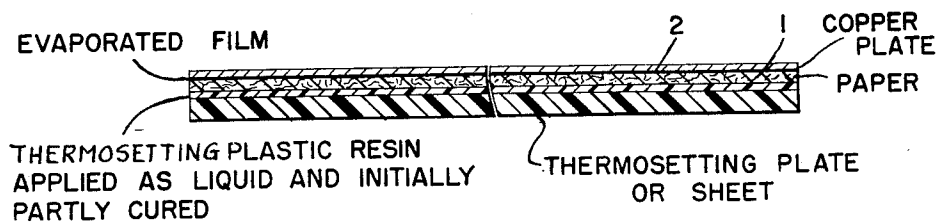


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METHOD OF MANUFACTURING A CONDUCTIVE
COATED SHEET AND SAID SHEET
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METHOD OF MANUFACTURING A CONDUCTIVE COATED SHEET AND SAID SHEET

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The present invention relates to a method of producing a laminated sheet having a top surface formed as highly conductive film coating or plating beneath which are non-conducting layers of other material and to the product itself. Such articles are useful in so called printed circuits wherein electrical circuits are formed from such sheet material by etching, cutting or removing in some other fashion certain portions of the conductive film or coating leaving other portions of the conducting film or coating forming the circuit to which electrical elements are connected at various points.

One of the great difficulties in producing circuits of this nature is that the plating is not usually sufficiently permanent and will after a period of wear separate from its supporting plate or sheet causing either a break in the circuit or creating sections of very high resistance which makes the circuit useless. Other difficulties have also been experienced in providing coated or plated sheets of the present type. In many cases the coating is not uniform and often has voids where little or no metal has been deposited causing irregular electrical characteristics and thereby greatly affecting the design of the apparatus in which the sheets are used. It is extremely essential in all cases to provide a durable, strong sheet or plate on which the copper or other conductive layer is firmly attached with uniform thickness and constant homogeneity such that the conductivity is uniform throughout the whole sheet.

Various methods have previously been tried such as cementing a foil to a plastic base and spraying a coating on a plastic or other base, but neither of these methods have provided sufficiently strong and durable sheets with homogeneous conductive surfaces to warrant their continuous successful use.

By the present invention it is possible to secure to a non-conductive sheet or plate, a thin conductive coating or layer which will permanently adhere to the sheet and will not, even with rough usage, part from the sheet, be flaked off from the sheet or be removed by any ordinary usage or wear of the sheet. When a circuit is to be formed on the sheet, the parts desired to be removed may be removed by etching, cutting or other suitable means, but they will otherwise adhere durably and permanently.

Without further describing the merits and advantages of the present invention which will be more clearly understood from the specification set forth below, the invention will now be de-

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scribed in connection with a drawing illustrating an embodiment of the structure of the plate or sheet of the present invention which shows a section therethrough. In the process herein employed, a porous thin sheet material, such as a paper or paper-like material or a sheet which may be of woven or knitted fabric, such as cotton, linen or synthetic materials or which may be made of paper and synthetic materials, is used as the initial sheet base. Such a sheet should be thin as a paper sheet and should be flexible and readily impregnable with the liquids which will later be mentioned.

I have found that for the most part a fairly good grade of kraft paper is very satisfactory since such paper is sufficiently porous to accept the impregnating liquids used in the present invention.

The kraft paper shown at 1 in the diagram is coated with a very thin film 2 of evaporated conductive metal. Silver is preferable for this purpose and the coating or film may be deposited in any of the well known manners. Evaporation process is preferable since by this method a uniform very thin coating or layer of the metal may be obtained. Besides silver, other suitable metals, for instance, as aluminum, copper, may also be used.

After the thin silver film or coating which has a thickness in the range of a micron or thereabouts, that is a thickness substantially less than 0.001" there is plated on to the film a copper plate which may be done in a continuous process by dipping or by any other suitable means, as for instance, as electrolytic process. This copper plate may be .001" or more, and while copper is preferable, again it is possible to use another conductive element such as silver if that is desired. The sheet which then comprises a kraft paper thin sheet with a continuous plated copper film is then thoroughly washed and allowed to dry.

The copper plate should so coat one side of the sheet that no openings remain on the sheet where no copper has been deposited so that a continuous uniform plated copper sheet is obtained. After the sheet has been dried the non-plated side is brushed with a thermosetting plastic coating or the coating may be applied in any other suitable way. Such a coating is thoroughly absorbed by the kraft sheet so that it becomes impregnated right through to the back of the copper plate. The excess may be wiped off. I preferably use for this purpose a phenol-formaldehyde varnish compatible with the other materials used and which is thermosetting in character and will

withstand curing temperatures employed or some other thermosetting plastic viscous resin such as a urea-formaldehyde, silicone, vinyl, etc. This impregnation is then partially cured, which may be accomplished by heating the sheet at approximately 250° F. for a few minutes. Care must be taken to cure the sheet only partially since a further cure is necessary to complete the product. This sheet is then laid upon a partially or fully cured base sheet such as a phenolic resin base sheet or a linen base sheet impregnated with the phenol material or any of the usual thermosetting resins, plastic sheets or plates which may be themselves laminates of woven fabrics, reinforced fiber, filled or other types of sheets. The copper plate sheet with its partially cured resin base is then made integral with the thermo-setting base sheet by heat and pressure which usually is accomplished by pressures up to 250 lbs. to 300 lbs. per square inch at temperatures of 350° F. to 400° F. for a short period of approximately minutes or more. Lower temperatures and pressures than those given may be used. With a partially cured base sheet more time must be allowed for curing the entire plate dependent upon the thickness of the base.

I find that certain features in this process must be carefully observed.

(1) None of the varnish or thermosetting viscous liquid applied to the back of the kraft paper must be permitted to force its way through the metal coating so as to appear on the face of the metal coating. This is highly detrimental to the sheet itself.

(2) The paper or other material immediately in back of the film and conductive plate must either be somewhat porous or have microscopic recesses of sufficient area so that the impregnant put in the back of the paper will penetrate through the interstices and reach the deposited films and plating.

(3) Care must be taken that a continuous film is deposited on the kraft paper and that similarly the plate is deposited uniformly over the film.

(4) In the final curing of the composite sheet the sheet must be put under suitable pressure and while such pressure is not readily definable because it depends to some extent upon the kind of paper or initial sheet on which the film is deposited as well as upon the other elements which are used, the pressure must be such as to fill substantially all the depressions or interstices in the paper or fabric sheet which is used. While it is preferable to use pressures in the range of 200 lbs. to 300 lbs. per square inch in effecting the final bond, other pressures may be used. Higher pressures may be used for thicker and less porous layers.

(5) It is highly essential in the present method to deposit the film and plate the metal on the paper sheet before applying to the reverse side of the sheet the thermosetting varnish or other materials used in bonding the sheet on its ultimate back plate.

It has been mentioned above that the initial film is deposited on the kraft or other sheet by evaporation. In the sense as used in the present application, evaporation includes any means by which the metal is vaporized and allowed to settle upon the sheet. Such for instance as heating the metal under vacuum conditions to provide a vapor or obtaining the same general effect by electric sputtering or other equivalent means.

Having now described my invention, I claim:

1. A method of manufacturing a plate or sheet having an electrical conductive non-alkali metallic plated coating which comprises taking a base sheet of flexible, impregnable paper material, evaporating a non-alkali metallic film on one surface thereof, then plating over the film a continuous non-alkali metallic coating, washing, rinsing and drying the sheet, impregnating the unplated side only with a liquid thermosetting resin, partially curing the same on the sheet and finally curing to the partially cured face of said sheet with heat and pressure a thermosetting base sheet.

2. A method of manufacturing a plate or sheet having an electrical conductive non-alkali metallic plated coating which comprises taking a base sheet of flexible, impregnable paper material, evaporating a non-alkali metallic film on one surface thereof, then plating over the film a continuous copper plate, washing, rinsing and drying the sheet impregnating the unplated side only with a liquid thermosetting resin, partially curing the same on the sheet and finally curing to the partially cured face of the sheet with heat and pressure, a thermosetting base sheet.

3. A method of manufacturing a plate or sheet having an electrical conductive non-alkali metallic plated coating which comprises taking a base sheet of kraft paper, evaporating a conductive non-alkali metallic film of a thickness of substantially less than 0.001" on one side of said sheet, then plating over said film a continuous non-alkali metallic coating having a thickness of substantially 0.001" and greater, washing, rinsing and drying the sheet, impregnating the unplated side only with a thermosetting resin, partially curing the same on the sheet and finally curing to the partially cured face of the sheet a thermosetting base sheet with heat and pressure.

4. A method of manufacturing a plate or sheet having an electrical conductive non-alkali metallic plated coating which comprises taking a base sheet of kraft paper, evaporating a conductive non-alkali metallic film of a thickness of substantially less than 0.001" on one side of said sheet, then plating over said film with a continuous non-alkali metallic coating having a thickness of substantially 0.001" and greater, washing, rinsing and drying the sheet, impregnating the unplated side only with a thermosetting resin, partially and finally curing the same on the sheet and finally securing to the said sheet on the unplated face a heavier base sheet.

5. A plate or sheet having a conductive non-alkali metallic plated coating comprising a sheet of paper material having deposited on one side thereof a thin non-alkali metallic film of several microns thick, a conductive non-alkali metallic plated coating deposited on said non-alkali metallic film of substantially .001" in thickness, a thermosetting plastic resin forming a coating over, filling the interstices in said paper sheet and impregnating said paper from the side opposite to that on which said metallic film is formed and a thermosetting sheet cured to said thermosetting plastic resinous coating.

6. A plate or sheet having a conductive non-alkali metallic plated coating comprising a sheet of paper material having evaporated on one side thereof thereon a thin silver film of substantially a micron thick, an electrolytic plating deposited on said silver film forming a continuous conductive non-alkali metallic surface of substantially uniform thickness, a thermosetting plastic resinous coating impregnating only the unplated face

of the paper sheet but free from the continuous metallic surface and partially cured to said paper sheet, and a thermosetting resinous plate secured to said partially cured surface.

7. A plate or sheet having a conductive non-alkali metallic plated coating comprising a sheet of paper material having evaporated on one side thereof a thin silver film of substantially a micron thick, an electrolytic plating deposited on said silver film forming a continuous conductive non-alkali metallic surface of substantially uniform thickness, a thermosetting plastic resinous coating impregnating only the unplated face of the paper sheet but free from the continuous metallic surface and partially cured to said paper sheet and a phenolic resinous sheet secured thereto.

8. A method of manufacturing a plate or sheet having an electrical conductive non-alkali metallic plated coating which comprises taking a base sheet of flexible, impregnable paper material, evaporating a non-alkali conductive metallic film on only one surface thereof, then plating over the film with a continuous conductive non-alkali metallic coating, washing, rinsing and drying the sheet, impregnating the unplated side only with a liquid thermosetting resin, partially curing the same on the sheet and finally curing to the partially cured face of said sheet with heat and pressure a partially cured thermosetting base sheet.

9. A method of manufacturing a plate or sheet having an electrical conductive non-alkali metallic plated coating which comprises taking a base sheet of flexible, impregnable paper material, evaporating a non-alkali conductive metallic film on only one surface thereof, then plating over the film with a continuous conductive non-alkali metallic coating, washing, rinsing and drying the sheet, impregnating the unplated side only with a liquid thermosetting resin, partially curing the same on the sheet and finally curing to the partially cured face of said sheet with heat and pressure a fully cured thermosetting base sheet.

10. A plate or sheet having a conductive non-alkali metallic plated coating comprising a sheet of paper material having deposited on one side thereof a thin metallic non-alkali film of substantially less than .001", a conductive non alkali

metallic coating plated on said film of the order of .001" in thickness providing a continuous closed surface and a thermosetting plastic resin forming a coating on the other side of the sheet and impregnating said paper but leaving the plated side of the sheet forming a continuous metallic surface.

11. A plate or sheet having a conductive non-alkali metallic plated coating comprising a sheet of paper material having deposited on one side thereof a thin metallic non-alkali film of substantially one micron, a conductive non-alkali metallic coating plated on said film of the order of .001" in thickness providing a continuous closed surface and a thermosetting plastic resin forming a coating on the other side of the sheet and impregnating said paper but leaving the plated side of the sheet forming a continuous metallic surface.

12. A plate or sheet having a conductive non-alkali metallic plated coating comprising a sheet or paper-like material having deposited on one side thereof a thin metallic non-alkali film of substantially less than .001", a conductive non-alkali metallic coating plated on said film of substantially .001" in thickness and a thermosetting plastic resin forming a coating on the other side of the sheet and impregnating said paper but leaving the plated side of the sheet forming a continuous metallic surface, said coating and impregnation being cured in the sheet so formed.

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