Etched Foil Printed Circuits

With Particular Reference to Photomechanical Methods of Production

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FOR the production of identical circuit patterns in large quantities, printed wiring is becoming increasingly popular. At the time of writing, only wiring is being attempted; the printing of component parts, with the exception of r.f. coils and low-value capacitors, is still a long way off.

The etched foil method appears to offer more advantages than other methods, and is more easily scaled down for use in laboratories and in pilot plant production. Basically, this system uses a thin copper foil, usually between 0.001 and 0.002in thick, bonded to an insulating material; this may be practically any type of laminate but, as it needs to be machined, cut and punched, synthetic resin bonded paper (s.r.b.p.) is almost universally used. Special circuits may need either a base material suitable for use at higher temperatures than s.r.b.p. or one possessing better dielectric properties (lower permittivity and power factor). The printed circuit pattern is impressed on to the copper in acid-resisting ink (the resist) and all the unwanted copper is removed by etching in a weak acid.

Methods of Printing.—The word "printing" is used in a loose way when discussing "printed" circuits. Sometimes real printing methods are used, such as the offset-litho or the silk-screen, but photography is often used to produce the same result, and, although this is hardly "printing," the method is very similar to that used in making printing plates of the "line" or "half-tone" variety.

A few words about the non-photographic methods will show the relative merits of each.

Offset-Litho Methods.—When a large quantity of printed circuits is required, the offset-litho method is probably the most suitable way of producing them. The work is done by specialist printers using a flat-bed machine over which a roller travels from end to end. The printing plate is made by a method very similar to the one to be described in detail, but it is made on an aluminium sheet which has been lightly roughened or "grained." The prepared plate is placed on the bed of the press where it is first inked and then traversed by a blanket roller, usually of rubber, which transfers its inky pattern to the copper-clad laminate. The layer of ink transferred from the printing plate to the laminate is very thin and would not in itself stand up to the acid which is later used to remove all the unwanted copper, leaving the pattern alone on the insulated base. A layer of powdered bitumen or resin is brushed or blown on to the inky pattern and adheres to it. This is fused by heat to form a reinforced layer that will resist the acid etchant.

This process is carried out by skilled printers using standard methods and equipment, as used in the quantity production of nameplates, etc. It is not possible to scale it down to laboratory proportions.

Silk-Screen Methods.—The silk-screen method of printing is extensively used for the production of large-sized prints, e.g., posters. It is attractive for printing circuits because of its general use in the radio and electronic industry for the printing of dials, scales, etc. Circuit and nameplate printing both use non-absorbent base materials—an essential difference to printing on paper. The method of production may be scaled down for use in the laboratory and it is quite economical for the making of a few prints, but several hundred may also be made in the same way.

The silk-screen consists of a fine woven material either of silk or fine wire, which is stretched tightly over a wooden or metal frame. The pattern is made into a stencil by photographic means and this is attached to the silk, leaving holes only where the pattern is required, all the rest being blanked out. The laminate is placed under the screen, ink is poured on one end and transferred to the other by means of a square-cut rubber squeegee. In this way the ink is forced through the holes in the stencil and forms a pattern on the laminate. The inks used for silk-screen work are very viscous and, as a thick layer can be applied, they are, when dry, good acid resists.

Limitations of Offset-Litho and Silk-Screen Methods.—Apart from difficulties in production which have already been mentioned, there are technical reasons why both the methods discussed are unsuitable for certain electronic circuits. The most serious limitation is in the degree of fine detail that can be obtained by their use.

In a large number of circuits, fine detail is not necessary and it should be part of the design to eliminate unduly narrow lines and spaces, but when these cannot be avoided, or when coils must be printed, photographic printing methods must be used.

Photomechanical Methods.—Printing on metals is not done by the same means as is used in portrait or landscape photography, neither are emulsions stripped from plates and transferred to metal surfaces. The process is to deposit a photo-sensitive material on to the plate, then expose and develop it.

When making printing plates or blocks, the base material is metal and is able to withstand heating, which hardens the coating material and greatly improves its acid resistance. In addition, the etching is only carried on for a fraction of a mil (thousandth of an inch)—in the trade a "deep etch" is 0.0005in. For circuit printing, the copper must be etched right through and, as it is usually about 0.0015in thick, this may take 10-15 minutes or more, according to the density of the etchant and its temperature, and on the degree of agitation.

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