Dec. 27, 1966 J. P. GERAGHTY 3,294,576

METHOD OF PRODUCING PRINTED CIRCUIT STRUCTURES

Filed Jan. 14, 1963

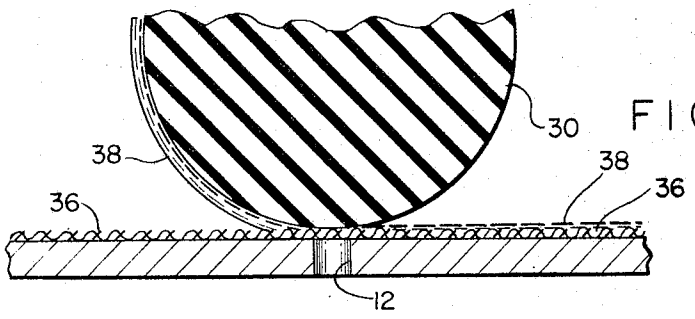

FIG. 3

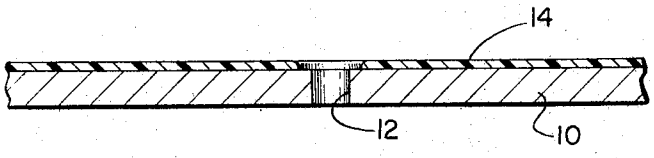

FIG. 1

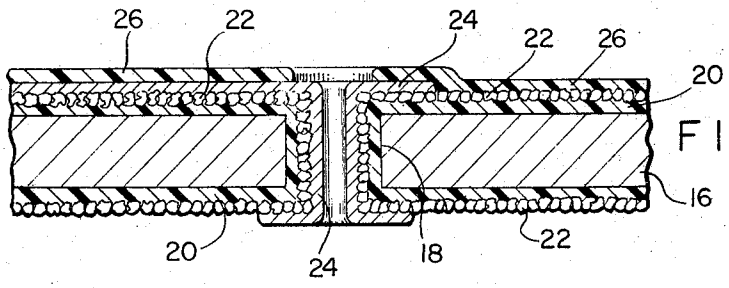

FIG. 2

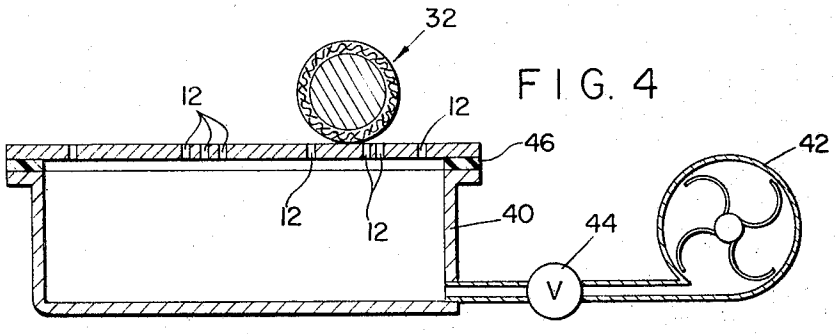

FIG. 4

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METHOD OF PRODUCING PRINTED CIRCUIT STRUCTURES

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This invention relates to methods of applying coatings of viscous liquids to surfaces of members having openings therethrough, and more particularly, to methods useful in the production of printed circuit structures.

Printed circuit structures generally comprise a preformed supporting member to which are applied various layers including insulating strata and electrically conductive elements. The supporting member frequently takes the form of a panel with openings extending therethrough, the openings having dimensions which may be relatively small, e.g., of the order of the thickness of the panel. It is frequently desirable to completely coat either or both sides of the supporting panel with a dielectric layer. However, in many instances, for example, when it is desirable to make electrical contact with a metal supporting member at (within) an opening, or to make electrical contact with a conductive element within an opening, the openings are required to be free of the dielectric material. A number of satisfactory methods are available for applying a dielectric coating to a surface rapidly, easily and inexpensively, however, leaving relatively small openings free of the coating is a problem, and the practice heretofore has been to apply the coating as a liquid, through a mask or stencil. Not only are such masks or stencils expensive, but they are required to be oriented very precisely with respect to the openings, thereby representing a manufacturing operation which constitutes both an expense and a source of difficulty.

The invention has, as an object, the provision of a novel and improved method of applying a liquid coating to a surface of a member having an opening therethrough in such a way as to prevent the liquid from entering the opening.

Another object of the invention is to provide a method as described in which a viscous liquid coating is applied from an applicator moved against the surface in closing relation to the opening, and the liquid is prevented from entering the opening by a stream of gas passing through the opening from the opposite side of the member.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the process involving the several steps and the relation and order of one or more of such steps with respect to each of the others which are exemplified in the following detailed disclosure, and the scope of the application of which will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawing wherein:

FIGS. 1 and 2 are sectional views of typical structures produced by the method of the invention; and

FIGS. 3 and 4 are somewhat schematic sectional views illustrating the method of the invention and apparatus therefor.

The method of the invention is particularly adapted for producing printed circuit structures of the type comprising a support member in the form of a sheet, plate or panel fabricated with openings extending therethrough. The support member may be formed of a dielectric material or a conductive material (metal), and is coated

on either or both sides with one or more layers including a layer of a dielectric material such as a polymer, which is applied in a liquid (usually viscous) form, either directly to the support member or to another layer or layers supported thereon. The support member may be of almost any thickness ranging from a minimum of a few thousandths of an inch and the openings may have a major dimension as small as a few thousands of an inch. The invention is concerned with a method of applying the liquid dielectric material to a side of the panel in such a way as to leave the openings free of the liquid.

A typical structure produced by the method of the invention is illustrated in FIGURE 1 and comprises a support member **10** formed of metal and having an opening **12** extending therethrough. The structure shown may be designed to provide the base or insulated support for a printed circuit structure including a circuit (conductive) element which is to be electrically connected to the support member **10** at opening **12**. The support member is provided with a dielectric coating **14** completely covering one side of member **10** and interrupted only at opening **12** and in the region immediately surrounding the opening to permit electrical contact to be made with the support member within the opening by means such as an eyelet, soldering or the like. Dielectric coating **14** is a hardened or solidified material, applied as a liquid; and materials particularly suited to this purpose are the polymers, paints and varnish, ceramics, etc., which can be applied as a liquid and later, hardened or solidified due to solvent evaporation and/or curing. For electric circuit structures, thermosetting polymers, such as the epoxies, applied in a solution, find special utility. Such thermosetting polymers or, for example, frits in a liquid binder, are applied and then subjected to a heat treatment to eliminate the solvent or bender and then cure the polymer or fuze the frit.

A printed circuit structure of the type described in the copending U.S. patent application of Robert A. Curran, Serial No. 196,319, filed May 21, 1962, is shown in FIG. 2 of the drawings. This circuit structure includes a support panel **16** having an opening **18** therethrough and coated on both sides and through opening **18** with a continuous layer **20** of a dielectric material (such as a polymer) in which is embedded a coextensive coating **22** of finely divided particles of a hard, inorganic, dielectric such as aluminum oxide, quartz or the like. Coating **22** serves as a support and an anchor for a metal conducting element **24** supported on one side of the panel and extending through opening **18** where it is supported on the coating and layer covering the wall of opening **18**. A dielectric coating **26** is applied to the same side of the structure as conducting element **24** in order to completely cover the structure including the conducting element except within opening **18** wherein electrical contact is to be made with the conducting element.

The dielectric coating is applied to a surface of structure in the form of a liquid which is preferably quite viscous, and, if possible, thixotropic, so that liquid remains in place and does not flow readily once applied. Any of several well-known types of liquid applicators can be employed. These include roll type applicators such as a substantially non-porous, non-absorbent roll **30** (as shown in FIG. 3) formed, for example, of hard rubber; a porous, absorbent roll **32** such as employed for paint application and shown in FIG. 4, as comprising a roll with an absorbent fabric (pile) cover; a conventional brush such as used for painting; or a squeegee of the type employed in silk screen processes. The applicator, whatever its type, is charged or coated with the liquid and then is employed in the usual manner without any effort being made to avoid the openings from which the

liquid is to be excluded, so that during the course of a coating operation, the applicator extends across and in closing relation to each opening.

The liquid is excluded from the openings by passing a gas, such as air, through the openings from the opposite side of the support member and contacting the surface (to be coated) only with a material or element which is porous and does not arrest the flow of air through the openings. The air flowing through the openings prevents the liquid from entering the openings and may, in fact, cause a small area surrounding each opening, to be left free of the liquid. When the applicator itself is porous and allows the gas to pass, as in the case of a brush or absorbent applicator roll **32**, the porous applicator itself is brought into direct contact with the surface to be coated. In the use of a squeegee or a non-porous roll **30**, a porous element **36** such as a silk screen is interposed between the applicator and the surface being coated. This latter embodiment is shown in FIG. 3 in which a coating of liquid **38**, adhered to roll **30**, is transferred from the roll through screen **36** to support member **10** by rolling roll **30** against screen **36** which is superposed with the surface to be coated. The liquid passes through the screen and remains adhered to the surface when the screen is subsequently removed, preferably while the gas is passing through the openings.

Apparatus for passing a gas under pressure through openings in the support member is quite simple and may comprise (see FIG. 4) an open container or vessel **40** providing a chamber into which a gas is introduced under pressure by a blower or compressor **42** connected through a valve **44** to the lower portion of the container. The upper edge or lip of the container is provided with a sealing ring **46** of a pliant material against which the support member or circuit panel is pressed in closing relation to container **40**. In this way, a gas introduced under pressure into container **40** is forced to flow through the openings (**12**) in the panel (**10**). Because the panel is contacted only by a porous member, i.e., a screen or a porous applicator, the flow of gas through each opening is never arrested and continues to prevent the liquid from entering the opening.

The method of the invention thus makes it possible to coat a liquid onto a surface, leaving small openings therein free of the liquid, with the aid of conventional liquid applicator devices and without the necessity for masks, stencils and the like which are expensive to fabricate, are difficult to orient properly and may include openings or pores which become filled or clogged with the liquid. The method is easily performed using simple and inexpensive equipment, requires no special or precise operations, yet produces reliable and uniform results.

Since certain changes may be made in the above process without departing from the scope of the invention herein involved, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. The method of appling a viscous, liquid coating material to a surface of a member having an opening therethrough, said method comprising:

moving an applicator charged with said viscous liquid coating material across said surface and said opening against said surface to transfer said coating material to said surface;

said applicator having an area moved against said surface which exceeds the area of said opening and is disposed in closing relation to said opening during movement across said surface and said opening;

passing a stream of a gas under pressure through said opening from the side of said member opposite said surface during movement of said applicator against said surface across said opening; and

contacting said surface with a porous member to allow said gas to flow through said opening with said applicator extending across said opening in closing relation thereto and thereby exclude said coating material from said opening.

2. The method of claim **1** in which said applicator is porous and is moved directly against said surface.

3. The method of claim **2** in which said applicator is in the form of a roll and is rolled against said surface.

4. The method of claim **1** in which said applicator is a substantially non-porous roll coated with said coating material, said porous member is a screen disposed in contact with said surface extending across said opening, said applicator is rolled against said screen to transfer said coating material to said surface through said screen, and said gas is passed through said opening until said screen is removed from said surface.

5. The method of claim **1** in which said applicator is a brush and is moved directly against said surface.

6. The method of claim **1** in which said coating material is thixotropic.

7. The method of claim **1** in which said gas is passed through said opening by mounting said member in closing relation to a chamber and introducing said gas under pressure into said chamber.

8. The method of claim **1** in which said coating material is a polymer and following its application is treated to soldify said polymer.

9. The method of claim **1** in which said coating material is a thermosetting polymer which, following its application to said surface, is heat treated to complete the curing of said polymer.

10. The method of forming a multilayer structure comprising:

fabricating a support member with an opening extending therethrough;

moving an applicator charged with a viscous liquid coating material across a surface of said member against said surface to transfer said coating material to said surface to form a layer thereon;

said applicator being moved across said opening in closing relation thereto during movement across said surface to apply said coating material thereto;

passing a stream of a gas under pressure through said opening from the side of said member opposite said surface during movement of said applicator against said surface across said opening;

contacting said surface with a porous member to allow said gas to flow through said opening with said applicator extending across said opening in closing relation thereto and thereby exclude said coating material from said opening; and

treating said layer of said coating material to solidify said layer.

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