wrapper paper also has well-known basis weights, measured in grams per square meter, abbreviated as "gsm". The permeability and basis weight for the base web of typical smoking article papers commonly used in the industry are set out in the table below:

Permeability, Coresta units	**Basis Weight, gsm**
24	25
33	25
46	25
60	26

For purposes of this description, the base web of a preferred wrapper paper has a permeability of at least about 20 Coresta units. Most preferably, the wrapping paper has a permeability greater than about 30 Coresta, such as common base webs having nominal permeabilities of about 33 and about 46 Coresta with a basis weight of about 25 gsm. For some applications, the base web may have a permeability of greater than about 60 Coresta, or greater than about 80 Coresta, or even higher permeability values.

It is noted for sake of convention that, in describing dimensions of various embodiments herein, that "width" of a banded region extends in a longitudinal direction of the tobacco rod, whereas a dimension in the circumferential direction of a banded region will be expressed as "transverse" or "in cross-direction" of "cross-web direction".

For purposes of this description, banded regions of add-on material as described herein are applied to the wrapper paper to obtain improved ignition propensity characteristics and also to obtain improved self-extinguishment characteristics. Ignition propensity is a standard test conducted as set forth in ASTM E 2187-04, "Standard Test Method for Measuring the Ignition Strength of Smoking articles", which is incorporated herein in its entirety by this reference thereto. Ignition propensity measures the probability that a smoking article, when placed on a substrate, will generate sufficient heat to maintain static burning of the tobacco rod. Low values for ignition propensity are desirable as such values correlate with a reduced likelihood that a smoldering smoking article will cause combustion in an underlying substrate.

Self-extinguishment herein is a reference to smoldering characteristics of a smoking article under free burn conditions. To evaluate self-extinguishment, a laboratory test is conducted at a temperature of 23°C ± 3°C and relative humidity of 55% ± 5%, both of which should be monitored by a recording hygrothermograph. Exhaust hood(s) remove combustion products formed during testing. Prior to testing, smoking articles to be tested are conditioned at 55% ± 5% relative humidity and 23°C ± 3°C for 24 hours. Just prior to testing, the smoking articles are placed in glass beakers to assure free air access.

Self-extinguishment testing takes place within an enclosure or test box. A single port smoking machine or an electric lighter is used to ignite the smoking articles for the test. During testing, an apparatus or "angle holder" holds the smoking articles to be tested by holding an end at angles of 0 degrees (horizontal), 45 degrees, and/or 90 degrees (vertical). Twenty (20) smoking articles are tested at each of the 0 degrees, 45 degrees, and 90 degrees positions. If more than one apparatus is used, the apparatuses are preferably positioned such that the smoking articles face away from each other to avoid cross interference. If a smoking article goes out before the front line of the smoldering coal reaches the tipping paper, the outcome is scored as "self-extinguishment"; on the other hand, if the smoking article continues smoldering until the front line of the smoldering coal reaches the tipping paper, then the outcome is scored as "non-extinguishment". Thus, for example, an self-extinguishment value of 95% indicates that 95% of the smoking articles tested exhibited self-extinguishment under free burn conditions; while an self-extinguishment value of 20% indicates that only 20% of the smoking articles tested exhibited self-extinguishment under free burn conditions.

The self-extinguishment value may be referred to in terms of "self-extinguishment at 0 degrees value", " self-extinguishment at 45 degrees value", or " self-extinguishment at

90 degrees value", each of which refers to the value of self-extinguishment at the specified tested angle. In addition, the self-extinguishment value may be referred to in terms of " self-extinguishment average value", which refers to an average of the three angular positions: namely, an average of (i) the " self-extinguishment at 0 degrees value", (ii) the " self-extinguishment at 45 degrees value", and (iii) the " self-extinguishment at 90 degrees value". A reference to "self-extinguishment value" does not distinguish between self-extinguishment at 0 degrees, self-extinguishment at 45 degrees, self-extinguishment at 90 degrees, or self-extinguishment average values and may refer to any one of them.

The phrases "self- extinguish under free burn conditions" or "self-extinguishment under free burn conditions" as used herein, refer to the extinguishment of a smoldering cigarette without puffing, when such cigarette is subjected or exposed to free burn conditions.

The word 'undulated' as used herein to describe the leading edge of a banded region means that the leading edge has a wave like shape. The wave like shape may be curved or composed of straight line segments, including rectangular or square, and the words encompass 'crenellated'. As used herein, the term "crenellated" refers to a pattern of multiple, regularly spaced, geometrically shaped spaces removed from an otherwise continuous solid banded region. A crenellated pattern or band can also be described as notched or appearing similar to a pulse wave. As used herein, "crenels" refers to openings, or valleys, in a crenellated edge, while "merlons" refer to raised portions, or plateaus of a crenellated edge, between crenels.

As used herein, the phrase "leading edge" refers to the edge of a banded region that is closest to an approaching coal during smoldering of a smoking article whose wrapper contains the banded region, while the phrase "trailing edge" refers to the edge of a banded region that is farthest from an approaching coal during smoldering of a smoking article whose wrapper contains the banded region. In crenellated embodiments, the overall width "W" of the banded region is measured from the furthest forward extent of the leading edge to the furthest trailing extent of the trailing edge, as is illustrated in FIG. 6 with the width "W".

A wrapper for a smoking article comprises a base web 10 (see FIG. 2), having a nominal permeability and a plurality of banded regions 12 with sufficient add-on material such that the wrapper has a permeability at the banded region less than the nominal permeability of the base web. A leading edge 14 of each banded region 12 is crenellated. Optionally, a trailing edge 16 of the banded region may also be crenellated.

While various arrangements of the crenellated regions may occur to those skilled in the art, several such arrangements are illustrated in the appended figures. For example (see FIG. 2), the banded region 12 may have a leading edge 14 in which the crenels 20 are disposed between merlons 18. In this embodiment, the merlons 18 have a dimension in the transverse direction of the base web 10 which is substantially the same as the dimension in the transverse

direction of the crenels 20. As depicted, the merlons 18 and associated crenels 20 may be generally rectangular. If desired, however, the merlons 18 and crenels 20 may have other geometric shapes including, without limitation, quadrilaterals, trapezoids, triangles, hexagons, and other regular or irregular geometric configurations. The distance between the top of a merlon 18 and the bottom of an adjacent crenel 20 may lie in the range of about 2mm to about 5mm, and preferably may be about 3mm.

At the trailing edge of the banded region 12, a similarly crenellated arrangement may also be provided. To this end, a plurality of merlons 22 may be spaced transversely across the base web 10 and separated from one another by a corresponding plurality of crenels 24. As depicted, merlons 18 of the leading edge are transversely aligned with crenels 24 of the trailing edge and crenels 20 of the leading edge are transversely aligned with merlons 22 of the trailing edge. The crenels 24 have a cross-web dimension substantially the same as the cross-web dimension of the merlons 18 at the leading edge 14 of the band. Similarly, the merlons 33 of the trailing edge 16 may have a cross-web dimension substantially the same as the cross-web dimension of the crenels 20 of the leading edge 14. The distance between the top of a merlon 22 and the bottom of an adjacent crenel 24 at the trailing edge may also lie in the range of about 2mm to about 5mm, and preferably may be about 3mm. As with the merlons 18 and crenels 20 of the leading edge 14, the merlons 22 and crenels 24 of the trailing edge may be generally rectangular, generally quadrilateral, generally trapezoidal, generally triangular, generally hexagonal, or other geometric configurations.

The bottom 21 of the crenels 20 of the leading edge 14 is preferably spaced from the bottom 25 of the crenels 24 of the trailing edge by a distance *x* lying in the range of about 2 mm to about 5 mm, and preferably in the range of about 3 mm to about 4 mm. With such an arrangement, a substantially continuous band portion of width *x* extends transversely across the base web 10. The bottom 21 of the crenels 20 of the leading edge correspond to a leading edge of the substantially continuous band portion "*x*", while the bottom of the crenels 24 of the trailing edge correspond to a trailing edge of the substantially continuous band portion "*x*". The continuous band portion "*x*" will provide a region of the base web where the wrapper paper of the smoking article experiences relatively decreased access to air, compared to regions lacking add-on material. Accordingly, the distance *x* may be adjusted to achieve a desired balance of ignition propensity performance and self-extinguishment performance.

Adjacent banded regions 12 and 12' of the paper web 10 are spaced longitudinally from one another by a nominal spacing. That nominal spacing "S" (measured between the rearmost extent of a trailing edge 16 to the forward-most extent of the most-near leading edge 14) may lie in the range of about 10mm to about 30mm. In particular, the band period, which can be dependent upon the tobacco rod length of the smoking article, can be about 27mm, meaning

the nominal spacing would be about 27mm minus the crenulated band width. The spacing minimizes total coated area (*i.e.*, area containing add-on material) in a smoking article, thereby reducing carbon monoxide (CO) levels in mainstream smoke. While the depth of the crenels 20 on the leading edge of the banded region 12 and the depth of the crenels 24 on the trailing edge of the banded region 12 are shown in FIG. 2 to be the same, it is within the scope of this disclosure to make those depths different, if desired.

The cross-directional dimensions of the merlons 18, 22 and the crenels 20, 24 may be substantially equal as depicted in FIG. 2. Preferably, however, an integral number of pairs of merlons 18 and crenels 20 have a cross-web dimension corresponding to the nominal circumference of a smoking article. For example, two sets of merlons 18 and crenels 20 may have cross-web dimensions of about 6.2mm so that two pairs of each have a total cross-web dimension of about 24.8mm, which corresponds to the nominal circumference of a smoking article. With such sizing for the merlons and crenels, when the base web 10 is split longitudinally to form bobbins of wrapper paper for smoking articles, for example at lines 30, 32, the crenellated pattern of the banded region 12 will substantially perfectly overlap at a longitudinal seam making the tobacco rod.

Stated differently, when establishing a printing pattern for a roll of crenellated (or sawtooth) paper, the pattern should repeat itself across the roll according to a transverse dimension equal to the nominal circumference of the cigarette that is to bear the pattern, even though the roll may be slit at a slightly greater dimension than the nominal circumference of the cigarette (to provide edge portions for the seam along the tobacco rod). This practice will assure establishment of the pattern as intended on the cigarette regardless of where slitting is initiated or the dimensions of the seam. For example, if the cigarette is to have a pattern of eight (8) merlons (or teeth) and the cigarette is to have a nominal circumference of the cigarette of 24.8mm, the roll of crenellated (or sawtoothed) paper would be slit every 27mm but the pattern of eight (8) merlons (or teeth) would repeat every 24.8mm.

Turning to FIG. 3, the proportions of the merlons 44 and the crenels 46 of the leading edge 40 are different from the arrangement of FIG. 2. In FIG. 3, the merlons 44 may have a cross-web dimension of about half the cross-web dimension of the associated crenel 46. Nevertheless, an integral number of pairs of merlons 44 and crenels 46 corresponds to the nominal circumference of smoking article, as discussed above. The height of the merlons 44, or depth of the crenels 46 preferably lies in the same range of values as discussed in connection with FIG. 2.

At the trailing edge of the embodiment of FIG. 3, the cross-web dimensions of the trailing edge merlons 50 and the trailing edge crenels 48 are different from the cross-web dimensions of the leading edge merlons 44 and the leading edge crenels 46. Here again, however, an integral

number of set of merlons 48 and crenels 50 have a cross web dimension corresponding to the nominal circumference of a smoking article. As shown, the cross-web dimension of the crenels 48 is substantially less than the cross-web dimension of the merlons 44 on the opposed portion of the leading edge 40. Moreover, the depth of the crenels 48, or the height of the merlons 50 lies in the range of dimensions discussed above in connection with FIG. 2. Furthermore, the spacing between the bottom of the crenels 46 on the leading edge and the bottom of the crenels 48 on the trailing edge also lies in the range of dimension discussed above in connection with FIG. 2. Spacing between adjacent banded regions 12 in FIG. 3 also lies in the same range discussed above in connection with FIG. 2.

Turning to FIG. 4, the leading edge 14 of the banded region 12 may have substantially the same characteristics discussed above in connection with FIG. 2. However, the trailing edge 64 may have merlons 60 having cross-web dimensions substantially greater than the cross-web dimensions of the opposed crenels 20 of the leading edge, while the cross-web dimensions of the trailing edge crenels 62 are substantially less than the cross-web dimensions of the corresponding opposed merlons 18 of the leading edge 14. Spacing between the crenellated leading and trailing edges in FIG. 4, and longitudinal spacing between adjacent banded regions 12 of FIG. 4 are substantially the same as described above in connection with FIG. 2.

FIG. 5 illustrates yet another embodiment of the crenellated banded regions in accordance with this disclosure. In this embodiment, the leading edge 14 may have the characteristics described above in connection with FIG. 2, or FIG. 3. In this embodiment, however, the trailing edge 70 of the crenellated banded region 12 may be straight. Spacing between the bottom of the crenels 20 and the trailing edge 70 may be selected the same as the spacing between the crenellated regions 20, 24 of FIG. 2. Moreover, adjacent banded regions 12 (FIG. 5) are preferably spaced as described in FIG. 2.

Merlons of the leading edge may have a transverse dimension in the range of about 3mm to about 7mm. For example, merlons of the leading edge may have a transverse dimension of about 3.1mm, about 4.2mm, or about 6.2mm. Crenels of the leading edge may have a transverse dimension in the range of about 3mm and about 7 mm. For example, crenels of the leading edge may have a transverse dimension of about 3.1mm, about 4.2mm, about 5.2mm, or about 6.2mm. Merlons of the trailing edge may have a transverse dimension in the range of about 6 mm and about 10 mm. For example, merlons of the trailing edge may have a transverse dimension of about 5.775mm, about 6.2mm, or about 6.775mm. Crenels of the trailing edge may have a transverse dimension in the range of about 1mm and about 7mm. For example, crenels of the trailing edge may have a transverse dimension of about 1mm, about 2.1mm, or about 6.2mm.

Still referring to FIG. 5, described in another manner, the banded region of a smoking article can comprise an undulated leading edge so as to define an interdigitated leading edge zone 114 (shown between dashed lines *z*1 and *z*2) comprising alternating regions of increased 117 and decreased 115 permeability relative to each other. The leading edge zone 114 can be crenellated, with the regions of relatively decreased permeability 115 being merlons of the crenellated leading edge zone 114 and the regions of relatively increased permeability being crenels 117 of the crenellated leading edge zone 114, which are preferably regions 117 of no or lesser applications of add-on material.

In this way, the path of the leading edge 14 is seen to undulate along the leading edge zone 114, and it is envisioned that these undulations could take other wave-forms, such as sinusoidal or triangular wave-forms, instead of a stepped wave form as shown in FIG. 5. The frequency of the undulations may be adjusted to improve SE performance.

Not wishing to be bound by theory, it is believed that the leading edge zone 114 will improve self-extinguishment performance with little to no impact on ignition propensity performance over a band of similar banded width. The regions of increased permeability 117 are believed to increase airflow to a coal as it approaches the banded region 12.

A trailing edge portion of the banded region can also be undulated so as to define an interdigitated trailing edge zone 116 comprising alternating regions of increased 117 and decreased 115 permeability relative to each other. Advantageously, the regions of relatively increased permeability can allow for relatively increased access of air to the base web of the wrapper paper of the smoking article, compared to the regions of relatively decreased permeability.

While the foregoing embodiments depict crenellated edges have a traditional notched shape, the crenellated band 12 of FIG. 6 has a different shape for the crenellated edges 80. More particularly, the crenellated edge 80 has merlons 18 that are substantially triangular. The triangular merlons 18 are separated by, and define, substantially triangular crenels 20. If desired, the trailing edge 82 of the band may be straight. Preferably, however, the trailing edge 82 of the band 12 may also have the triangular crenellation configuration described above in connection with the leading edge 80. Significantly, the bottoms of the leading edge crenels 20 are spaced longitudinally along the paper web 10 from the bottoms of the trailing edge crenels 20' by a distance *w*. Another significant feature is that the longitudinal spacing *S* between the peaks of merlons of the trailing edge 82 and the peaks of merlons of the subsequent leading edge 80' is greater than the width *w* of the continuous portion of each band 12.

The triangularly crenellated bands 12 are believed to function like conventional band in the region *w*. The crenellations coupled with the longitudinal interband spacing *S* cooperate to

reduce the carbon monoxide component of smoke in a smoking article fashioned from this wrapper paper. Moreover, by selecting the cross-web spacing *z* between the peaks of an integral number of merlons to correspond to the circumference of a smoking article to be manufactured with the paper web 10, the paper web 10 can be longitudinally slit without concern to the location of the cuts and the paper web 10 will overlay substantially precisely at a longitudinal seam of the wrapper paper. The spacing *z* may also be adjusted to achieve a desired balance of ignition propensity performance and self-extinguishment performance for the smoking article.

Similar to the crenellated band of FIG. 6, the crenellated band 12 of FIG. 7 has a crenellated edge 80 having merlons 18 that are substantially triangular, the triangular merlons 18 separated by, and defining, substantially triangular crenels 20. While, the trailing edge 82 of the band may be straight, in FIG. 7, the trailing edge 82 of the band also has the same triangular crenellation configuration as the leading edge 80. As further illustrated in FIG. 7, the band may be divided into two band portions 112, 112' that are spaced from one another by a "slit" 81. The slit 81 typically does not exceed the widths of the individual band portions 112, 112' as measured in a direction generally parallel to the axis of a smoking article having the bands. The spacing feature provides a "slit" 81 (or discontinuity) in the band structure where there is a lesser amount of or no add-on material.

FIGs. 8 and 9 each shows a crenellated bands 12 similar to that of FIG. 7, but with the band divided into three band portions 112, 112', 112" that are spaced from one another along the axis of a smoking article by a pair of slits 81, 83. Further, the slit 81 between the individual, divided band portions 112, 112' in FIG. 7 differs from the slits 81, 83 between the individual, divided band portions 112, 112', 112" in FIGs. 8 and 9. FIGs. 8 and 9 differ from each other in the widths of the individual, divided band portions 112, 112', 112", but not the width of the overall crenellated band W.

In an embodiment shown in FIG. 10, the band 12 has a different shape for the crenellated edges 80. In particular, FIG. 10 shows a leading edge that is crenated (*i.e.*, cut into rounded scallops). The scallops 19 (*i.e.*, circle segments or angular projections) can have variable or uniform widths and/or lengths. The trailing edge 82 of the band can be straight, crenellated (in accordance with any of FIGs. 1-6), or crenated. It is contemplated that the crenated band of FIG. 10 can further include a "slit" in the band structure, as illustrated in FIGs. 7-9. In addition, while not illustrated, a band structure can comprise a crenulated (*i.e.*, having an irregularly wavy or serrate outline) leading and/or trailing edge, the band optionally featuring one or more "slits".

A smoking article may comprise a tobacco rod and a wrapper as described herein. The wrapper preferably has a dimension in cross-direction that takes into account a circumference of

the tobacco rod and an overlapping seam. As a result, regardless of where the wrapper is slit, when forming the smoking article there is always an exact overlap of the crenellated pattern. Stated otherwise, dimensions in cross-direction of merlons and crenels of the crenellated banded region are determined such that on the smoking article, the leading edge of the banded region preferably comprises at least two crenels and at least two merlons. For example, the leading edge of the banded region can comprise two crenels and two merlons, three crenels and three merlons, or four crenels and four merlons. Thus, regardless of how the smoking article is placed on a substrate during ASTM testing, there is always symmetry of the banded region. Without wishing to be bound by any theory, it is believed that as the smoking article lies on the substrate during smoldering, combustion is modulated by the crenellated leading edge; specifically, merlons of the leading edge reduce the progression of the smoldering, while crenels of the leading edge allow a limited amount of smoldering to continue during free burn conditions. Accordingly, desirable self-extinguishment and ignition propensity characteristics are to be achievable.

As presently understood, the banded regions of add-on material according to this description permit a smoking article to be designed with an advantageous combination of low ignition propensity values and low self-extinguishment values. The low permeability banded regions of add-on material provide areas of film-forming compound along the length of the tobacco rod which can cooperate with a substrate to extinguish the lit smoking article when it is placed on a substrate, yet these areas of film-forming compound do not cause the smoking article to self-extinguish when the smoking article is held by a smoker in a free burn condition. Thus, the smoking article can exhibit a reduced ignition proclivity while retaining a desirable free-burn quality or low self-extinguishment value by applying banded regions of film-forming compound to the base web according to this description. The add-on material can be applied to one or to both sides of the base web.

To achieve desirable ignition propensity and self-extinguishment characteristics of the smoking article, banded regions are applied to the base web of the wrapper paper. An object of this description is to provide wrapper papers which, when formed into a tobacco rod, exhibit ignition propensity values no greater than 25 and self-extinguishment values no greater than 50. Even more preferred, is an ignition propensity value for the resulting smoking article no greater than about 15; and the most preferred ignition propensity value for the resulting smoking article is no greater than about 10. Lower self-extinguishment values are also desired. In this connection, a more preferred self-extinguishment value is less than about 25; while the most preferred self-extinguishment value is less than about 10.

The transverse dimensions of the wrapper paper are selected based on the diameter of the finished smoking article (about 7mm to about 10mm) and allowing for overlapping material

at a longitudinal seam of about 1mm to about 2mm. For example, allowing for 1mm overlapping seams, the wrapper paper dimension in cross-direction may be about 27mm for a smoking article having a circumference of about 25.6mm.

The banded regions may be formed by applying one or more layers of an aqueous film-forming composition to the base web of the wrapper paper to reduce the permeability of the paper in those banded regions. Alternatively, a cellulosic material may also be used to form the banded regions. Where a film-forming composition is used, that film-forming composition preferably may include water and a high concentration of an occluding agent, e.g., 20% to about 50% by weight. The film-forming compound can include one or more occluding agents such as starch, alginate, cellulose or gum and may also include calcium carbonate as a filler. Where starch is the film-forming compound, a concentration of about 24% may be advantageous.

The film-forming composition may be applied to the base web of the wrapper paper 24 using gravure printing, digital printing, coating or spraying using a template, or any other suitable technique. For example, the film-forming compounds and methods for applying film-forming compounds described in U.S. Application Publication No. 2007/0102017 A1, which is hereby incorporated herein in its entirety by this reference thereto, may be chosen for applying banded regions to the base web of the wrapper paper. If desired, the banded regions of add-on material can be formed by printing multiple, successive layers, *e.g.*, two or more successive layers registered or aligned with one another. Furthermore, when layers are used to form the banded regions of add-on material, the material in layers may be the same of different. For example, one layer may be starch while the next layer may be starch and calcium carbonate.

Additionally, the ability to extinguish the smoking article may depend more on providing minimum lengthwise extent of film-forming compound, rather than a particular weight per area of film-forming compound. The amount of film-forming compound used may be increased without losing a free-burn quality if a burn accelerator is applied to the paper. Preferably, the banded regions of add-on material reduce permeability of the wrapper paper to the range of from about 0 to about 10 Coresta.

A multiple stage printing apparatus as described herein typically includes a reel, first gravure printing station, second gravure printing station, third gravure printing station, collection reel, rollers, impression cylinder, backing roller, nips, reservoir, pump, heat exchanger, applicator, bath, collector, drain, doctor blade, adjustment cylinders, and idler roller.

As an alternative to a gravure printing operation, the banded regions, or stripes, can be applied to a base web using the same cellulosic material that forms the base web. The banded regions may comprise a slurry of highly refined fibrous cellulose (*e.g.*, fibers, fibrils, microfibrils, or combinations thereof) or other add-on material applied using various spray or coating techniques, including application techniques that utilize a moving orifice applicator at the

forming section of a paper-making machine as described in commonly owned US 5 997 691 and US 6 596 125, the contents of which are hereby incorporated by reference in their entirety. While in the past such technology has been used to fashion circumferentially banded regions, by adjusting the relative motion between the paper web and the moving orifice band of the equipment described in commonly owned US 5 997 691 and US 6 596 125, the banded regions of this disclosure can readily be fashioned. It is appreciated that such arrangement operates the moving orifice device at a slower belt speed which is conducive to applying broader bands and greater application rates.

The terms and phases used herein are not to be interpreted with mathematical or geometric precision, rather geometric terminology is to be interpreted as meaning approximating or similar to the geometric terms and concepts. Terms such as "generally" are intended to encompass both precise meanings of the associated terms and concepts as well as to provide reasonable latitude which is consistent with form, function, and/or meaning. The term "about" when used in connection with numerical quantities is intended to include values within a tolerance of 10% of the stated quantities.

While various embodiments have been described, it is to be understood that various modifications, variations, and equivalents may be resorted to as will be apparent to those skilled in the art. Such modifications, variations, and equivalents are to be considered within the purview and scope of the claims appended hereto.

CLAIMS:

1. A wrapper for a smoking article comprising:

a base web having a nominal permeability; and

a banded region comprising sufficient add-on material such that the wrapper has a permeability at the banded region less than the nominal permeability of the base web,

wherein a leading edge of the banded region is undulated.

2. The wrapper of Claim 1, wherein a leading edge of the banded region is crenellated.

3. The wrapper of Claim 1, wherein a trailing edge of the banded region is crenellated.

4. The wrapper of Claim 3, wherein merlons of the leading edge are transversely aligned with crenels of the of the trailing edge and crenels of the leading edge are transversely aligned with merlons of the of the trailing edge.

5. The wrapper of Claim 1, wherein crenels of the leading edge and merlons of the leading edge have transverse dimensions that are substantially the same.

6. A smoking article comprising a tobacco rod and the wrapper of Claim 1.

7. The smoking article of Claim 6, wherein the wrapper has a length in cross-direction that takes into account a circumference of the tobacco rod.

8. The smoking article of Claim 6, wherein merlons of the leading edge reduce progression of smoldering of the smoking article.

9. The smoking article of Claim 6, wherein merlons of the leading edge reduce progression of smoldering of the smoking article as a lit smoking article lies on a substrate.

10. The smoking article of Claim 6, wherein crenels of the leading edge allow a limited amount of smoldering to continue during free burn conditions.

11. The smoking article of Claim 6, wherein the leading edge comprises at least two crenels and at least two merlons.

12. A method of adjusting ignition propensity and/or self-extinguishment performance of a smoking article by adjusting a frequency of undulations in a banded region.

13. A cigarette wrapper comprising:

a base web; and

a plurality of spaced apart banded regions,

each banded region comprising an undulated leading edge so as to define an interdigitated leading edge zone comprising alternating regions of increased and decreased permeability relative to each other.

14. The cigarette wrapper of Claim 13, wherein the leading edge zone is crenellated, said regions of decreased permeability relative to said region of increased permeability being merlons of said crenellated leading edge zone, said regions of increased permeability relative to said region of decreased permeability being crenels of said crenellated leading edge zone.

15. The cigarette wrapper of Claim 13, wherein a trailing edge portion of the banded region is undulated so as to define an interdigitated trailing edge zone comprising alternating regions of increased and decreased permeability relative to each other.

FIG. 1

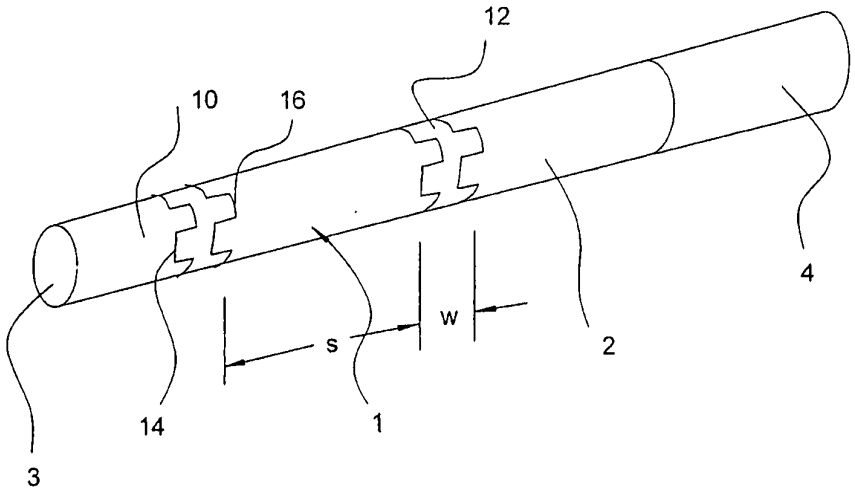

FIG. 2

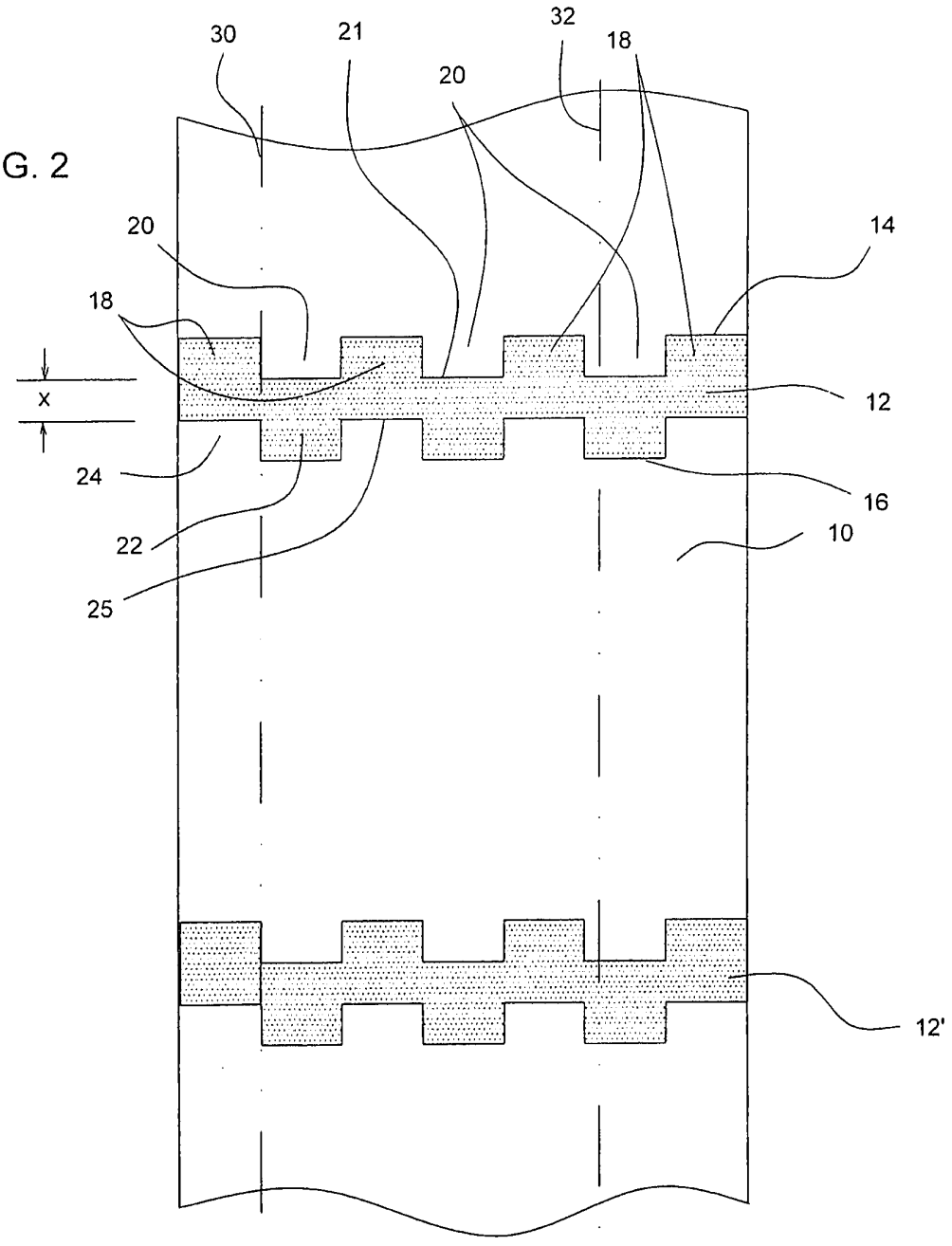

FIG. 3

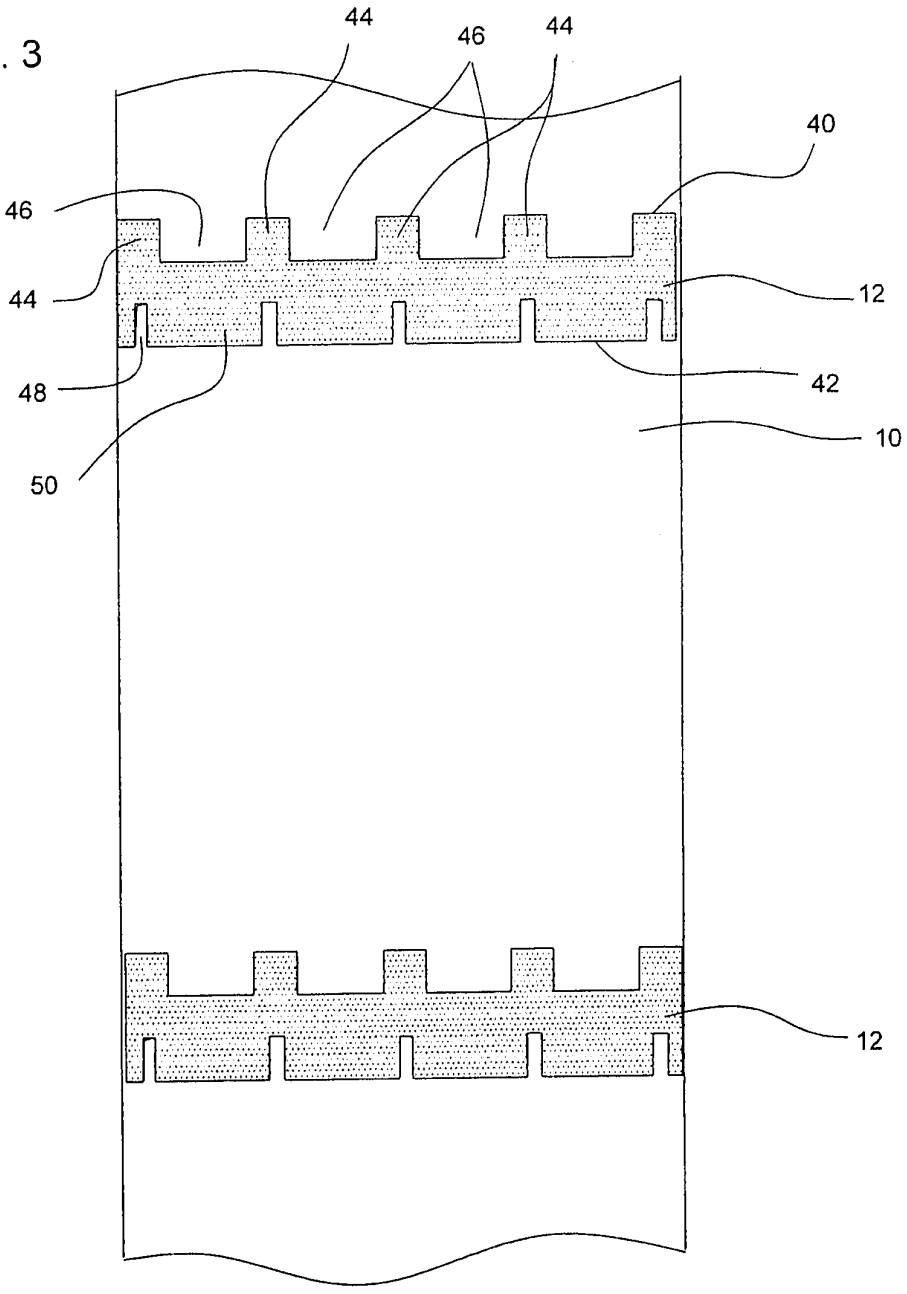

FIG. 4

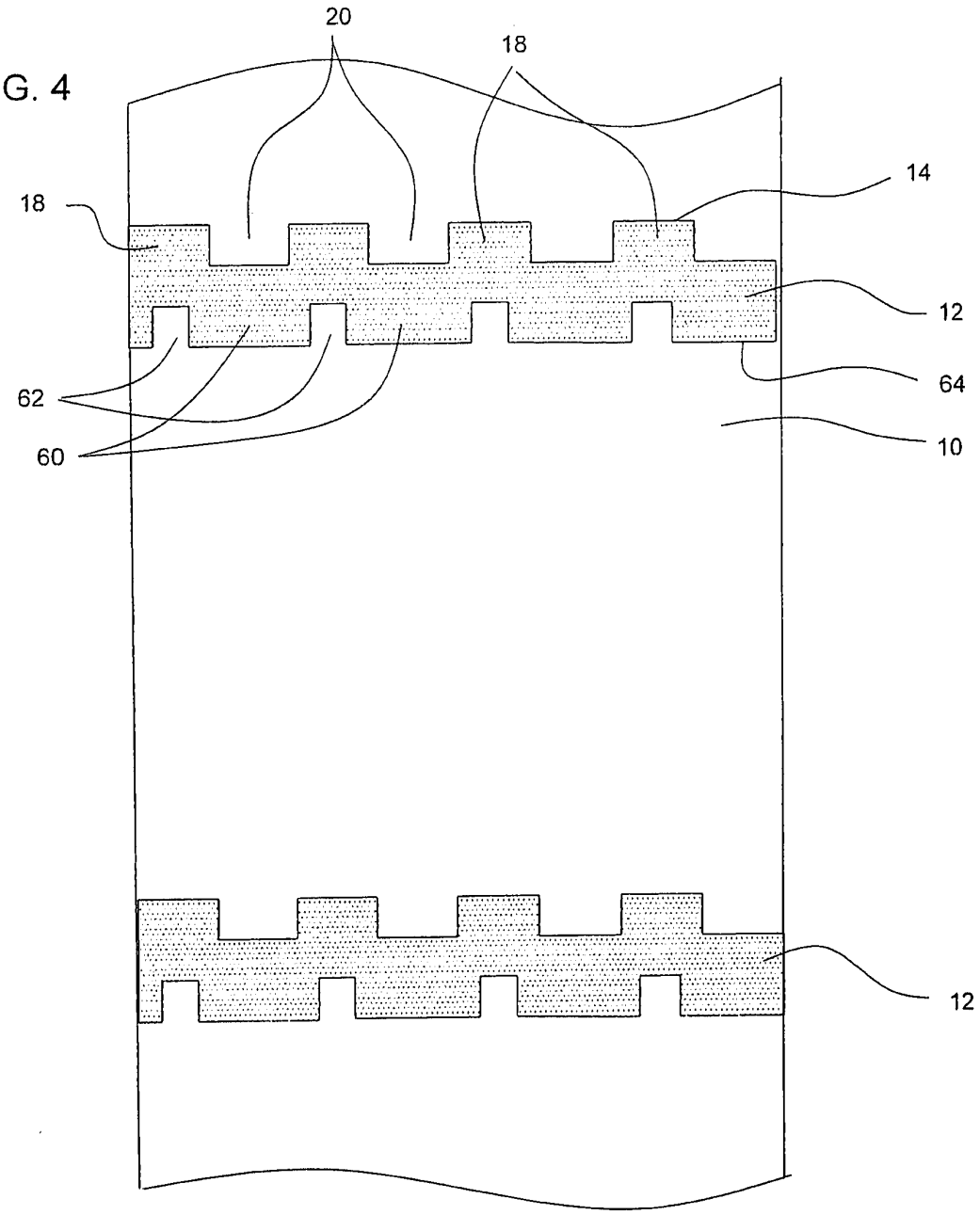

FIG. 5

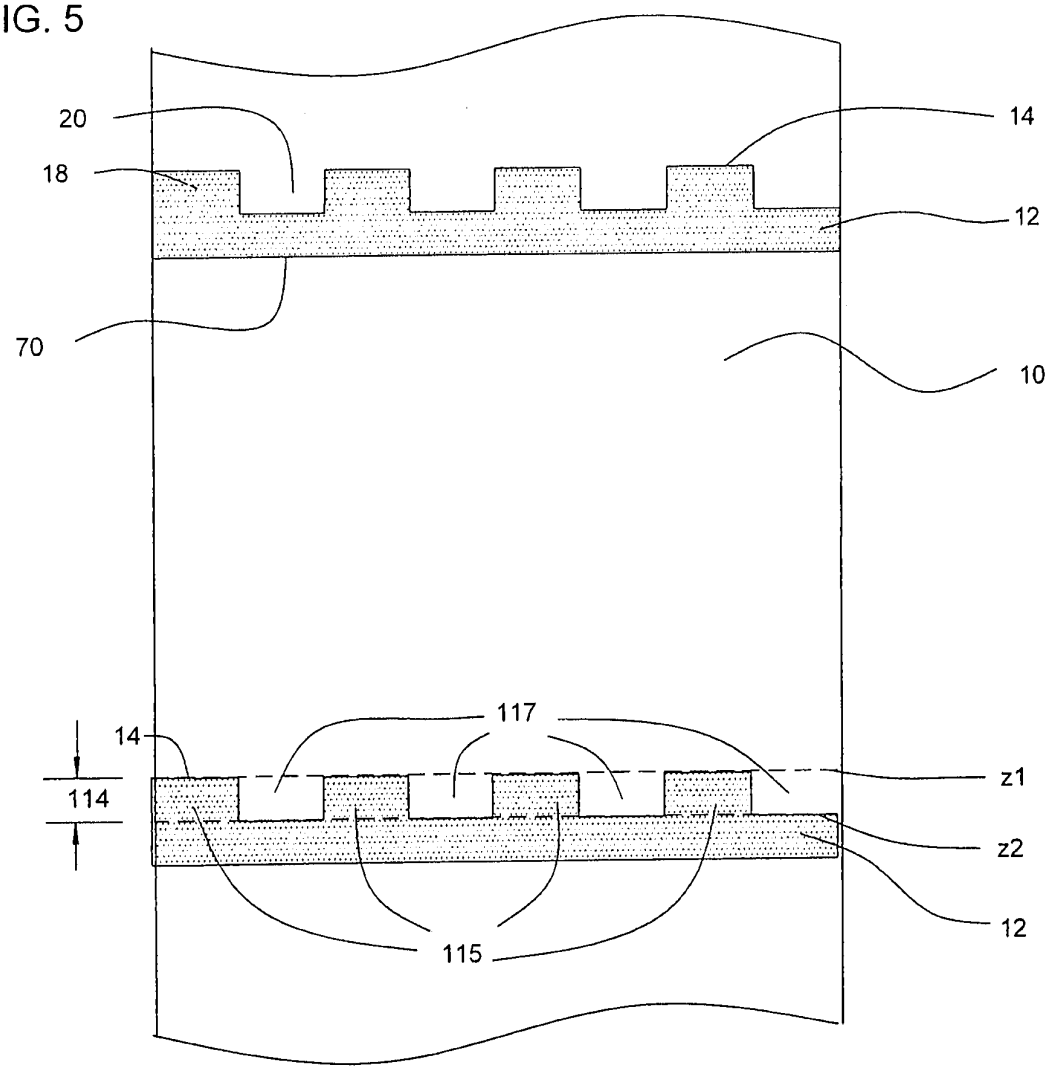

FIG. 6

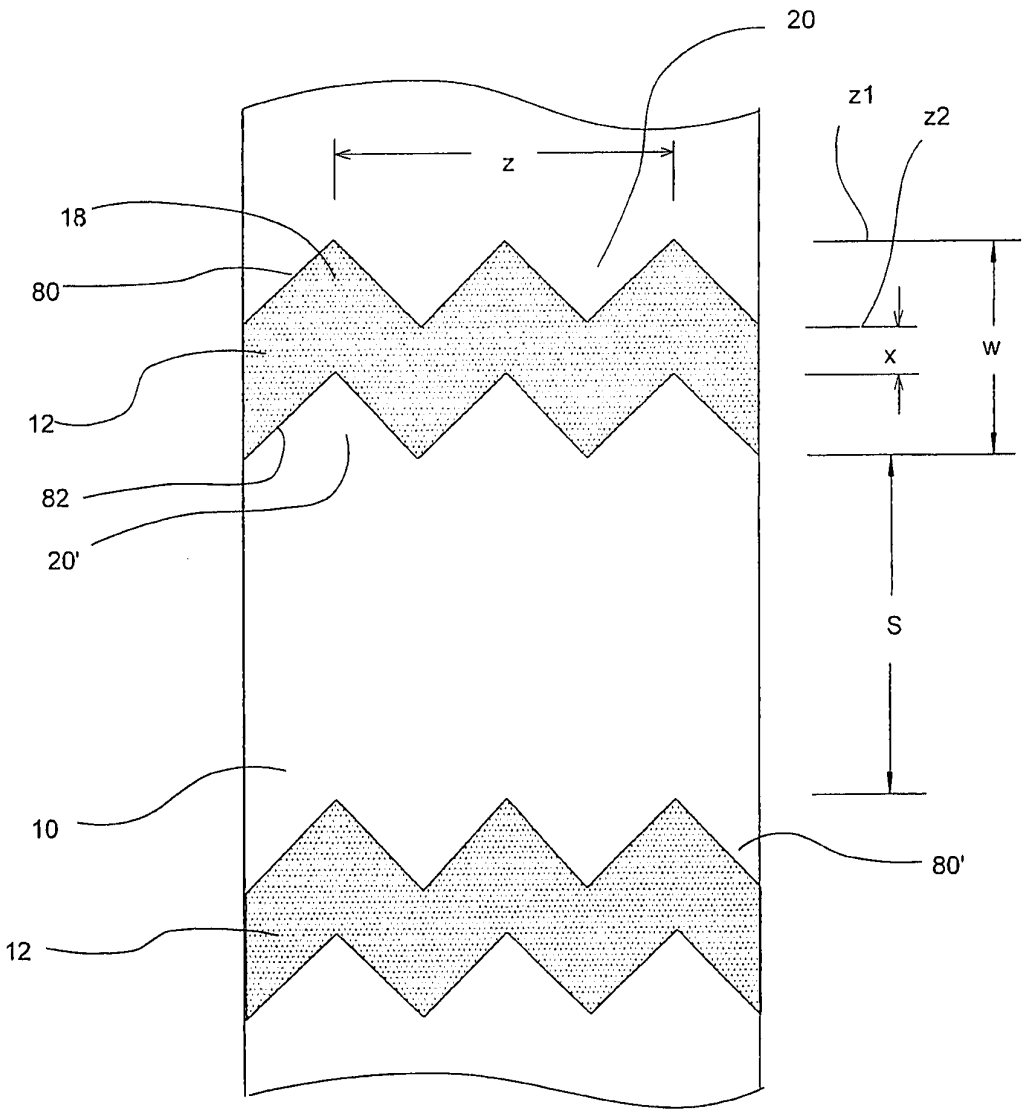

FIG. 7

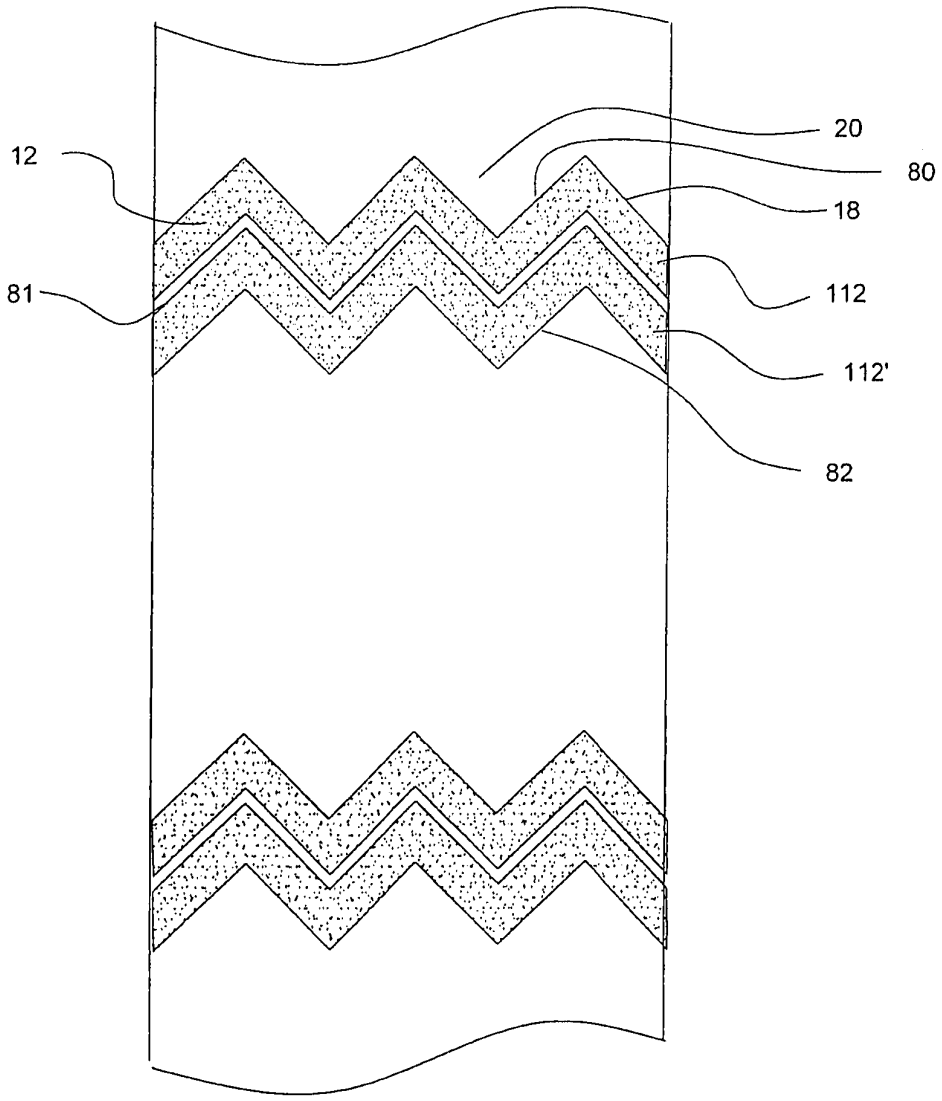

FIG. 8

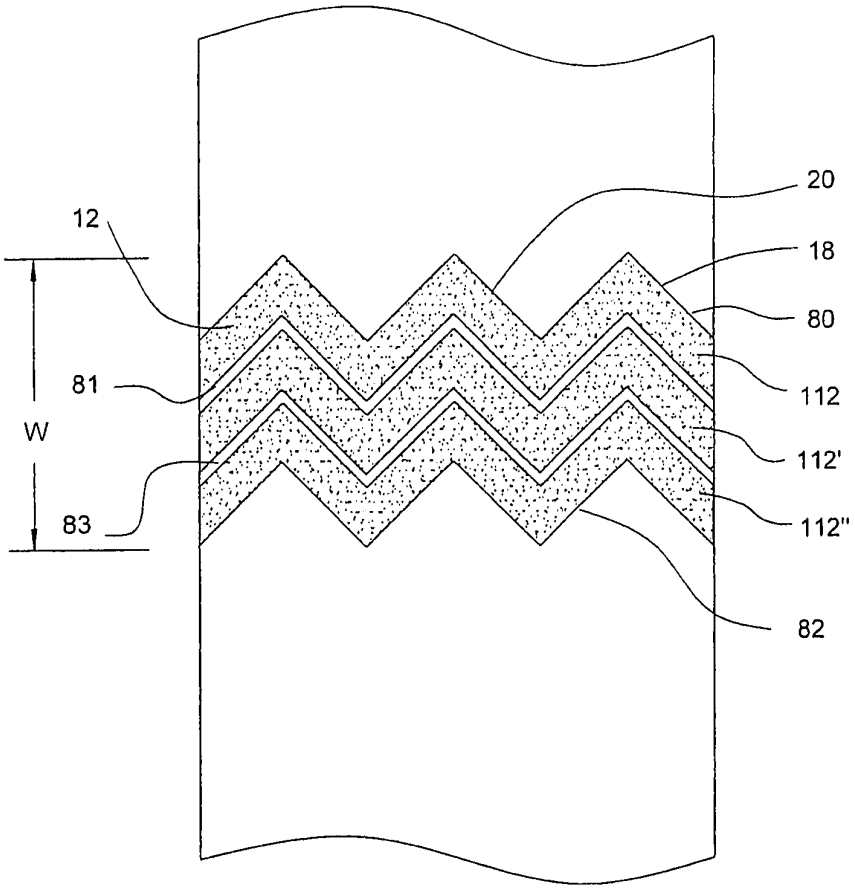

FIG. 9

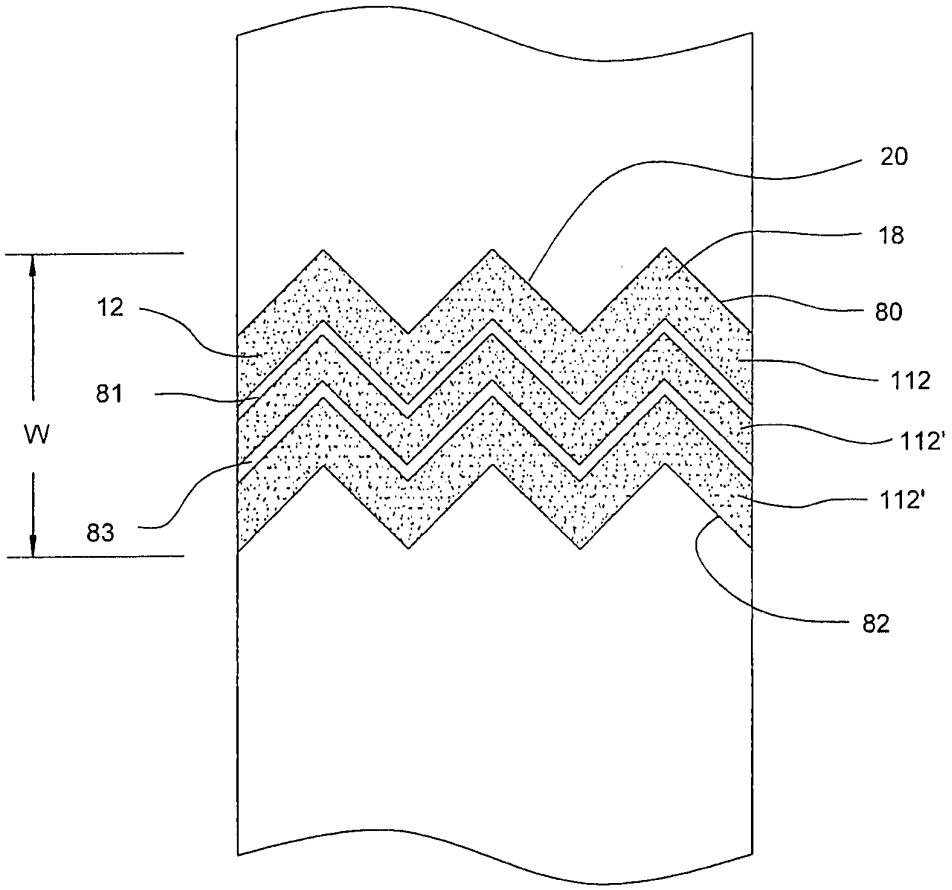

FIG. 10