United States Patent

Mishler

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[54] APPARATUS FOR REPETITIVELY APPLYING COATINGS TO A SUBSTRATE

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[52] **U.S. Cl.** **118/412,** 118/413, 118/415

[51] **Int. Cl.** **B05c 3/18,** B05c 3/20

[58] **Field of Search** ..... 118/411, 412, 413, 415, DIG. 9

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[57] **ABSTRACT**

An apparatus for repetitively striping the surface of a dielectric substrate with two or more micro-thin coatings from a single applicator station with each coating of substantially even thickness and interconnected along adjacent edges, each coating being formed from a flowable viscous plastic material having a dispersion of particles therein that exhibit discrete electrical properties so that there is formed a thin line overlapped junction between adjacent edges with the junction providing uniform and improved electrical characteristics.

10 Claims, 8 Drawing Figures

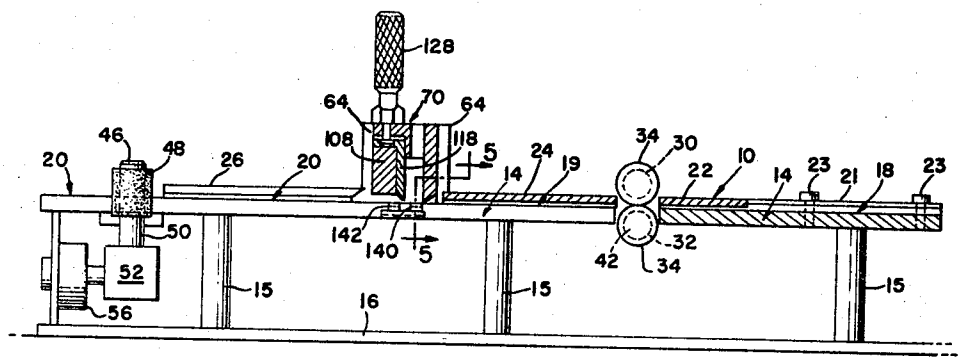

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FIG. 1.

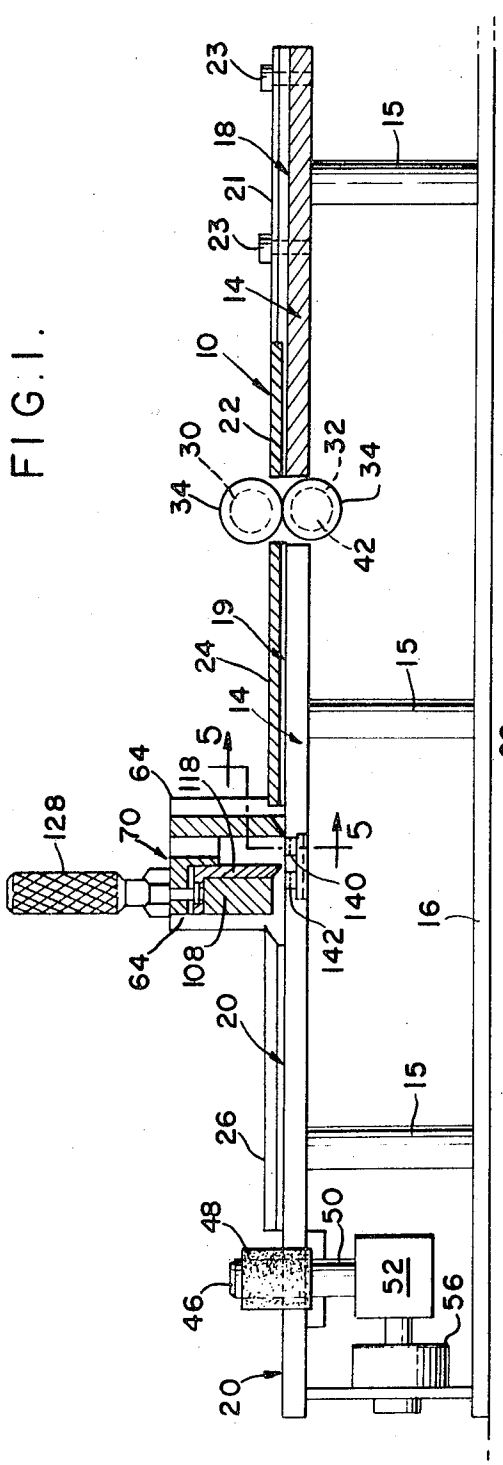

FIG. 2.

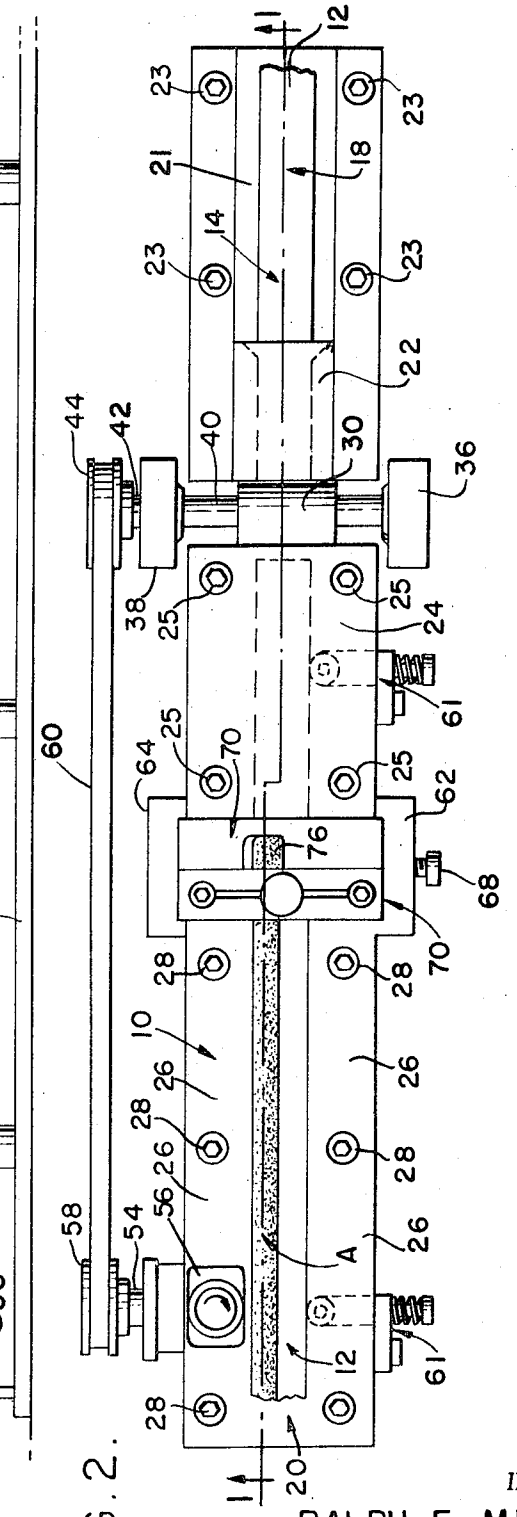

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FIG. 3.

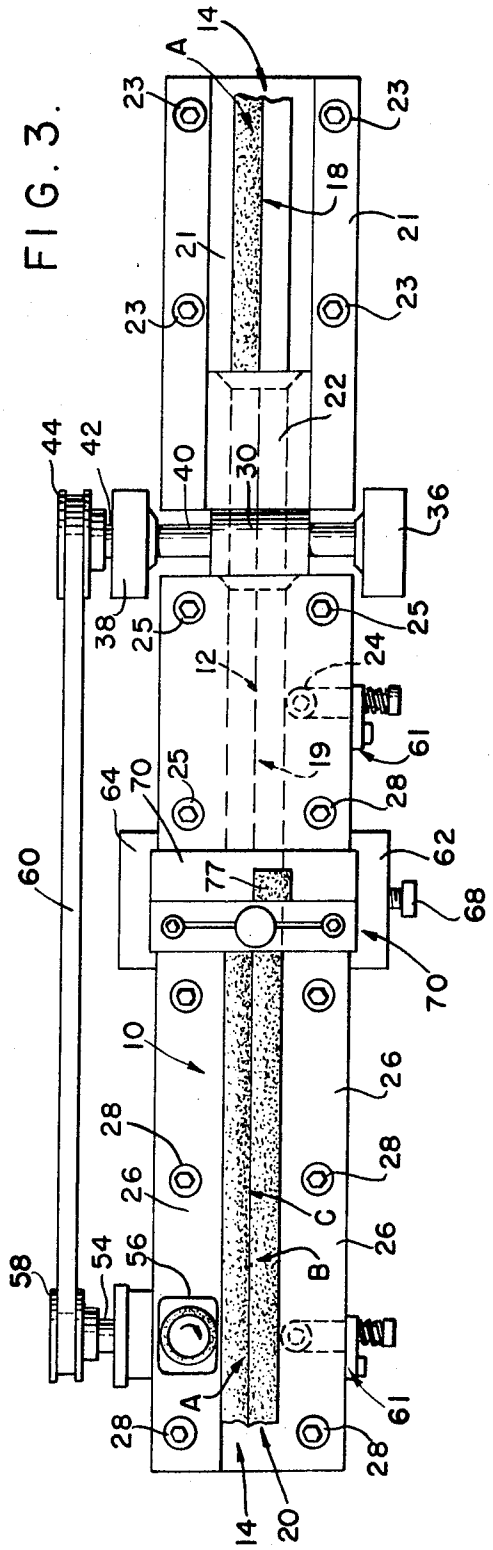

FIG. 5.

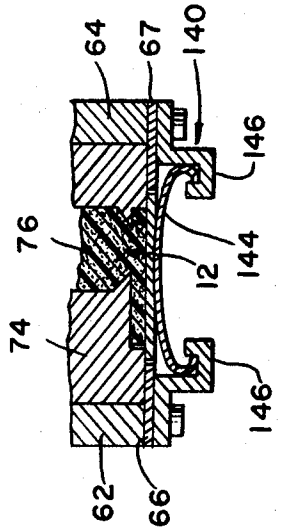

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FIG. 4.

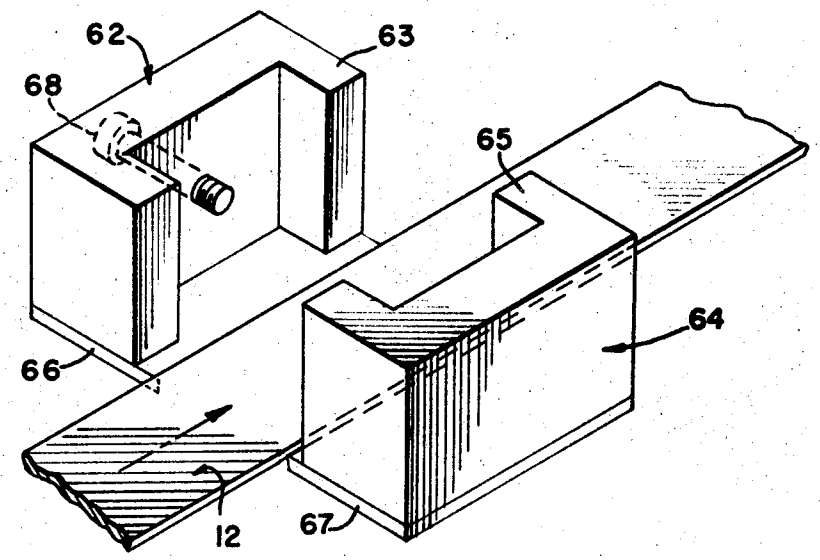

FIG. 6.

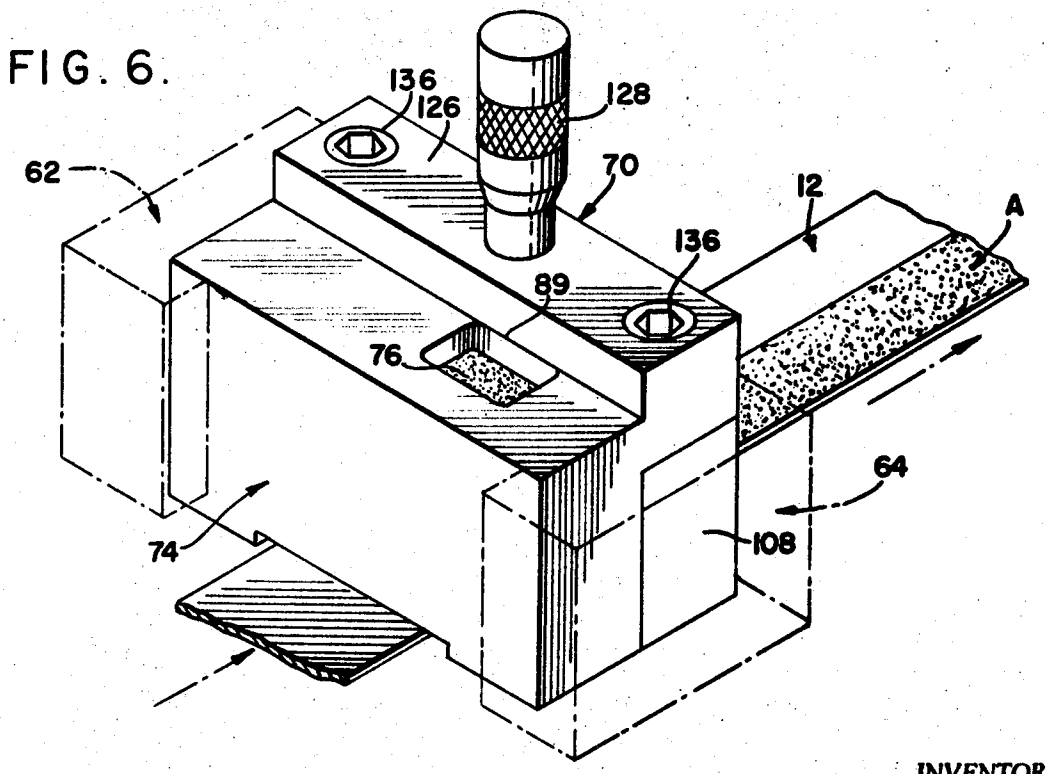

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FIG. 7.

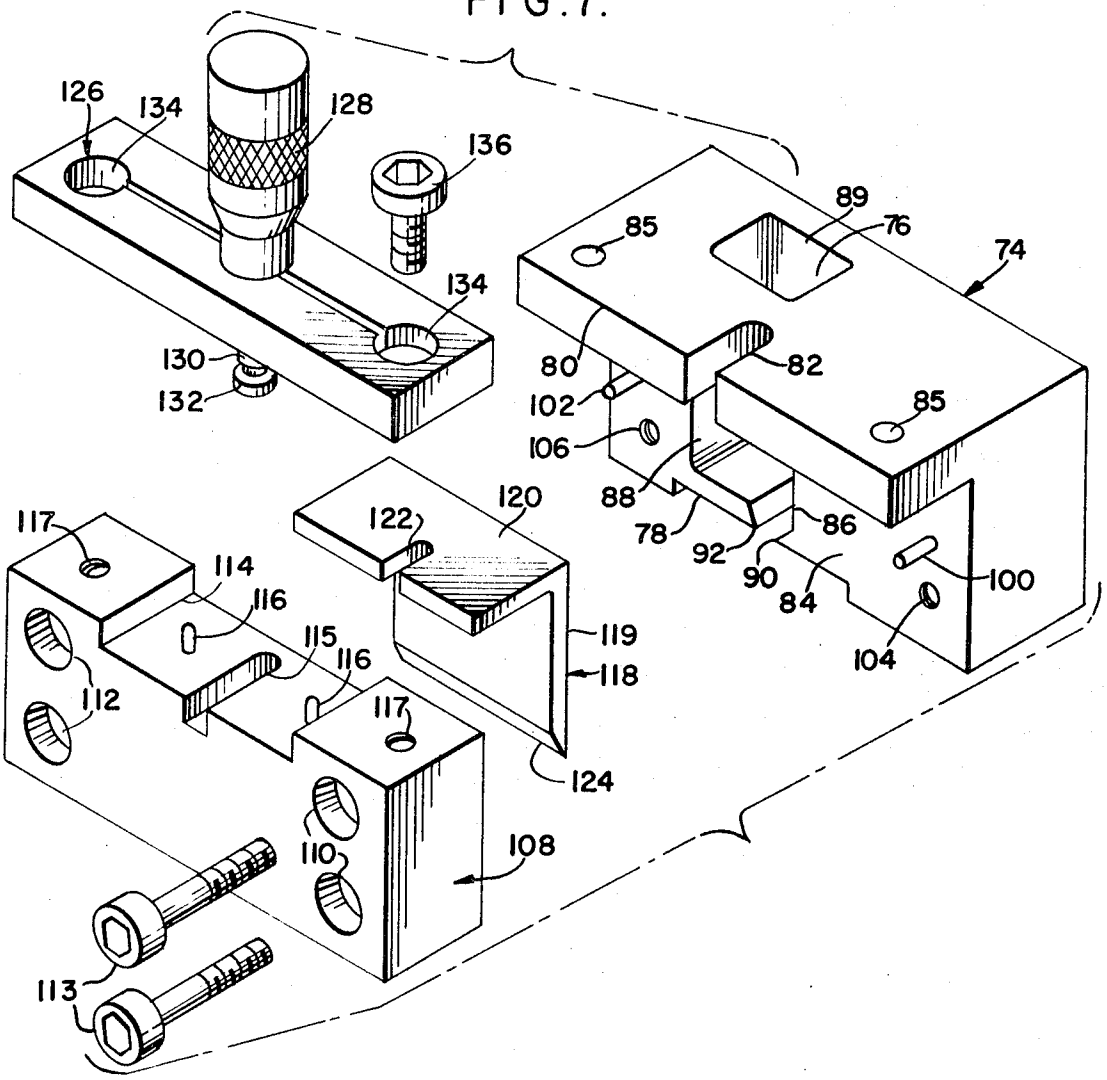
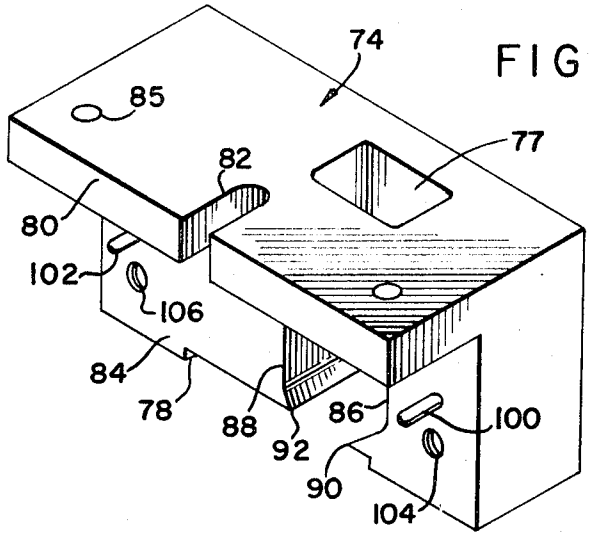


FIG. 8.



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APPARATUS FOR REPETITIVELY APPLYING COATINGS TO A SUBSTRATE

BACKGROUND OF THE INVENTION

This invention relates to an apparatus for stripe coating a substrate from which resistor type elements, such as linear and non-linear resistors, can be formed for use as components in sophisticated electronic circuitry where the uniformity of quality of the resistor type elements is of paramount importance to their function and ability to remain operative over extended periods of time. Such elements require a plurality of coatings in striped form of material having different electrical properties by forming on the surface of a substrate, such as a dielectrical substance, a plurality of coatings that are parallel to each other with adjacent coatings in an edge-to-edge relationship so that there is a fine edge overlap junction between adjacent coatings. It is important that the resistor type elements have only a fine edge-to-edge overlap between adjacent parallel coatings, the overlapped edges being reversely tapered to mate one another to present a smooth surface across the junction of the parallel coatings to produce on the top of the surface a fine line division between the coatings so that there is a smooth transition in the change of electrical characteristics when passing from one coating to its adjacent coating. Stripe coating of two or more conductor type materials having different electrical properties in edge-to-edge overlapped relationship is particularly difficult where the coatings are applied to a thin phenolic resin substrate. For example, the forming of a substrate striped with two parallel coatings of a flowable plastic material, one having silver particles and the other having carbon particles, with the coatings in edge-to-edge overlapped relationship, and curing the plastic coatings produces a basic type element having two zones, each zone having different electrical properties, from which resistor elements can be made.

The prior art has employed both the spray and doctor blade techniques for coating many types of articles. Such coated articles do not have a sharp junction between adjacent edges of coatings; for example, the spray coating of a substrate with two or more parallel strips of sprayable plastic material, each having different properties, produces an edge junction between coatings of a relatively wide band of intermingling of the plastics from each plastic material due to overspray in the spraying of one coating onto the other. This intermingling of the different materials in the case of resistor elements would produce a zone between coatings not having a fine line division and therefore exhibiting poor electrical properties across the wide band junction of the coatings, thus resulting in a resistor element that exhibits poor electrical resolution when an electric contact element is passed from the surface of one conductor material to the other.

In like manner, the technique of doctor blade spreading known to the coating art still does not produce a consistent edge abutment of a plurality of adjacent coatings without a relatively wide zone of intermingling of the material of one coating into the other. Although the art teaches many forms of doctor blade spreading of flowable plastic materials on substrates, it does not teach means for obtaining accurate edge overlap contact between two or more adjacent coatings repetitively applied so that there is a fine edge junction between the materials of the adjacent coats.

SUMMARY OF THE INVENTION

The apparatus of this invention overcomes the disadvantages presented in the prior art by providing means for continuously stripe coating the surface of a plurality of pieces of a dielectric substrate and then repetitively parallel stripe coating the pieces of substrate to produce an edge-to-edge overlap having a fine line junction between the edges of adjacent coatings. The substrate is passed under a stripe applicator means having register and holding means adapted to receive and retain interchangeable dispensing compartment means, each compartment means adapted to contain a flowable plastic material with particular type of particles therein depending upon the electrical characteristics desired in the coating. Each compartment means has edging means therein for providing a deposit of a stripe of plastic material having uniform parallel edges. A doctor blade means provides for doctoring a coating as it passes from under the compartment means to provide for the desired thickness of coat. By employment of the registering and holding means and repetitively feeding the substrate through the apparatus, one stripe of plastic material can be first deposited with another stripe of plastic material deposited in edge abutment with the first coating and having a thin overlap therewith, and the cycle can be repeated for as many coatings deposited in edge overlapped relationship as desired. It will be appreciated that a partial cure of a coating may be induced by heating the stripe of plastic material before it is passed into the apparatus for the next coating. In the applying of the repetitive stripe coating either a different compartment means may be placed in the registering and holding means or in the case of a dual striped substrate the substrate may be reverse end fed with the registering and holding means providing for the alignment of the second strip coating in thin edge overlap with the first stripe coating.

Advantageously, the coating apparatus of this invention may provide for suitable roller means such as nip rolls to advance the substrate through its repetitive coating operations. Also, suitable edge guide means may be employed at points along the advancement of the substrate to assure that the substrate remains in registry with the dispensing compartment means so that the laydown of the stripe of plastic material is in its proper position for producing an edge-to-edge overlap relationship between adjacent stripes of the plastic material after the striping of a plurality of coatings has been completed. It will be appreciated that each compartment means is positioned over the surface of the substrate passing under it with the doctor blade maintained at a distance equal to the thickness of the plastic material to be coated. This positioning allows for the doctor blade to doctor the surface of the coating to the desired thickness as the substrate exits from under the compartment means. A second roller means may be positioned downstream of the applicator head so as to assure continuous movement of the substrate through the apparatus, particularly where continuous end-to-end abutted pieces of substrate are fed through the apparatus and one piece has passed through the nip rolls. The second roller means continues the travel of the substrate when it has passed through the nip rolls until it is out of contact with the flowable plastic material in the compartment means and ready to be removed from the apparatus. The second roller means may be vertical in operation, such as an edge contact roller or rollers so that the uncured flowable plastic coated on the substrate is not disturbed by the roller action. Also, the vertical roller means may assist in maintaining one edge of the substrate against a guide means to assure registry of the surface of the substrate with the stripe coating being deposited.

Advantageously, the doctoring of the flowable plastic material may be accomplished by a doctor blade that forms a forward wall of the compartment means and is adjustable so that changes in the thickness of the coatings can be made when desired. Also, a micrometer biasing means may be operationally connected to said doctor blade so that the lower edge of the doctor blade may be micrometrically set to produce micro-thin coatings that are held to close tolerances which are reproducible. Also, the doctor blade used to form the forward wall of the compartment means may be bevelled outwardly and upwardly from its bottom edge to form a sharp edge that places a minimum of friction on the surface of the coatings immediately passing from under the compartment means.

The registering and holding means may be in the form of spaced support brackets, one positioned on each side of the guide track means upon which the substrate advances adapted to receive and hold an applicator head having a dispensing

compartment means therein in alignment with one of the parallel edges of a piece of substrate moving under it. In the registering and holding means can be placed one at a time applicator heads having differently positioned compartment means with respect to the parallel edges of the substrate depending upon the number of parallel stripes of plastic material to be deposited and the width of parallel stripes desired. Since each applicator head has its dispensing compartment means in registry with the parallel edges of the substrate passing under it, there is deposited one at a time a plurality of stripes of plastic material with each adjacent stripe in edge-to-edge overlap relationship so that a fine line of surface overlap is produced between the adjacent edges. Thus, by placing a first compartment means in the registering and holding means and depositing a first stripe and then placing a second compartment means in the registering and holding means and repassing the substrate through the apparatus, a second stripe is deposited with the registered thin edge overlap.

In order to maintain the surface of the substrate in its proper position with respect to the bottom surface of the compartment, spring means may be provided to bias the substrate upwardly so that coatings of even thickness are applied by the doctor blade. Also, the compartment may have its outer side wall edge tapered downwardly and inwardly to form a sharp edge for flowing even parallel edging to the stripe of the plastic material.

It is believed that by having the plastic material in highly viscous state, such as for example 1,000 cps to 50,000 cps, at 10 rpm on Brookfield viscosimeter, there is produced a condition of edge overlapping of adjacent edges so that at the point of doctoring there is produced a thin edge overlap abutment of the material to provide, when cured, a fine edge junction between adjacent coatings that results in consistent electrical characteristics across the junction. It has been found that this range of viscosity of the plastic material effects reproducible tapering of the abutted edges by controlling sidewise flowing of the coating outwardly of the parallel edge on the surface of the substrate. Also, it has been found that where the plastic material is thixotropic, the apparatus of this invention produces a fine edge reverse tapered junction between the adjacent coatings.

Advantageously, the applicator head can be so positioned by the registering and holding means that the dispensing compartment means therein can stripe two parallel stripes of plastic material by having the guide means so related to the compartment that after the substrate is first striped, it can be edge reversed and fed through the nip rolls so that the next stripe will be applied in an edge-to-edge reversed tapered overlap with the preceding striped coating.

The products and the method for producing the products which may be made and carried out by the apparatus of this invention are particularly set forth and described in my application for Letters Patent entitled "Production of Resistive Coatings" filed concurrently herewith.

BRIEF DESCRIPTION OF THE DRAWINGS

Additional advantages of the apparatus of this invention for applying, one after the other, a plurality of micro-thin coatings of flowable plastic materials on the surface of a substrate will become apparent from the following description of the accompanying drawings of a preferred embodiment, in which:

FIG. 1 is a view in elevation having a portion of the view in section as taken on the line 1—1 of FIG. 2 of an apparatus of this invention showing a guide track means, roller means for advancing the substrate, a coating applicator head, and a vertical edge roller for removing the coated substrate from under the applicator head;

FIG. 2 is a plan view of the apparatus shown in FIG. 1 illustrating the position of a dispensing compartment means arranged in the applicator heads maintained in registering and holding means;

FIG. 3 is a plan view of the apparatus shown in FIG. 2 with a strip of substrate passing therethrough to receive a second coating;

FIG. 4 is a view in perspective showing the registering and holding means for positioning the applicator head for striping parallel coatings on the surface of the substrate;

FIG. 5 is a cross-sectional view taken on the line 5—5 of FIG. 1 showing the registering and holding means without an applicator head therein and one of the spring biasing means for holding the substrate in position with respect to the dispensing compartment means;

FIG. 6 is a view in perspective of the applicator head showing its position with respect to the registering and holding means, with a piece of substrate passing under the dispensing compartment means therein;

FIG. 7 is an exploded view in perspective showing the component parts of one of the applicator heads and its micrometer adjusting means for raising and lowering the doctor blade; and

FIG. 8 is a view in perspective showing the body portion of an interchangeable applicator head with its compartment positioned for striping a second coating of flowable plastic material so that its edge overlaps the adjacent edge striped by the applicator head shown in FIG. 7.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, numeral **10** represents a coating apparatus for continuously applying to the surface of pieces of substrate or base material **12** a stripe coating of flowable plastic material and then applying a second stripe coating in a thin edge overlap relationship to the adjacent edge of the first coating. The coating apparatus has a guide track **14** upon which the substrate advances and is edge guided. Guide track **14** is supported by upright members **15** which in turn are anchored to a base **16**. The track **14** is in three sections: a roller feed section **18**, coating guide sections **19** and a removal section **20**. Roller feed section **18** has an edge guide **21** and a raised cover guide plate **22** downstream thereof, both held in position by bolts **23**. Coating guide section **19** has a raised guide cover plate **24** held in fixed position by bolts **25**. Removal section **20** has raised retaining strips or plates **26**, one positioned on each side of the guide track **14** and extending lengthwise therewith and covering an edge portion of the parallel edge of the substrate to retain the substrate in the guide track during its advancement through the apparatus. The raised retaining plates are maintained in position by suitable bolts **28**.

Positioned between feed section **18** and coating guide section **19** is a pair of horizontally disposed top and bottom nip feed rolls **30** and **32**, respectively, whose axis of rotation is normal to the centerline of guide track **14**. Feed roll **30** is biased downwardly into contact with roll **32**. The feed rolls **30** and **32** are covered with a soft resilient material **34**, such as rubber, capable of frictional gripping of the substrate between them to move it at a constant predetermined speed through the apparatus. The top feed roll **30** operates rotationally in front and rear bearings **36**, **38** on shaft member **40**. The front and rear bearings **36**, **38** are maintained in pivoted arms, not shown, which provide for downward biasing of the top feed roll **30**. The bottom feed roll **32** operates rotationally in front and rear bearings, not shown, on drive shaft member **42** with the front and rear bearings maintained in bearing blocks. Drive shaft member **42** at its rearward end has a drive pulley **44** for turning the drive shaft during operation of the feed rolls **32** which in turn rotates feed roll **30** biased against roll **32** so as to move a piece of substrate **12**, when it is nipped between the rolls, through the apparatus (see FIGS. **1**, **2** and **3**).

Positioned in the removal section **20** of guide track **14** is a vertically disposed edge roll **46** for contacting the edge of the substrate as it is passed along guide track **14** to convey the substrate from the apparatus. The roll **46** has a soft surface **48** thereon, such as a rubber coating. The vertical roll **46** has a drive shaft **50** which is operatively connected to a bevel gear

arrangement **52** which is in turn operatively connected to a second shaft **54** that is coupled at one end to a drive motor **56** and at the other end to a second drive pulley **58**. A drive belt **60** operatively connects feed roll drive pulley **44** with drive pulley **58** so that operation of motor **56** turns bottom feed roll **32** and vertical edge roll **46** at a speed that maintains the passage of the substrate through the apparatus at a constant speed. Positioned opposite from vertical roll **46** is a spring biased roller mechanism **61** that contacts the edge of the substrate and pushes its adjacent parallel edge in contact with roll **46**. (See FIGS. **1**, **2** and **3**).

Positioned over the guide track **14** between sections **19** and **20** is a pair of registering and holding brackets **62**, **64**, respectively, which are attached to the apparatus **10** with one bracket on one side of the guide track and the other bracket on the opposite side. The registering and holding brackets have support plates **66**, **67**. In registering and holding bracket **62** is a locking set screw **68**.

Positioned between the registering and holding brackets **62**, **64** is an applicator head **70** with its ends held by the wing extensions **63**,**65** and its outer side bottom edges resting on support plates **66**, **67** to maintain applicator head in a fixed position to guide track **14** for dispensing a coating of a flowable plastic material onto the surface of the substrate **12** as it advances under the head. The applicator head **70** has a block shaped body portion **74** with a milled out dispensing compartment **76** formed therein and a rectangular slot **78** in the bottom thereof of a size and shape that permits the strip of substrate **12** to pass under the dispensing compartment. The top of the body portion **74** extends forward to form an integral lip or edge **80** that defines therein a U-shaped elongated slot **82** that terminates at the top of front face **84**. On each side of elongated slot **82** is a screw receiving hole **85**. The compartment **76** has outer side walls **86** and **88** and a back wall **89** that are shaped so as to provide a rectangular opening that is smaller in width than the width of the major portion of the compartment, but of the width of a the coating to be applied to the substrate. The bottom portions of the outer side walls **86** and **88** angle inwardly towards each other to form a sharply tapered edge **90** and **92**, respectively.

Positioned in the front face **84** and spaced from each side of outer walls **86** and **88** are dowel pins **100**, and **102**, respectively, and two threaded screw retaining holes **104** and **106**, two other threaded screw retaining holes, not shown, are positioned above holes **104** and **106**. A rectangular holding block **108** defining two bolt holes **110** on one side of the front face of block **108** and two bolt holes **112** on the other side are positioned to mate with threaded screw holes **104** and **106** when bolts **113** are assembled. In like manner there are two holes, not shown, in back of block **108** adapted to receive dowel pins **100** and **102** when the holding block is assembled to the front face **84** of body portion **74** of one of the applicator heads. The top surface of holding block **108** has a centralized wide slot **114** therein with a U-shaped slotted groove **115** extending from the front face of the block inwardly. On each side of the slotted groove **115** are vertically positioned biasing pins **116** and outboard of each side of wide slot **114** are thread holes **117** which are in registry with screw receiving holes **85** positioned in edge **80** or body portion **74**.

Between holding block **108** and front face **84** is positioned a doctor blade **118**. The doctor blade is of an L-shaped configuration having a downwardly projecting portion **119** and a horizontally projecting top portion **120** at right angles to each other. The outer edge of top portion **120** has a second U-shaped slot **122** defined therein while the bottom edge of the downwardly projecting portion **119** also forms the front wall for closing the compartment **76** when abutted thereto with the tapered edge **124** presenting a sharp edge along the bottom thereof where it meets with front face **84** when the top portion **120** is positioned in wide slot **114** of the holding block **108**. In this position the horizontal projecting top portion **120** of the doctor blade is positioned in wide slot **114** with the U-shaped slots **82** and **122** in registry with slotted groove **115** with bottom surface of the top portion **120** resting on biasing pins **115** when holding block **108** is assembled to front face **84** with the doctor blade **118** therebetween.

Positioned on top of edge **80** is a micrometer holding bar **126** having a centrally disposed micrometer barrel **128** and shaft **130** positioned therein with the shaft extending vertically downward through U-shaped slot **82**. The end of shaft **130** has an annular groove **132** therein adapted to be received in and retained by U-shaped slot **122** so that an incremental movement of shaft **130** by turning barrel **128** causes the doctor blade **118** to be moved vertically with biasing by pins **116** thereby assuring that a fine adjustment in height above the top surface of the substrate can be made to produce the desired thickness of coatings on the substrate. The end portion of shaft **130** projects into U-shaped slot **115**. Bolt retaining holes **134** are defined near each end of the micrometer holding bar **126** in register with holes **85** and threaded holes **117** in holding block **108**. When bolts **136** of holding bar **126** and bolts **113** of holding block **108** are assembled, the micrometer holding bar, the doctor blade, and the holding block are united to the body portion to complete the assembly of the applicator head **70**. The assembled applicator head is removably retained in fixed position by registering and holding brackets **62** and **64** with respect to guide track **14**. The applicator head **70** is held in brackets **62** and **64** by a locking screw **68**, bearing against the side of applicator **70**. The doctor blade **118** is adjusted by not bring bolts **113** to a tight position so that the doctor blade **118** can be slidably moved up and down between holding block **108** and front face **84** by the turning of barrel **128** to set it. After it is set the bolts **113** are tighter. In this position a strip of substrate passing under the dispensing compartment **76** in the applicator head **70** receives a coating that is in a predetermined position (See FIG. **7**). FIG. **8** shows a second applicator head having the same functional elements as described above with its compartment **77** in a different registered position with respect to the parallel edges of the substrate.

Positioned under the bottom of applicator head **70** and normal to the length of guide track **14** are two spring biasing means **140** and **142**. Each biasing means has a leaf spring **144** adapted to support the substrate in its proper position with respect to the bottom of the dispensing compartment **76** as it passes under the bottom of it in slot **78** so that the flat surface of the substrate is always maintained against the bottom edges of the two outer side walls **86** and **88** and the back wall **89** in the proper spaced relationship with the bottom of the sharp edge of the doctor blade to provide for a constant doctoring of material on the surface of the substrate that is of uniformly deposited thickness. The spring **144** is held by holding lugs **146** which in turn are attached to the frame of apparatus **10** (See FIGS. **1**, **2**, **3** and **5**).

In operation, the micrometer barrel **128** is adjusted in applicator head **70** so that the bottom edge of the doctor blade **118** is positioned at the desired height above the surface of the substrate passing under compartment **76**. When the proper adjustment is set, the screws **113** are tightened to place the doctor blade in a fixed position. The motor is then energized and feed roll **32** driving roll **30** and edge roll **46** are placed in continuous operation. With a piece of substrate positioned under the applicator head flowable plastic material having the desired electrical characteristic is placed in compartment **76**, the material being of such consistency that it will edge spread to produce an even taper edge when deposited.

Pieces of dielectric substrate are continuously fed flatwise on the guide track **14** of feed section **18** with the substrate pushed longitudinally of the bed with the forward edge of each piece of substrate in engagement with the rearward edge of the piece directly preceding it. The forward edge of each piece is nipped between feed rolls **30** and **32** to continuously advance the substrate into and a long coating guide section **19**, being held in a predetermined position by the spring biased roller mechanisms **61**. The top surface of the piece of substrate, after passing through the coating guide section **19**, passes into slot **78** of applicator head **70** where the top surface

of the substrate is brought into contact with the coating material. Spring biasing means **140** and **142** maintains the surface of substrate in its proper relationship with the bottom of applicator head **70** and the sharp edge **124** of the doctor blade **118** to assure that the stripe coating is doctored to the proper thickness. After the first stripe coating "A" is applied to the substrate, the coating is partially cured to harden the surface of it and then passed through the apparatus a second time to receive a second stripe coating "B" by passing under an interchanged applicator head that has a compartment therein that is in a different registered position or by end reversing the piece of substrate.

The tapered bottom edges of the outer side walls **86, 88** of compartment **76** cause the plastic materials to be applied to the surface of the substrate with sharply defined edges and the doctor blade **118** assures a smooth even thickness in each coating so that a precise and sharp fine line electrical junction "C" between coatings is formed with the result that upon curing, the electrical characteristics across the line junction are of more uniform and higher quality than hereto presented in the art. The knife edge doctor blade produces an even thickness coating as the dielectric substrate passes from in under the applicator head **70** with the feed rolls **30** and **32** and the edge roll **56** assuring that the strip is fed at a constant continuous rate through the coating operation. After the substrate has been coated with as many stripes as desired it is then finally cured to set the coatings on the substrate.

It will be appreciated that the registering and holding brackets **62** and **64** are so arranged with respect to the guide track **14** that a multiple number of different applicator heads may be used depending upon the number of stripe coatings and/or the width of the stripe coatings desired. Also one applicator head may be used for producing two stripes of plastic material in edge overlap by registering the outside edges of the deposit from a compartment with the edge in guide track **14** so that a piece of substrate can be first passed under the applicator head **70** and receive a stripe coating in a fixed position in relationship to the parallel edges of the substrate and then, after surface hardening of the coating, repassed through the apparatus by turning the piece of substrate end to end so that its parallel opposite edge is used thereby depositing a second stripe coating with a reversed tapered edge overlap with the tapered edge of the first stripe coating.

In forming an electrical element from which small resistors can be made, a piece of dielectric substrate of about 20 mils in thickness and about 1 ½ inches wide may have a lay down of a first stripe coating of about ⅜ inch wide having silver particles therein and a second stripe coating of about ½ inch wide having carbon particles therein with their adjacent edge in a thin reversed tapered overlap so that upon curing there are provided two parallel stripes of plastic material having different electrical properties with a thin edge overlap junction therebetween separating the materials of different electrical characteristics. From such coated substrate can be cut crescent type resistor elements oriented so that the ends of the resistor elements are in the stripe with the silver particles while the center of the crescent forms the stripe having the carbon particles.

Also, it will be appreciated that the apparatus of this invention can produce a variety of coating thicknesses by adjustment of the doctor blade on the applicator head. Substrates of as little as 10 mils in thickness may be used and suitable multiple stripings have been found to be produced when the thicknesses of the stripe coatings are from about 0.5 to about 10 mils. It has been found that excellent stripe coatings are obtained having a uniform reversed tapered edge junction when the plastic material has a viscosity of from about 1,000 cps to about 50,000 cps at 10 rpm on a Brookfield viscosimeter when the surface advancement of the substrate is at a speed of from about 20 to 60 feet per minute. It will be appreciated that the speed of advancement and the viscosity of the plastic material are interrelated to produce the desired reversed tapered electrical junction. Also excellent results are obtained when the plastic material is in a thixotropic state for it is believed that there is a flowing of the plastic material when the substrate is passing under its respective compartment and doctor blade to produce a more sharply defined tapered edge overlap in the area of contact between the edges of the adjacent coatings. Such an even reversed tapered contact produces an excellent true fine line junction on the surface of the adjacent edges of the stripe coatings with the electrical resolution of the junction being better than has been heretofore produced in the art.

It will also be appreciated that many different types, sizes, and shapes of dielectric substrates can be striped with a plurality of parallel coatings in accordance with the apparatus of this invention. Among the suitable forms of dielectric substrates are ceramics, glass, various types of plastic materials, and the like. The substrate may be in the form of sheets, films or any other form that has a flat surface with the capability of receiving and holding the coatings applied thereto. Also the surface of the dielectric substrate may have a group of indexing holes therein for registering the surface of the substrate with the stripe coatings applied thereto so that the parallel coatings will always be in the exact desired position on the substrate. Also, the indexing holes may be used as guides to punch, cut and break away desired units of resistor elements from the body of the coated substrate.

It has been found that the reversed tapered overlap between adjacent edges of said parallel stripe coatings produces a transition zone extending lengthwise on the top surface of the substrate with distinct lines of demarcation at the end of the taper portion to provide substantially linear edges, one on the surface of adjacent parallel stripe coatings and the other on the bottom of the stripe coating that is in contact with the top surface of the substrate. Thus, the reversed taper with its sharp lines of demarcation provides a transitional zone for effecting smooth change from the electrical characteristics of one stripe coating to the coating adjacent to it.

It has also been found that the alignment of the parallel edges of the substrate with the compartment outer walls that form the overlapped edge of the adjacent stripe coating particularly is effective when the registry of the edges of the outer wall is from substantial alignment to about 0.005 inch in overlap position. Such an alignment of the compartment in the one applicator head with another or the positioning of the compartment with respect to the parallel edges of the substrate so that reverse feed of the substrate after one coat has been applied, produces the aforesaid positional alignment of the stripe coatings with the desired reversed interfacial tapered overlap.

It will be further appreciated that many changes, modifications and additions may be made to the apparatus of this invention in which only a preferred embodiment has been illustrated and described.

What is claimed is:

1. An apparatus for depositing, repetitively, micro-thin stripe coatings on the surface of an advancing thin strip of a flat elongated dielectric substrate having lengthwise parallel edges with adjacent coatings having an inter-facial reversed tapered edge overlap comprising: support means including edge means for registering and guiding said flat elongated dielectric substrate along at least one of its parallel edges; an interchangeable applicator head defining a compartment therein having side walls, a rearward wall and a forward wall adapted to contain and dispense a stripe coating of gravity flowable plastic material having particles therein exhibiting definitive electrical characteristics, said side walls having inwardly and downwardly bevelled edges at the line of contact of deposited plastic material so that there are formed sharply defined outer edges on the stripe coating as it passes out of contact with said body of flowable plastic material; registering and holding brackets holding one of a plurality of interchangeable applicator heads in a fixed position with respect to said at least one of the parallel edges of said substrate, each of said applicator heads providing when positioned in said brackets a differently positioned stripe coating having at least one of its edges in a reversed tapered edge overlap with an adjacent

stripe coating; means operatively connected to said brackets for maintaining one of said interchangeable applicator heads in said fixed registered position so that said flowable plastic material in said compartment produces from each applicator head a stripe coating of plastic material that is in edge registry with at least one of said parallel edges as well as being in edge overlap with its adjacent coating; doctor blade edge means in said forward wall for doctoring an even thickness to each of said stripe coatings; and roller means operatively in contact with said substrate before and after said coating is applied for continuously advancing said substrate during said application of said stripe coating.

2. The apparatus of claim 1 in which said means for advancing said dielectric substrate is a pair of horizontally placed advancing nip rolls having their axis of rotation normal to the axis of length of said substrate and positioned for feeding the forward end of said substrate under said compartment and an edge contacting roll that removes said substrate from under said compartment when the rearward end of said substrate has passed through said advancing rolls.

3. The apparatus of claim 2 in which a biased roller means maintains an edge of the substrate in contact with said edge contacting roll.

4. The apparatus of claim 1 in which said substrate is a ceramic.

5. The apparatus of claim 1 in which said substrate is glass.

6. The apparatus of claim 1 in which said substrate is a flexible plastic material.

7. The apparatus of claim 1 in which the substrate is a thin cured phenolic resin.

8. The apparatus of claim 1 in which said flowable plastic material is a homogeneous mixture of a curable plastic substance and conductive particles having a viscosity of from about 3,000 to 50,000 cps at 10 rpm on a Brookfield viscosimeter.

9. The apparatus of claim 1 in which said flowable plastic material is thixotropic.

10. The apparatus of claim 1 in which said doctor blade edge means for doctoring each of said coatings is positioned from about 0.5 mils to about 10 mils above the surface of the advancing substrate.

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