

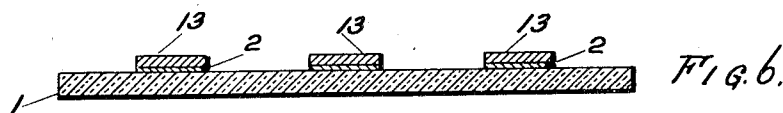
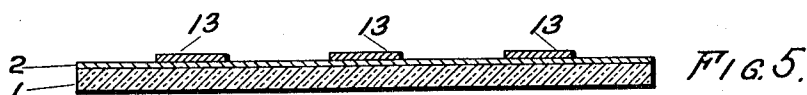
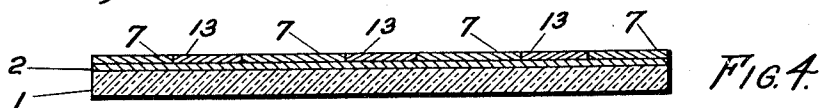
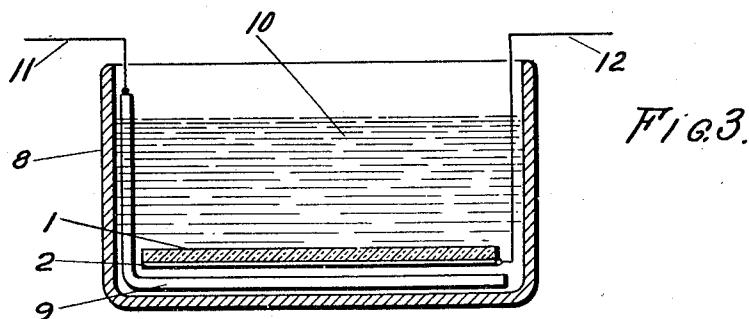
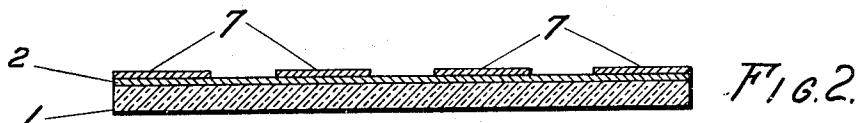
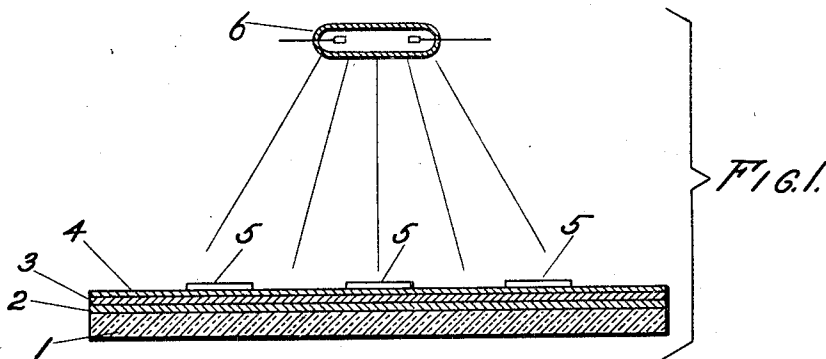
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2,443,119

PROCESS OF PRODUCING PREDETERMINED METALLIC PATTERNS

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PROCESS OF PRODUCING PREDETERMINED METALLIC PATTERNS

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2 Claims. (Cl. 204-18)

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This invention relates to a method of forming a predetermined pattern of electrically conducting lines which may serve as one or more elements of an electrical system.

An object of this invention is to devise a method whereby a pattern of electrically conducting lines of any degree of complexity may be reproduced by photochemical means in a simple, reliable and inexpensive manner.

The foregoing and other objects of this invention will be best understood from the following description of exemplifications thereof, reference being had to the accompanying drawings wherein:

Figs. 1-6 are diagrammatic views illustrating the various steps in one form of my novel process.

The pattern of conducting lines or members may be formed on any suitable carrying or base member 1, such as an insulating plate of plastic or ceramic material, or the like. To the surface of the member 1 is secured a conducting film of metal 2. The film 2 is covered with a film or layer 3 of a suitable light-sensitive material, such as bichromated albumen, glue, gelatin, gum, resin, colloid, or the like, all of which are adapted to be modified under the action of actinic radiations, as indicated below.

A satisfactory composition for coating the member 1 with a bichromated albumen layer is made by mixing 7½ grams of dried albumen and 6 grams of ammonium bichromate in 1000 cc. of water until a complete solution or suspension is obtained. This composition may then be coated on the member 1 and dried.

The desired pattern is formed on a negative 4 which may be a transparent sheet having opaque portions 5 thereon corresponding to the conductive portions of the final device. The negative 4 is placed on the light-sensitive layer 3, and the assembly subjected to the action of a source of actinic light 6, light from which shines through the negative 4 and falls upon the light-sensitive layer 3. After the proper exposure, the actinic light source 6 is extinguished and the negative 4 is removed. The assembly is then developed in water or alcohol, alcohol being used in the case of light-sensitive resin. The action of the actinic light hardens that portion of the light-sensitive layer 3 upon which it falls, and renders it insoluble in the developing liquid. The unexposed portions of the layer 3, however, are soluble in the developing liquid, and are therefore removed during the developing process, as shown in Fig. 2. This leaves the hardened insoluble portions 7 on the metal film 2 with intervening portions of the metal film 2 exposed.

As shown in Fig. 3, the assembly is then placed in a tank 8 containing a plating electrode 9 and a suitable plating electrolyte 10, preferably such as to deposit copper. A conductor 11 is con-

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nected to the electrode 9 and another conductor 12 is connected to the conducting film 2. A suitable source of plating potential is then connected between conductors 11 and 12 so as to make the film 2 the cathode, whereupon conducting metal, such as copper, is deposited upon the exposed portions of the metal layer 2 to the desired thickness, in accordance with known electroplating technique. Although I have shown an electroplating step, it is to be understood that in certain instances other plating methods involving the deposition of metal upon the exposed portions of the metal film 2 may be resorted to.

Upon removing the assembly from the plating bath, the metal film 2 will have deposited thereon conducting metal portions 13 wherever the film 2 was not covered by the hardened insoluble portions 7, as shown in Fig. 4.

In the above process the portions 7 were presumed to be sufficiently resistant to the action of the electrolyte 10 and sufficiently insulating to produce a satisfactory electric plating upon the exposed portions of the film 2. In some cases these portions 7 may not have these necessary properties. Under these conditions, after exposure to the actinic light and before developing, the layer 4 is coated with a thin film of greasy ink. The assembly is then developed, as before, in water or alcohol, and the insoluble portions 7 which are left each will be coated with a film of greasy ink, the ink on the soluble portions of the layer 4 being removed along with said soluble portions. Thereupon powdered bitumen or a finely-powdered insulating plastic of low melting point is spread upon the developed surface, causing said powdered material to stick to the greasy ink. It may be desirable to agitate the plate sufficiently to loosen any powdered material which tends to adhere to the bare metal of the layer 2. The assembly is then washed in water to be sure that the bare metal of the layer 2 is free of the powdered material. The assembly is then heated to a temperature at which the powdered material melts and forms a protective insulating and acid-resisting coating on the hardened portions 7. The assembly is then electroplated as described above in connection with Fig. 2.

In either of the above processes, after the electroplating, the remaining bichromated layer is removed with a lye solution. Where the greasy ink and bitumen have been used, they are first removed with turpentine prior to the treatment with the lye solution. Thus the arrangement as shown in Fig. 5 is produced in which the metal deposits 13 are alone left upon the metal film 2.

After the removal of the hardened portions 7, the assembly is dipped for a short period of time into an acid bath which etches away the thin film of metal 2 between each metal deposit 13.

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The thickness of the metal deposit 13 and the duration of the acid dip are so correlated that an insignificant portion of the deposit 13 is removed. The result is the arrangement as shown in Fig. 6, in which the insulating plate 1 carries the metal deposits 13 separated from each other by insulating material.

For certain purposes it may be practicable to start with an insulating plate 1 covered by a metal layer 2 having a sufficient thickness to provide the necessary electrical conductivity and being in turn coated by the light-sensitive layer 3. Under these conditions the process may be carried out to the stage as represented by Fig. 2, the negative 4 having the characteristics as described in the preceding paragraph. Thereupon the exposed metal of the layer 2 is removed by an acid etching bath. It may be desirable to remove the exposed metal by electrolytic etching. After the exposed metal is thus removed, the hardened portions 7 are removed as described above, leaving the metal layer 2 disposed in the desired conducting pattern on the plate 1.

Although in the above processes the negative 4 has been described as in contact with the light-sensitive layer 3, it is to be understood that the desired pattern may be projected as an actinic light image on said layer 3. In this way any desired size ratio may be secured between the pattern on the basic negative and the pattern reproduced on the finished article.

The foregoing processes lend themselves to the mass production of various devices in a simple manner and with a minimum of skill to be exercised by the person or persons carrying out the processes.

While the above processes are particularly applicable to the production of electrical equipment, certain aspects of this invention may be applied to other types of devices. For example it may be desired to produce a piece of glass which is opaque except for transparent figures thereon. In order to produce a device of this kind, a glass layer coated with a silver film is in turn coated with a bichromated layer, all as illustrated in Fig. 1. If the arrangement is then treated as described in connection with Figs. 1 and 2, it will be seen that in the final product the glass will be coated with an opaque layer of metal, except at the desired portions where the glass is transparent, said portions being produced after finally etching away the exposed portions of the film 2 where it is not coated with the deposited metal.

It is also to be understood that in the case of electrical equipment, a complete and complex circuit, including such elements as resistances, condensers, chokes and the like, may be formed in accordance with my invention.

What is claimed is:

1. The method of producing a predetermined pattern of metallic members secured to an insulating base which comprises preparing an insulating base member having an electrically-conducting surface with a coating of a photochemically-active material normally soluble in a selected developing fluid, said material being adapted to be changed into a form insoluble in said developing fluid when subjected to actinically-active radiations, shining said radiations onto said coating while blocking off said radia-

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tions along the predetermined pattern to be reproduced, whereby said coating, where it is subjected to said radiations is changed into its insoluble form, covering said coating with a film of greasy ink, dissolving the remaining soluble coating by said developing fluid to expose the underlying conducting surface, covering the remaining surfaces bearing the greasy ink with powdered insulating plastic material having a melting point substantially below the melting point of said insulating base, melting said powdered insulating material, allowing said melted insulating material to reharden, plating metal upon the exposed conducting surface, and removing the last-named insulating material, the greasy ink, the insoluble portions of said coating and the conducting surface beneath it to expose the underlying insulating base member, leaving said predetermined pattern of metallic members secured to said insulating base member.

2. The method of producing a predetermined pattern of metallic members secured to an insulating base which comprises preparing an insulating base member having an electrically-conducting surface with a coating of a photochemically-active material normally soluble in a selected developing fluid, said material being adapted to be changed into a form insoluble in said developing fluid when subjected to actinically-active radiations, shining actinic radiations through a negative onto said coating, said negative having a predetermined pattern of transparent and opaque portions, whereby said coating, where it is subjected to said radiations shining through said transparent portions, is changed into its insoluble form, covering said coating with a film of greasy ink, dissolving the remaining soluble coating by said developing fluid to expose the underlying conducting surface, covering the remaining surfaces bearing the greasy ink with powdered insulating plastic material having a melting point substantially below the melting point of said insulating base, melting said powdered insulating material, allowing said melted insulating material to reharden, plating metal upon the exposed conducting surface, and removing the last-named insulating material, the greasy ink, the insoluble portions of said coating and the conducting surface beneath it to expose the underlying insulating base member, leaving said predetermined pattern of metallic members secured to said insulating base member.

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