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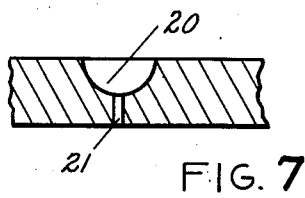
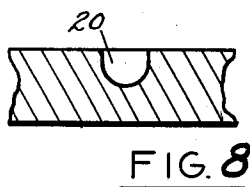
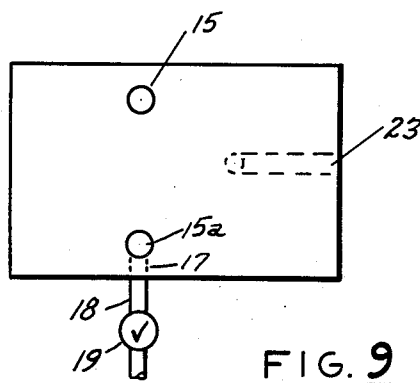
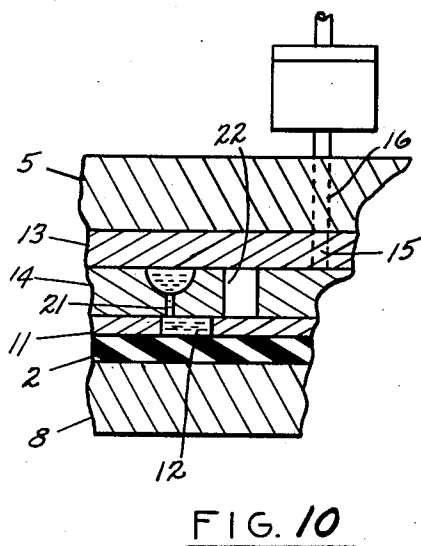
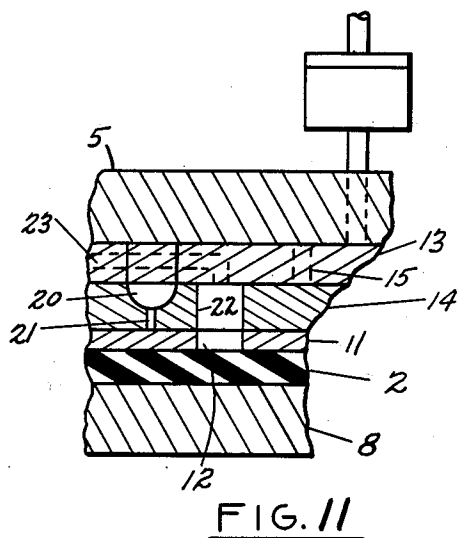
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APPARATUS FOR PRODUCING PRINTED CIRCUITS

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2 Sheets-Sheet 2



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1

2

2,766,482

APPARATUS FOR PRODUCING PRINTED CIRCUITS

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4 Claims. (Cl. 18—30)

This invention is intended to print resistors or conductors on an insulating base by the use of a stencil having openings corresponding to the dimensions of the resistors to be printed. While the openings are being filled the stencil has its under face pressed against the surface of the base on which resistors are to be printed and has its upper face closed by a valve plate. After filling of the stencil openings by injection of a fluid resistance material such as a carbon varnish mixture, the injection is shut off and the valve plate is moved to vent the upper surface of the stencil openings. Then when the resistor carrying base is separated from the stencil, substantially all of the resistance material is deposited on the base and a negligible, or at least a uniform amount, adheres to the edges of the stencil openings.

In the drawings, Fig. 1 is a plan view of a printed electric circuit having three resistors printed thereon in contact with leads carried by a base of insulating material; Fig. 2 is a section on line 2—2 of Fig. 1; Fig. 3 is a section through apparatus for printing the resistors in the printing position; Fig. 4 is a section similar to Fig. 3 with the apparatus in the venting position; Fig. 5 is a top plan view of the stencil through which the resistors are printed; Fig. 6 is a top plan view of the lower plate of the valve; Figs. 7 and 8 are sections on the correspondingly numbered lines in Fig. 6; Fig. 9 is a top plan view of the upper plate of the valve; Fig. 10 is an enlarged fragmentary section through the apparatus in the printing position; and Fig. 11 is a view similar to Fig. 10 in the venting position.

The invention is shown applied to the printing of an electrical circuit having three resistors 1 printed on a base 2 of suitable insulating material carrying leads 3 and terminals 4 for making the electrical connections to the resistors and to other circuit elements which may be subsequently attached to the base. The leads and terminals are applied to the base 2 by any of the techniques available for printing electric circuits, and are preferably applied before the printing of the resistors. The resistors are printed from suitable resistance material, which may for example consist of carbon carrying paints which typically consist of carbon black, a varnish binder, a filler and a solvent. Such resistance paints are commercially available.

The resistors are printed in a press having an upper platen 5 carrying a reservoir 6 for the resistance paint which is fed under pressure developed from a piston 7. The upper platen is ordinarily stationary. The press has a lower platen 8 which is vertically reciprocable by means of a plunger 9. The upper surface of the platen 8 has a cavity 10 for receiving and locating the base 2 on which the resistors are to be printed. After the base is loaded into the cavity 10, a stencil 11 is placed on the upper surface of the platen 8 and is suitably aligned (by means not shown) so that openings 12 in the stencil register with the sections of the base 2 on which resistors are to be printed. The stencil 11 is preferably made of a conforming material such as rubber, a flexible plastic such as polyethylene, or a suitable paper. If the upper surface

of the base 2 were flat the stencil 11 could be made of metal. The purpose of having the stencil 11 of conforming material is to make a tight seal between the openings 12 in the stencil and the upper surface of the base 2 on which the resistors are to be printed. The sealing function obviously only requires that the openings 12 in the stencil be defined by material having the properties of gaskets.

On the under side of the upper platen 5 is carried a composite valve member consisting of an upper valve plate 13 and a lower valve plate 14. The upper valve plate 13 controls the flow of resistance paint from the reservoir 6. For this purpose, the upper valve plate has an opening 15 which in the printing position shown in Fig. 3 registers with a passageway 16 leading from the reservoir 6. In the venting position at the end of the printing operation, the opening 15 is out of register with the passageway 16 so that the flow of resistance paint from the reservoir is shut off. If desired, the upper valve plate 13 can also be provided with an opening 15a, which in the printing position will register with another passageway 16 leading to another reservoir of the same construction as the reservoir 6 and serving as an overflow reservoir. This opening 15a in the venting position will be out of register in the same manner as the opening 15 so that the overflow reservoir will be shut off. The purpose of the overflow reservoir is to vent the stencil cavities so that air trapped in the cavities will not interfere with the complete filling of the cavities. The venting problem has heretofore been encountered in injection molding and many expedients are available for venting. The opening 15a may for example be connected by a passageway 17 to the suction line 18 controlled by a valve 19. Either prior to or during the filling of the cavities in the stencil, the valve 19 can be opened so as to remove the air from the cavities. At the end of the filling operation, the valve 19 can be closed. This is one of the expedients used in injection molding or casting for removing the air from the casting cavity.

The lower valve plate 14 which is rigidly fixed to the upper valve plate 13 has in its upper surface grooved passageways 20 which lead from the underside of the opening 15 to openings 21 which in the filling position shown in Fig. 3 register with one end of the openings or cavities 12 in the stencil. The grooves 20 are like the runners used in casting. In the venting position shown in Fig. 4, the openings 21 are moved to one side of the cavities 12 in the stencil so as to shut off the flow of resistance paint into the cavities. For the purpose of venting the cavities 12 there may be grooves 20a in the upper side of the valve plate 14 leading to openings 21a which register in the printing position with the opposite end of the stencil cavities 12 so as to remove the air from these cavities and permit the complete filling thereof. In the venting position the openings 21a, like the openings 21, are moved to one side so that there can be no removal of the resistance paint from the stencil cavities.

The lower valve plate 14 also has openings 22 which in the printing position shown in Fig. 3 are to one side of the stencil cavities 12 and in the venting position shown in Fig. 4 are in register with the stencil cavities. In the venting position, where the openings 22 register with the stencil cavities 12 the upper surface of the stencil cavities is vented to the atmosphere for example by passageways 23 in the upper valve plate 13. In order not to complicate the drawing, only one of the passageways 23 is shown. There will, however, be at least one of the passageways 23 for each of the cavities 12. The passageway 23 is shown connected at all times to the opening 22. This does not interfere with the injection printing because during printing the openings 22 are out of register with the stencil cavities 12.

3

After the valve plate has been moved to the Fig. 4 position the lower platen 8 of the press can be lowered and the resistance paint in the stencil cavities will remain on the base 2 as the stencil 11 is separated from the base. A small amount of the resistance paint will stick to the edges of the stencil cavities 12, but this amount will be negligible, or at least not subject to great variation because the edges of the stencil cavities 12 are quite thin compared to the other dimensions of the cavities.

The operation will be readily apparent from the enlarged fragmentary views, Figs. 10 and 11. Fig. 10 shows the printing position of the apparatus where the base 2 carrying the stencil 11 is pressed against the underside of the valve plate 13, 14 by the platen 8. In this position, the opening 21 in the lower valve plate 14 registers with one end of the cavity 12 in the stencil and the opening 15 in the upper valve plate 13 registers with the passageway 16 in the upper press plate 5 leading to the reservoir 6 containing the supply of resistance paint which is fed under pressure. By this arrangement, the entire stencil cavity 12 is filled with resistance paint. This insures the deposition of resistance paint to a measured thickness and area on the upper surface of the base 2. Either before or during the filling, the air in the cavity 12 is evacuated so that there are no forces restricting the complete filling of the stencil cavity. At the end of the printing operation when the valve plate 13, 14 is moved to the left as viewed in Fig. 3, the opening 22 in the valve plate 14 is brought into register with the stencil cavity 12 and the opening 21 in the lower valve plate 14 is moved out of register with the stencil cavity thereby shutting off the flow of resistance paint into the stencil cavity. This same movement also moves the opening 15 in the upper valve plate 13 out of register with the passageway 16 to further shut off the flow of resistance paint. Since the opening 22 in the lower valve plate 14 is vented to atmosphere by the passageway 23, in the venting position shown in Fig. 11, there are no forces on the upper surface of the resistance paint in the stencil cavity 12 tending to lift the paint out of the cavity. Due to the sealing between the lower surface of the lower valve plate 14 and the upper surface of the stencil 11, the sidewise movement of the valve plate 13, 14 to the Fig. 11 position does not tend to remove any of the resistance paint from the stencil cavity. The stencil cavity is accordingly filled completely and the resistance of the paint in the cavity will be uniform. As the lower press platen 8 is lowered and the stencil 11 is lifted off the upper surface of the base 2, by far the greater portion of the paint in the stencil cavity 12 will adhere to the base. A small but controllable amount of the paint will adhere to the edges of the stencil cavity 12, but this amount will not interfere with the uniformity of the resistance of the paint deposited on the upper surface of the base 2.

After the removal of the base from the press, the resistance paint deposited thereon is subjected to the usual drying and curing operations which convert the deposited paint to a solid stable form. These further operations obviously depend upon the type of resistance paint used.

Bases of the type used for printing on electric circuit elements are in some applications non-conforming, i. e. rigid, and not perfectly flat. In such cases, it is necessary to construct the apparatus described above so as to first of all conform to the irregular surface of the base and secondly do so in such a way as to not exert undue pressure which would cause breakage. To accomplish these objectives, the stencil is made of conforming material such as thin metal, polyethylene, or gasket material. The valve parts would be made of similar material, the whole urged into conforming contact with the upper surface of

4

the base by a cushion type of upper platen, such as rubber. Or the upper valve plate itself could be made of cushioning material and of appreciable thickness so that it in itself would take up the variations in height. The lower platen would also be made of a cushioning material such as rubber to equalize the pressure applied to the base which is not flat by the stencil.

What I claim as new is:

1. Apparatus for printing electric circuit elements on a supporting base comprising a stencil overlying the base and having openings with edges in sealing engagement with the base and defining cavities of the desired area of the elements to be printed, a plate slidably overlying the stencil and in sealing engagement therewith, the plate being slidable relative to the stencil to filling and venting positions and in the filling position having walls closing the stencil openings and in the venting position having openings of substantially the size of the stencil openings registering with the stencil openings, injection passageways in the plate leading to the stencil openings in the filling position of the plate, means for injecting paint of the desired electrical properties through said injection passageways into the cavities in the filling position of the plate, and means for thereafter sliding the plate relative to the stencil to the venting position and venting the cavities through the openings in the plate.

2. The apparatus of claim 1 in which the stencil is of flexible gasket material accommodating surface irregularities on the base.

3. The apparatus of claim 1 in which the plate has injection openings registering with the stencil cavities in the filling position through which the paint is injected, said injection openings being opposite an imperforate section of the stencil out of register with the stencil cavities and blocking the flow of paint in the venting position of the plate.

4. Apparatus for printing electric circuit elements on a supporting base comprising a lower platen supporting the base, a stencil overlying the base and having openings with edges in sealing engagement with the base and defining therewith cavities of the area and thickness of the elements to be printed, a cooperating upper platen having on its under surface a slide valve, the under surface of the valve being slidable on and sealing against the upper surface of the stencil when the platens are closed, said valve having injection openings alignable with the cavities in one position of the valve and in said one position having flat surfaces cooperating with the stencil cavities to define the top walls thereof, and said valve having other openings of substantially the size of the stencil openings registering with the stencil openings in another position of the valve, said valve being slidable over the stencil from said one to said other position while the platens are closed, means for injecting paint of the desired electrical properties through the injection openings when the valve is in said one position, and means for venting to the atmosphere the other openings in the valve when registering with the stencil openings whereby as the platens are opened the paint in the stencil openings is not lifted off the base.

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