Feb. 22, 1955 E. I. BARTH 2,702,760

METHOD OF APPLYING METALLIC STRIPES TO A WEB OF PAPER

Filed April 25, 1951

FIG. 1

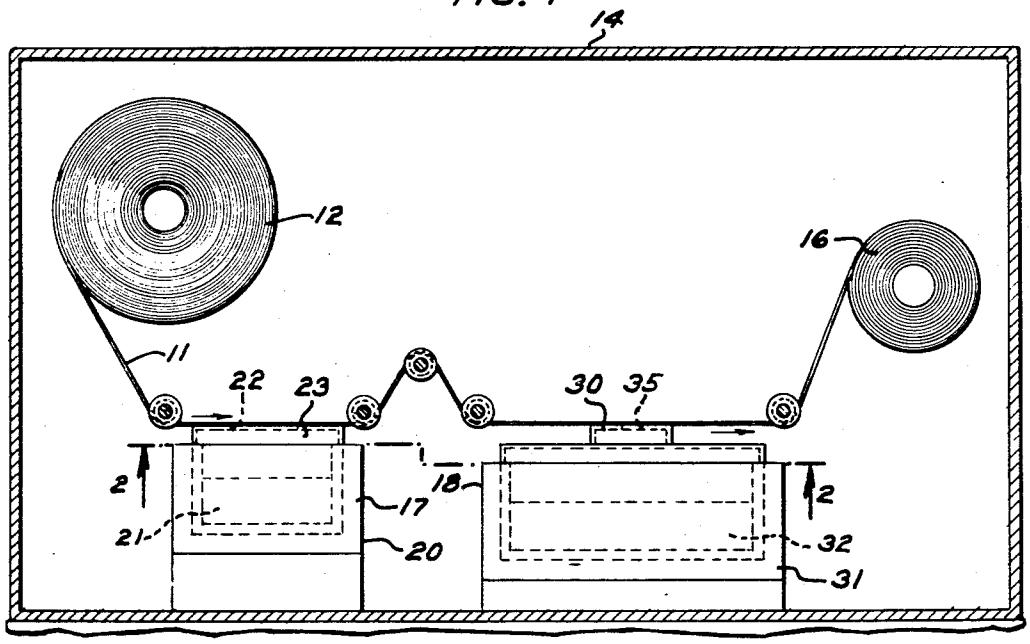


FIG. 2

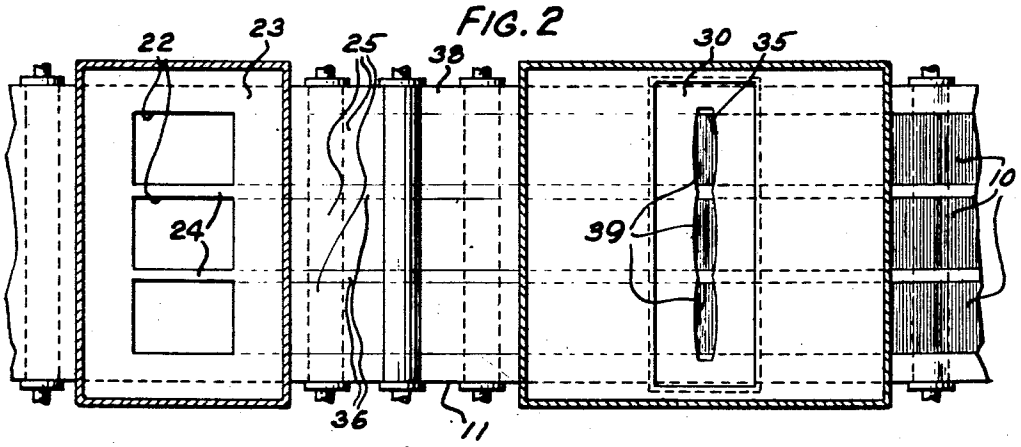
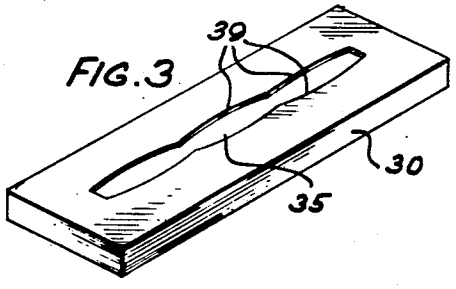


FIG. 3



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METHOD OF APPLYING METALLIC STRIPES TO A WEB OF PAPER

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8 Claims. (Cl. 117—38)

This invention relates to methods of and apparatus for coating articles, and more particularly to methods of and apparatus for sputtering metal coatings on elongated strips of insulating material.

In the manufacture of strips of paper having a plurality of stripes or bands of metal extending along one face thereof and separated from each adjacent band for use in making condensers, it has been very difficult to apply such bands of uniform thickness from edge to edge of each band. It has been proposed in the past to completely mask each portion of the strip separating the bands. However, when this is done, heavier deposits of metal have been built up at the edges of the stripes than at the central portions of the stripes, particularly when the portions to be striped have seeding particles thereon to facilitate precipitation of the primary coating metal.

An object of the invention is to provide new and improved methods of and apparatus for coating articles.

Another object of the invention is to provide new and improved methods of and apparatus for applying stripes of metal coatings to elongated strips of insulating material.

A further object of the invention is to provide methods of and apparatus for forcing finely divided metal particles toward a strip while differentially masking the strip to form bands uniform in thickness from edge to edge.

In a method illustrating certain features of the invention, a strip of insulating material having seeded bands separated by uncoated stripes is advanced past a metal vaporizer, and the portion of the strip passing the vaporizer is masked differentially less proceeding from the uncoated portions toward the central portions of the stripes.

A complete understanding of the invention may be obtained from the following detailed description of a method and an apparatus forming specific embodiments thereof, when read in conjunction with the appended drawings, in which

Fig. 1 is a vertical section of an apparatus for practicing a method forming a specific embodiment of the invention;

Fig. 2 is a horizontal section taken along line 2—2 of Fig. 1, and

Fig. 3 is a perspective view of a portion of the apparatus shown in Fig. 1.

Referring now in detail to the drawings, there is shown therein an apparatus for applying stripes or bands 10—10 of metal to a web or strip 11 of insulating material, such as, for example, thin paper coated within cellulose acetate butyrate on the face to be metallized, to form components of condensers. The strip 11 is advanced continuously from a supply roll 12 mounted in a chamber 14, the interior of which is kept at a very low absolute pressure of from 0.25 to 0.5 millimeter of mercury. The paper is taken up on a takeup roll 16 and is advanced continuously over a seeding applicator 17 and a metallizing applicator 18. The applicator 17 includes a heated chamber 20, which has a supply of a seeding metal 21 therein heated to the point of vaporization. The vaporized seeding metal, which may be silver, nickel, copper or the like, passes through openings 22—22 formed in a nozzle 23 and separated by solid masking strips 24—24 to form very thin seeding bands 25—25 on the strip, which are the same width as the bands 10—10.

The striped paper passes from the applicator 17 over a nozzle 30 of the metallizing applicator 18, which includes a heated chamber 31 having a supply of molten metal 32, such as zinc, aluminum or other suitable sputtering metals. The metal is maintained at or near the boiling temperature thereof so that the metal is volatilized and projected toward the nozzle 30 continuously. The nozzle 30 has an orifice 35 therein, which tapers from wide at the portions thereof over which the central portions of the bands 25—25 pass to narrow at portions thereof over which uncoated stripes 36—36 and uncoated edges 38—38 of the strip pass. Opposed pairs of intersecting arcs 39—39 form the orifice 35. Consequently, the outer edges of the bands 25—25 and the uncoated stripes 36—36 are masked greater than the central portions of each of these bands. However, the vaporized metal 32 projected through the orifice 35 moves from the spaces aligned with the uncoated stripes 36—36 into the edge portions of the seeded bands 25—25. The proportions of the exposed areas of the edge portions of the bands 25—25 relative to the exposed areas of the central portions of the bands 25—25 are such that the thickness of the metal precipitated on the bands is uniform in thickness from edge to edge. The strip 11 is advanced over the applicator 18 sufficiently rapidly that the metal projected through the nozzle 30 coats only the seeded bands 25—25, does not adhere to the uncoated stripes 36—36 or uncoated edge portions 38—38 of the strip 11, and damage to the strip 11 from heat of the applicators and the volatilized metal is prevented.

A strip of paper and cellulose acetate butyrate forming the surface to be coated was advanced over the applicators 17 and 18 continuously at a rate of speed of about 1500 feet per minute. The combined thickness of the paper and the cellulose acetate butyrate was in the order of 0.0003 inch. The interior of the chamber 14 was maintained under absolute pressure of 0.1 millimeter of mercury, and zinc in the applicator 18 was maintained at a temperature of about 1100° F. Silver in the applicator 17 was maintained at a temperature of approximately 1750° F. Silver was applied uniformly to the portions of the strip to be metallized in a quantity of the order of one molecular layer, and zinc was applied in uniform thickness to the bands 25—25 in the quantity of 0.00004 gram per square centimeter to form continuous, smooth, dense deposits of uniform thickness across the entire widths of the bands 25—25. The thickness of each of the bands 10—10 form one edge thereof to the opposite edge thereof and along the entire length of the strip was uniform, and there were sharp lines of demarcation at the edges of the bands between the metallized portions and the uncoated separating stripes 36—36 and edge portions 38—38 of the strip 11.

A lacquered strip of paper was advanced over the applicators 17 and 18 at a rate of speed of about 1500 feet per minute. The chamber 14 was maintained under an absolute pressure of about 0.1 millimeter of mercury, and aluminum in the applicator 18 was kept at a vaporization temperature. Silver in the applicator was kept at its vaporization temperature for the pressure of the chamber 14. Smooth, dense, fine-grained bands of aluminum uniform in thickness from edge to edge were formed and sputtered onto the strip through the nozzle with the unseeded portions on the strip kept entirely free of metal.

The nozzle 18 used in the above-described examples had an orifice 9¾ inches long in transverse cross-section and at the widest points thereof was ⅝ inch wide, while at the narrowest points thereof was ½ inch wide. The orifice was formed by three pairs of opposed arcs of a radius of 19 1/16 inches. The bands 10—10 formed by the nozzle were 2.692 inches wide and were separated by uncoated stripes 36—36 0.326 inch in width. The thickness of the metal plate in which the orifice was formed was 0.062 inch, and the nozzle was composed of type 300 stainless steel.

It is to be understood that the above-described arrangements are simply illustrative of the application of the principles of the invention. Numerous other arrangements may be readily devised by those skilled in the art which will embody the principles of the invention and fall within the spirit and scope thereof.

What is claimed is:

1. The method of coating articles, which comprises advancing a strip of material having very thin seeded

bands of a metal of the group consisting of silver, copper and nickel separated by unseeded stripes extending therealong continuously along a predetermined path, directing a vaporized coating of a metal of the group consisting of zinc and aluminum toward the strip at one portion of the path, and simultaneously masking all the strips at said portion of the path except a band across said portion that is narrow at the unseeded stripes and increases in width from the stripes toward the central portions of the seeded bands, whereby the second metal coats the bands uniformly from edge to edge without greater thickness at the edges.

2. The method of forming metallized strips of paper, which comprises advancing a strip of paper along a predetermined path, continuously applying vaporized silver at one point in said path to portions of the strip spaced laterally from one another to form very thin seeded bands on the strip spaced apart by uncoated stripes, directing vaporized zinc toward the strip at a subsequent point in the path, and simultaneously masking the strip incrementally less at said point from the uncoated stripes toward the centers of the seeded bands, whereby such difference in masking overcomes any tendency of the zinc to be deposited more quickly at the edges of the band and results in a uniform thickness of coating across the width of the bands.

3. The method of making metallized paper, which comprises continuously advancing a strip of paper over a silver chamber and a zinc chamber, continuously directing vaporized silver in the silver chamber at the strip to coat the strip very thinly, completely masking laterally spaced portions of the portion of the strip being advanced over the silver chamber to form uncoated stripes separating the coated portions, directing vaporized zinc in the zinc chamber toward the strip to coat the strip, continuously exposing substantially the entire width of the strip to the vaporized zinc with the length of exposure of the strip to the vaporized zinc being a minimum at the uncoated stripes and increasing toward the center of each coated portion, whereby thicker deposits of zinc at the edges of coated portions are prevented and the zinc is deposited in uniform thickness across the coated portions.

4. The method of applying zinc to strips of paper, which comprises advancing a strip of paper having very thin silver bands separated by unmetallized stripes extending therealong continuously along a predetermined path, directing vaporized zinc toward the strip at one portion of the path, and simultaneously masking all the strip at said portion of the path except a band across said portion that is narrow at the unmetallized stripes and increases in width from the stripes toward the central portions of the silvered bands, whereby the zinc coats the bands uniformly from edge to edge and thicker deposits at the edges of the bands are prevented.

5. The method of forming metallized strips of paper, which comprises continuously advancing a strip of paper along a predetermined path, creating low pressure around said path, continuously directing vaporized silver to portions of the strip spaced laterally from one another at one point in said path to form very thin seeded bands on the strip spaced apart by uncoated stripes, vaporizing and directing zinc toward the strip at a subsequent point in the path, and continuously masking the strip incrementally less at said second point from the uncoated bands toward the centers of the seeded bands, whereby thickened edge portions of zinc are prevented and the zinc is deposited in layers uniform in thickness from edge to edge of each layer.

6. The method of forming metallized strips of paper, which comprises advancing a strip of paper having a facing of plastic insulating material along a predetermined path, maintaining the area surrounding the path at a low pressure, continuously projecting vaporized silver against portions of the face of the strip spaced laterally from one another at one point in said path to form very thin seeded bands on the strip spaced apart by uncoated strips, continuously projecting vaporized zinc toward the face of the strip at a subsequent point in the path, and continuously masking the strip at said second point incrementally less from the uncoated stripes toward the centers of the seeded bands, whereby the zinc is deposited with uniform thickness from edge to edge of the seeded bands.

7. The method of metallizing strips, which comprises continuously advancing a strip of insulating material along a predetermined path in a predetermined direction, maintaining the space surrounding said path in a high vacuum, continuously directing toward the strip at one point in the path a vaporized metal of the group consisting of silver, nickel and copper adherent with respect to the strip at such a rate of deposition as to form an imperceptibly thin deposit of the metal of a thickness in the order of one molecular layer on the strip to form a band thereon, continuously directing toward the strip at a subsequent point in the path a second vaporized metal of the group consisting of zinc and aluminum adherent to the first metal, and simultaneously partially masking the portion of the strip continuously at said second point incrementally less from the edges of the band toward the center of the band to deposit the second metal uniformly on the band, whereby such differential masking overcomes any tendency of the coating of the second metal to be thicker at the edges and is of uniform thickness across the width of the band.

8. The method of metallizing strips, which comprises continuously advancing a strip of insulating material along a predetermined path in a predetermined direction, maintaining the space surrounding said path in a high vacuum, continuously directing toward the strip at one point in the path vaporized silver at such a rate of deposition as to form an imperceptibly thin deposit of the silver on the strip to form a band thereon of a thickness in the order of one molecular layer, continuously directing zinc toward the strip at a subsequent point in the path, and simultaneously partially masking the portion of the strip continuously at said second point incrementally less from the edges of the band toward the center of the band to deposit the zinc uniformly on the band to prevent thicker deposits of the zinc at the edges of the band and cause the deposits of zinc to be uniform in thickness from edge to edge of the band.

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