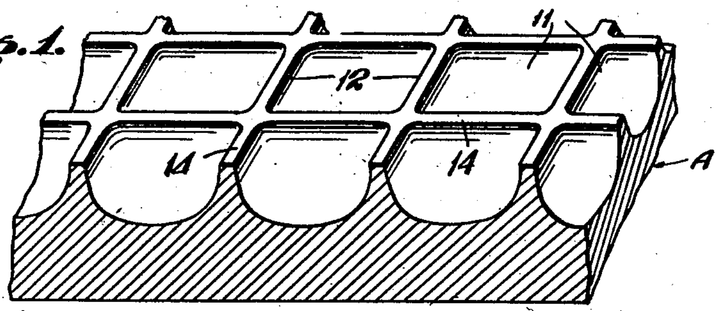
June 23, 1942. E. O. NORRIS 2,287,123

METHOD OF PRODUCING MATRICES FOR THE ELECTROFORMING OF FORAMINOUS SHEETS

Original Filed Oct. 6, 1939

Fig. 1.



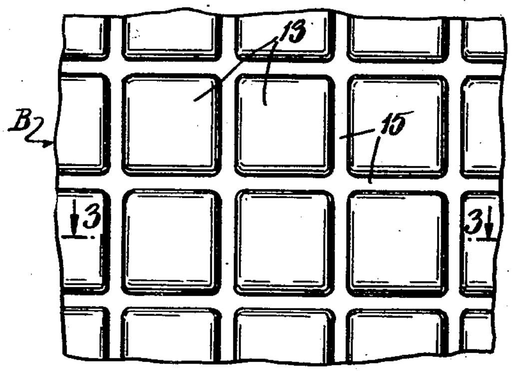


Fig. 2.

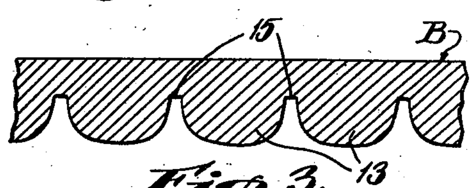


Fig. 3.

Fig. 4.

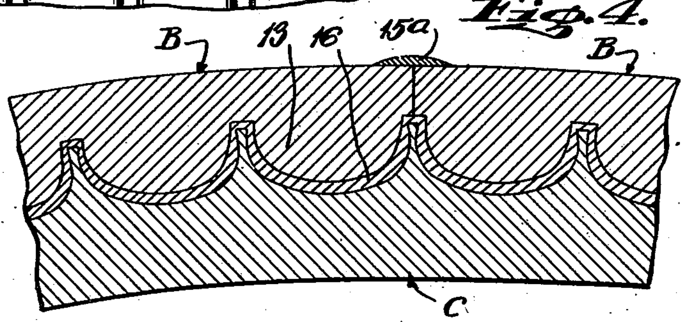
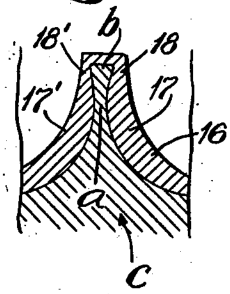


Fig. 4a.



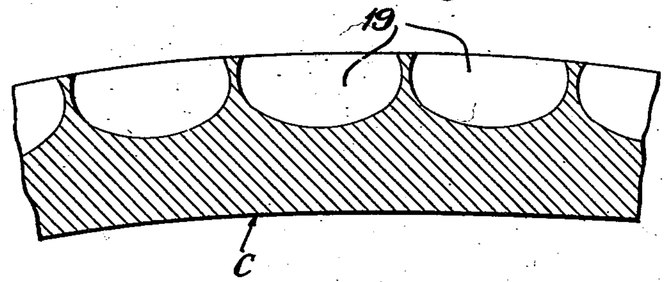


Fig. 5.

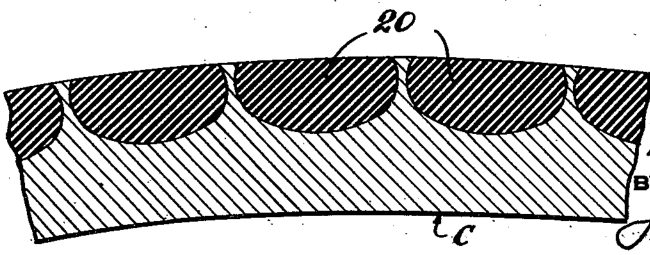


Fig. 6.

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METHOD OF PRODUCING MATRICES FOR THE ELECTROFORMING OF FORAMINOUS SHEETS

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Original application October 6, 1939, Serial No. 298,216. Divided and this application January 21, 1941, Serial No. 375,156

3 Claims. (Cl. 204—11)

This application is a division of my pending application Ser. No. 298,216, filed October 6, 1939, Patent No. 2,250,436, July 22, 1941.

The invention relates to matrices adapted to be employed as a cathode for the reception of a non-adherent electrolytic deposit in the form of foraminous sheet. The deposit-receiving surface of such a matrix comprises a network of electrically conductive material or at least of material capable of receiving an electrolytic deposit, the spaces delimited by said network being of electrically non-conductive material or at least of material that will not receive an electrolytic deposit. In matrices of this character, the insulated areas are produced by first creating a multitude of pits or depressions in a metal surface and then filling the pits or depressions with the insulating material, which may be Bakelite, glass, enamel or other material having the property above described.

The foregoing and various other methods of producing such a matrix are described in my United States Patents Nos. 2,166,366, issued July 18, 1939, and 2,166,367, issued July 18, 1939, and, as the details of the method are not involved in the invention, they will not be further described.

In order that the ultimate foraminous sheet to be produced shall be of as uniform construction as possible, including hole size, hole shape, and land cross-sectional shape, I find that it is desirable in the first place to produce what may be termed a "skeleton screen," which is subsequently built up by a second electroforming step after the skeleton has been removed from the matrix. However, by the simple etching process employed in producing the pits, it is very difficult to control the width of the lands of the matrix when this width gets to be very narrow, for the reason that in such cases the walls of adjoining pits are often broken down, which of course renders the matrix useless. It is therefore the principal object of the invention to produce a matrix having much narrower lands or depositing areas than is possible with a simple etching process.

Referring to the drawing,

Fig. 1 is a perspective view of a fragment of a copper plate provided with a multitude of pits in its surface;

Fig. 2 is a plan view of an obverse of the plate 1;

Fig. 3 is a view on the line 3—3 of Fig. 2;

Fig. 4 is a view showing two successive steps in the process;

Fig. 4a is a detail view of a fragment of Fig. 4;

Fig. 5 is a view in section of a base matrix;

Fig. 6 is a view similar to Fig. 5 showing the pits of the base matrix of Fig. 5 filled with insulating material.

It should be explained that the most practical use to which such a matrix is put is that of producing very "fine" screen—say, from that having fifty apertures to the linear inch to that having several hundred. It is therefore not feasible to illustrate the matrix of my invention except on a very exaggerated scale. Of course, it is also to be appreciated that only a very small area of an actual matrix can be shown.

In practicing the invention, I prefer to employ a base matrix having special characteristics that function to retain the fillings securely locked in place in the pits. The construction which I prefer for this purpose consists in so shaping the pits that, as viewed in vertical section, they appear to be slightly undercut to provide inwardly overhanging edges. A suitable process of producing a matrix of this character will now be described, reference first being made to Figs. 1–6, inclusive.

Fig. 1 shows a plate A which may be of any metal that lends itself to the process as I will describe it, but which is preferably of copper, the surface being provided with the pits 11 isolated from each other by the walls 12, and it will be observed that the walls of each pit flare slightly outwardly as they approach the surface of the plate. Such a plate can be produced by several already known methods, but for a specific description of one method reference is again made to my two patents above referred to.

Briefly, an illustrative method consists in first applying a light-sensitive film, for example of light-sensitized photographer's glue, to the surface of the plate, and then photo-printing a reticulated pattern on the light-sensitive film by projecting light upon it through a screen exhibiting a multitude of opaque dots arranged in rows and columns. After sufficient exposure the film becomes hardened where exposed to the light (i. e., the light passing through the screen between the dots) and the unexposed portions (i. e., where the light is stopped off by the dots) being easily removable by washing. After washing, etching fluid (e. g., ferric chloride) is applied to the plate, resulting in producing the pits 11 where the copper surface is exposed.

An obverse of the pitted surface of the plate just described which I will refer to as the "master plate" is then made by electrolytic deposition, the deposit being likewise preferably of copper. In order that the deposit shall be non-adherent, the surface of the master plate may be coated with a stripping film, for example a very thin film of a solution of carnauba wax in benzol. It is preferable that the solution be applied sparingly, although of course in sufficient quantity to cover the surface, and that the plate be heated in order to result in equal and complete distribution, and removal of the excess. Bronze powder such as is used by electrotypers may be then dusted over the waxed surface. Such a surface although conductive, is non-adherent to electrolytic deposition, and the result of this operation is illustrated in Figs. 2 and 3, the protuberances which are the obverse of the pits of the master plate being indicated by the numeral 13 and the valleys which are the obverse of the lands 14 of the master plate being indicated by the numeral 15.

After the plate of obverse pattern to that of the master plate (which I will indicate as a whole by the letter B) has been stripped from the master plate, it is formed into the shape of a hollow cylinder and its ends joined by any convenient means, such as by solder 15*a*, the protuberances being then located on the interior periphery of the cylinder. To clearly show this, it is possible to illustrate only a section of the cylinder in the region of the juncture. In point of fact, in the case of a cylinder of the curvature shown, protuberances would be almost, and in some cases actually microscopically small. The hollow cylinder formed from the plate B is in turn used as a matrix for the electrolytic deposition of a third plate indicated as a whole by the letter C. First, however, a thin adherent deposit 16 of copper is applied to the patterned surface of the plate B by electrodeposition, and the result is that if this step be carried out under standard conditions of operation, the rate of growth in thickness of the deposit in the depths of the valleys 15 is slower than the rate of growth on more exposed portions of the protuberances. The effect produced is illustrated in detail in Fig. 4*a*, where, as may be observed, the copper is considerably thicker in the regions 17 and 17′ than it is at the bottoms of the valleys as indicated at 18 and 18′. The deposition is carried out to a sufficient extent to cause the areas indicated by 17 and 17′ to approach each other, the ultimate result being that the dimension *a* is less than the dimension *b*, but yet the dimension *b* is much smaller than could be produced by simply etching pits in the original plate. The plate thus produced is illustrated in Fig. 4.

The plate C, of a metal different from copper—e. g., nickel—is now deposited by electrodeposition on the copper surface 16 on the interior of the periphery of the cylinder. While it might appear that the nickel, like the copper, would grow in thickness more rapidly in the regions 17, 17′ than in the regions 18, I find that such is not the case and that the valleys become completely filled with nickel. I am not able to explain this phenomenon except by the theory that it is due to the high throwing power of nickel. The plate B with its added copper film 16 is then removed either by chemical action or by deplating electrolytically, resulting in the plate shown in Fig. 5. If the copper is to be removed chemically, it may be done by subjecting it to the action of (e. g.)—

(1) A solution of potassium cyanide or preferably (2) a mixture of chromic or sulphuric acid in water, suitable proportions being about as follows:

Sulphuric acid	lbs	2
Chromic acid	lb	1
Water	gals	10

Neither of these reagents will have any appreciable effect on the nickel if merely enough time is allowed for the reaction to remove the copper. If removed by deplating, conventional methods may be employed, the entire plate of Fig. 4 being simply employed as an anode in an electrolytic copper bath.

The pits 19 of the plate C are then filled with Bakelite 20, cement or other substance electrically non-conductive or at least incapable of receiving an electrolytic deposit on its exposed surface. Bakelite is preferred.

It will be observed that, by virtue of the fact that the walls of each pit converge slightly as they approach the surface, the fittings 20 are securely locked in place and the cylinder of Fig. 6 with its fillings may serve as a matrix for the electrolytic production of foraminous sheet like screen or other fabric of reticulated pattern.

It is obvious from the foregoing that an important thing in the selection of metals (besides of course their adaptability for electrolytic deposition) is that one be passive to some kind of a corroding agent that has a destructive action on the other and that one have a low and the other a high throwing power as above explained. Nickel and copper have these contrasting properties but are noted merely by way of example, although it may be said that thus far I have found that they answer my purposes more satisfactorily than any other combination.

I have described above certain embodiments of my invention and a preferred process with certain modifications thereof, but I wish it to be understood that these are illustrative and not limitative of my invention and that I reserve the right to make various changes in form, construction, and arrangement of parts and also to make various changes in process of manufacture falling within the spirit and scope of my invention, as set forth in the claims.

I claim:

1. In the method of producing a matrix for the electroforming of foraminous sheet with very narrow lands, the steps which comprise producing a multitude of pits in the surface of a metal plate, rendering the pitted surface including the surfaces of the pits capable of receiving an electrolytic deposit that is non-adherent thereto, producing from the said plate by electrodeposition a second metal plate with a surface that is the obverse of the pitted surface of the first-mentioned plate, building out the resulting protuberances on the said second plate laterally by electrodeposition to partially overhang and narrow the valleys that separate them, electroforming on the said second plate a third plate which is the obverse of the second plate, then removing the second plate from the third plate, and filling the pits in the third plate with material passive to electrolytic deposition.

2. The method of producing a matrix for the

electroforming of foraminous sheet with very narrow lands, which comprises producing a multitude of pits in the surface of a metal plate, rendering the pitted surface including the surfaces of the pits capable of receiving an electrolytic deposit that is non-adherent thereto, producing from the said plate a second plate with a surface that is the obverse of the pitted surface of the first-mentioned plate, building out the resulting protuberances on the said second plate laterally to partially overhang and narrow the valleys that separate them, electroforming on the said second plate a third plate, then removing the second plate from the third plate, and filling the pits in the third plate with material passive to electrolytic deposition.

3. In the method of producing a matrix for the electroforming of foraminous sheet with very narrow lands, the steps which comprise producing a metal plate from the surface of which a multitude of protuberances having electrically conductive surfaces project, building out the said protuberances laterally by electrodeposition until the added electrodeposited material covers the entire surface of the plate including the surfaces of the protuberances and until the said added material partially overhangs and narrows the valleys that separate the protuberances, electroforming on the said plate an obverse of the built-up plate, and then removing the built-up plate from the electroformed plate, and filling the pits in the electroformed plate which are the obverse of the protuberances with material passive to electrodeposition.

EDWARD O. NORRIS.