United States Patent

[11] **3,602,190**

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[21] Appl. No. **771,725**
[22] Filed **Oct. 30, 1968**
[45] Patented **Aug. 31, 1971**

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[54] **MULTIPLE VAPORIZING SYSTEM**
3 Claims, 1 Drawing Fig.

[52] **U.S. Cl.** **118/5,**
118/8, 118/48, 219/272, 324/65
[51] **Int. Cl.** **B05c 11/00**
[50] **Field of Search** 118/1, 4, 7,
9, 5, 8, 6, 11; 324/61 RP, 61 SP, 61 TB, 65 RP;
340/259

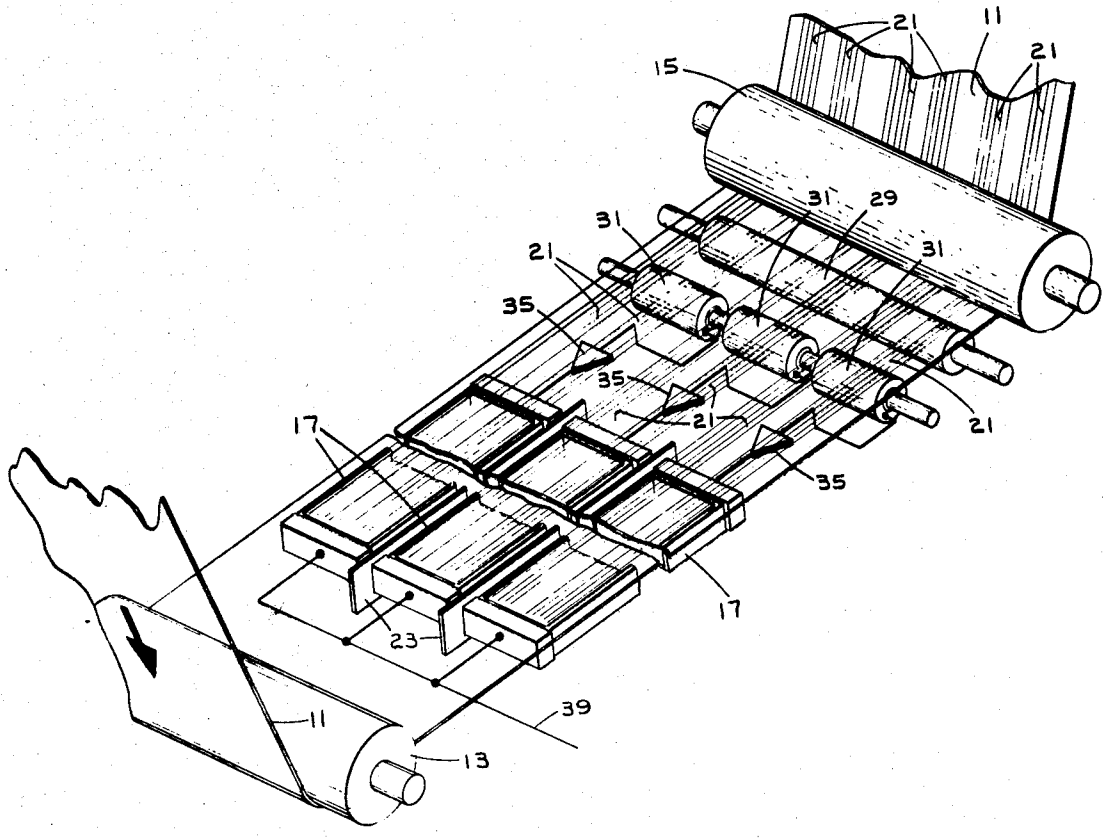
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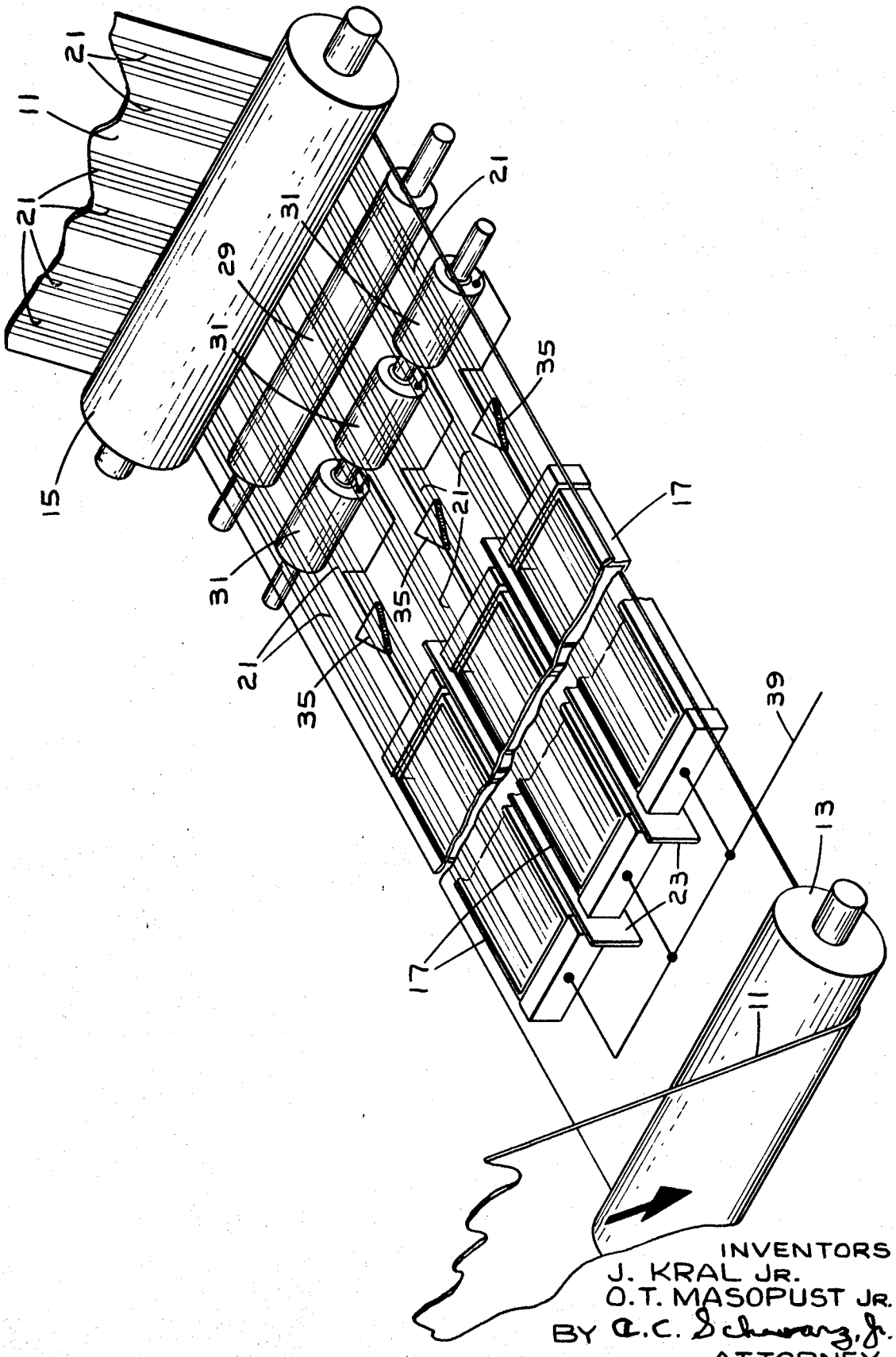
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ABSTRACT: An apparatus for depositing a metal coating on a wide strip of dielectric material wherein the thickness of deposition is maintained uniform across the width of the dielectric by vaporizing the metal in a plurality of individually controlled electric pots positioned across the width of the dielectric strip and wherein the energy supplied to each individual pot is controlled by an individual circuit sensing the resistance of the deposited metal at a lateral position across the width of the dielectric that is the same as the lateral position of the associated vaporizing pot that the circuit controls.



PATENTED AUG 31 1971

3,602,190



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MULTIPLE VAPORIZING SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to the deposition of metal and, more particularly, to the vapor deposition of metal on a moving, dielectric strip.

2. Description of the Prior Art

In the manufacture of deposited-electrode capacitors, a wide sheet or web of dielectric material in roll form is placed in a vacuum chamber and is unwound and passed first over a refactory vaporizing pot containing molten silver. Silver vapor condenses on the moving dielectric to form a very thin, seeding film. The top of the silver-vaporizing pot is masked to limit the silver deposition to a plurality of narrow longitudinal stripes on the dielectric. The dielectric then passes over a refractory vaporizing pot containing molten zinc. Zinc vapor condenses onto the surface of the moving dielectric material in the longitudinal stripes that have been seeded with silver. The sheet dielectric material is then wound onto a takeup roll, removed from the vacuum chamber, and slit into thin strips each having one metal stripe thereon. These thin, metallized strips are then wound into capacitors. Such a process is more completely described in U.S. Pat. No. 2,702,760 granted to E. I. Barth on Feb. 22, 1955.

To increase the productivity of this metallizing process, the dielectric sheets have been widened considerably with a great many metallized stripes being deposited simultaneously across the width of a sheet. Difficulty has been experience in the manufacture of capacitors of this material because it is difficult to assure a uniform thickness of deposited metal across the width of these wider sheets of dielectric material with the zinc vaporizing pots now in use. These prior zinc vaporizing pots are controlled by roller contacts positioned downstream of the vaporizing pot, these rollers being used to measure the average electrical resistance of the metal coating across the whole sheet of dielectric material as it is moved past the coating is then used to control the amount of electrical energy supplied to the zinc vaporizing pot in order to control thereby the average thickness of the coating applied to the dielectric material.

In order to prevent overheating of the dielectric material from the heat of vaporization received from the condensing zinc, a minimum thickness of coating, consistent with electrical continuity, is desired. However, when an adequately thick coating of deposited zinc is available in one area of the dielectric material, an insufficient thickness of deposited metal may exist at another area of the material. The area of highest heating, in practice, is not always predictable. Such nonuniformity over a single, wide area in the coating of a dielectric sheet is intolerable in the manufacture of low cost, high quality capacitors. One means for controlling the relative thickness of deposition is shown in the Barth patent mentioned above. This patent discloses a mask for the vaporizing pot which controls the relative amounts of time that adjacent areas of the sheet are exposed to the metal vapors. However, the Barth patent does not compensate for nonuniform local heating of the vaporizing pot that usually occurs over the width of a wide dielectric sheet, but rather, only compensates to promote uniform thickness of metal deposition across the width of a single stripe of metal.

Therefore, it is an object of the present invention to deposit a more uniform thickness of electrically conductive metal across the width of a sheet of dielectric material.

SUMMARY OF THE INVENTION

In accordance with the present invention, an apparatus for applying a metal coating to a sheet of dielectric material is provided with a plurality of individual pots for vaporizing the metal wherein the pots are arranged in a row that is substantially perpendicular to the path of movement of the dielectric material and wherein means are provided downstream of the pots and associated with each pot for sensing the thickness of the coating applied to the dielectric material by that pot and wherein there are means responsive to the sensing means and individually associated with each pot for controlling the amount of energy delivered to each individual pot.

DESCRIPTION OF THE DRAWINGS

A more thorough understanding of the present invention may be had by referring to the following detailed description when considered in conjunction with the accompanying drawing which shows a schematic view in perspective of a zinc-deposition portion of a metal-depositing apparatus having several vaporizing pots, electrical sensing contacts and current amplifiers controlling the individual vaporizing pots.

DETAILED DESCRIPTION

Referring now to the drawing, the vacuum chamber and the silver vaporizing pot have been omitted for clarity; but it is to be understood that metal deposition described herein is performed in a vacuum and that the surface of the dielectric sheet is first given a seeding coating of silver in stripes as it passes over a masked vaporizing pot of molten silver to facilitate subsequent coating with zinc. The drawing shows a continuous sheet of dielectric material **11** (usually a polyester film) that is taken from a supply roll (not shown) to a takeup roll (also not shown) on a pair of continuously rotating rollers **13** and **15**. The sheet **11** is carried past three long, trough-shaped, zinc vaporizing pots **17**, each of which is arranged longitudinally with the path of movement of the dielectric sheet **11**. The three pots **17** are arranged side-by-side across the width of the dielectric **11** in order to deposit a total of six individual stripes **21** of zinc on the bottom surface of the dielectric sheet in three different locations across the width of the dielectric sheet, each location being that part of the sheet that passes over a given one of the three pots **17**. the zinc vapor condenses and coats the dielectric material preferentially in the stripes that have been seeded with silver. However, if there is excessive coating between the stripes **21**, the pots **17** can also be masked.

Two individual baffle fins **23** separate the pots **17** in order to prevent zinc vapor from migrating from the region immediately above one pot to the dielectric sheet passing over another pot.

Somewhat downstream of the pots **17**, a common contact roller **29** makes an electrical connection with each of the six stripes **21** of zinc on the bottom surface of the dielectric sheet **11**. At a predetermined distance from the common roller **29**, each of three individual contact rollers **31** engages and makes electrical contact with two of the six zinc stripes **21**. The amount of current flowing between the common roller **29** and any given one of the contact rollers **31** is inversely proportional to the resistance of the two zinc stripes extending between the rollers. Therefore, these contact rollers, when connected across a voltage source, effectively measure the resistance of the predetermined length of the zinc stripes extending between them.

The individual rollers **31** are connected to three current-amplifier-inverters **35**, each of which, in response to the current passing through the two associated zinc stripes **21** (and thus their average electrical resistance) delivers a large electrical energy to one end of its associated pot **17**. A current passes through the pot, heats the zinc, and goes to a common return **39**.

If the average thickness of a given pair of stripes of zinc is less than a predetermined amount, the resistance between the contact roller **29** and the associated contact roller **31** is therefore higher than a predetermined value; and the current passing through the associated contact roller **31** is thereby less than that expected by the associated current-amplifier-inverter **35**. In response thereto, the amplifier-inverter increases the amount of current supplied to the associated pot **17**, thereby increasing the vapor density above that pot, which in

turn increases the thickness of the coating of zinc deposited in the associated location on the dielectric sheet **11**.

It can be seen that the common contact rollers **29** and **31**, together with the current-amplifier-inverter **35** and the individual pots **17** form three independent, closed-loop vapor-deposition, feedback-control systems, each capable of depositing a predetermined thickness of zinc on the surface of the sheet **11**.

Since each pair of stripes **21** that is deposited on the dielectric sheet **11** is individually controlled, spurious variations in the thickness of deposition across the width of the sheet **11** are minimized; because, uncontrolled variation in the thickness of the deposited metal can occur only across the width of a given zinc pot **17** instead of across the entire width of the sheet **11**.

While three vaporizing pots **17** have been shown for depositing metal on a dielectric sheet, two, four or more pots may be used as conditions warrant in order to secure an acceptably uniform thickness of coating on the dielectric sheet. Similarly, while each pot has been shown depositing two stripes on the dielectric sheet, applications may exist wherein each pot may be capable of depositing only one stripe with acceptable uniformity; or each pot may be able to deposit three or more stripes of uniform thickness.

It is to be understood that the above-described arrangements are simply illustrative of the application of the principles of this invention. Numerous other arrangements in addition to those specifically mentioned above 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. An apparatus for applying an electrically conductive metal coating to a sheet-dielectric material, including an enclosed chamber adapted to be maintained at an internal pressure substantially less than atmospheric, and means for moving the sheet dielectric material in a path within the chamber, wherein the improvement comprises:

a plurality of individual pots for vaporizing the electrically conductive metal, each of said pots associated with a different location across the width of the sheet-dielectric material;

means located downstream of said pots along the path of movement of the sheet-dielectric material and associated with each pot for sensing the thickness of the coating applied to the sheet dielectric material at the location across the width of the sheet-dielectric material at which the associated pot is located;

said sensing means comprising means for measuring the resistance of the coating applied to the sheet-dielectric material over a predetermined length of the material

said measuring means comprising a first contact common to all areas of the sheet-dielectric material across the width of the material and a plurality of second contacts displaced longitudinally from the first contact along the length of the sheet-dielectric material, each of said second contacts being individual to a predetermined location across the width of the sheet material, and

means responsive to the sensing means and independently associated with each pot for applying a controlled amount of energy thereto in order to control the amount of metal vapor generated so as to maintain a uniform, predetermined thickness of metal coating at each location across the width of the sheet-dielectric material.

2. An apparatus according to claim **1** wherein said pots are electrically heated and wherein said energy applying means comprises an electronic amplifier and inverter individual to each pot.

3. An apparatus according to claim **1** wherein said energy applying means comprises a resistance-responsive amplifier for increasing the electrical energy applied to said associated pot in response to the measurement of a resistance higher than a predetermined value, and for decreasing the energy applied to said associated pot in response to the measurement of a resistance lower than a predetermined value.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,602,190 Dated August 31, 1971

Inventor(s) J. Kral, Jr. - O. T. Masopust, Jr. (Case 2-1)

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 13, "refactory" should read --refractory--. Column 1, line 31, "experience" should read --experienced--. Column 1, line 40, "station. This average resistance of the zinc coating" should follow "ing". Column 2, line 37, "the" should read --The--.

Signed and sealed this 25th day of April 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents