April 15, 1947. E. O. NORRIS 2,419,028

PROCESS OF PRODUCING MESH FABRIC STENCILS

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Fig. 1.

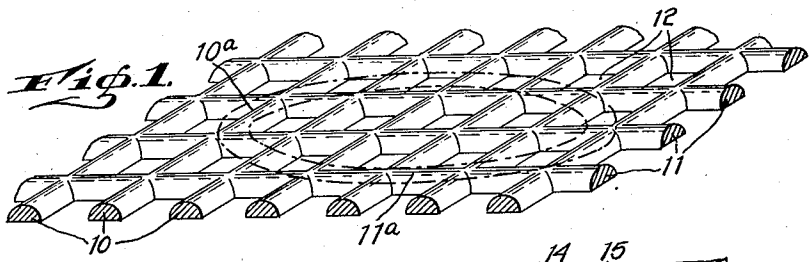


Fig. 2.

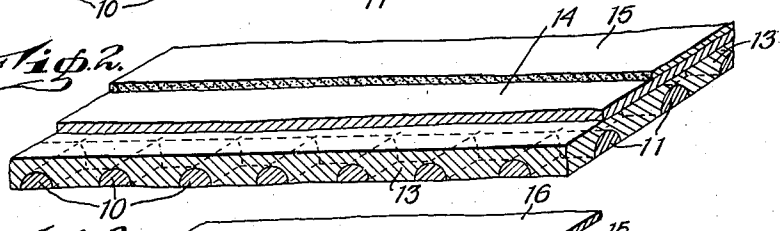


Fig. 3.

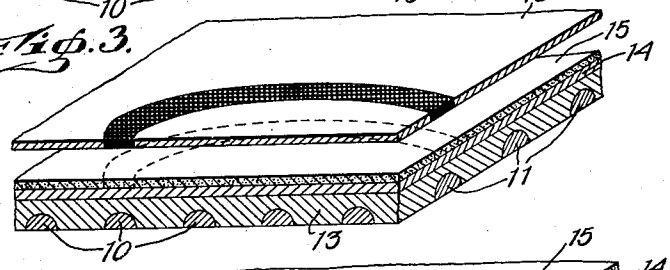


Fig. 4.

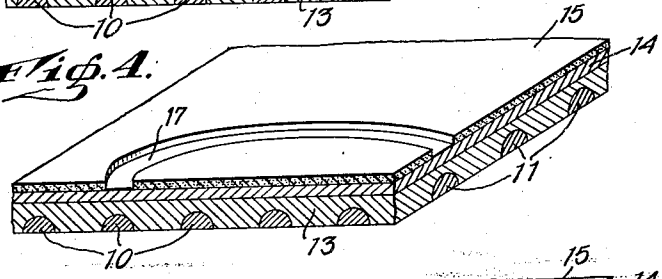


Fig. 5.

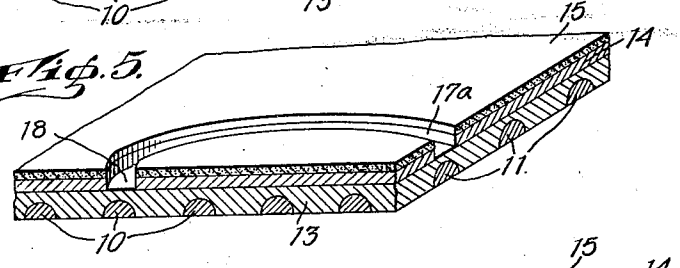
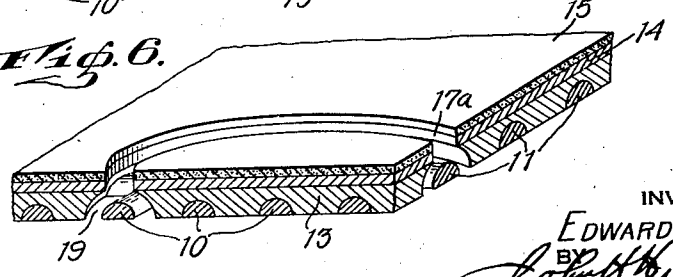


Fig. 6.



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Fig. 7.

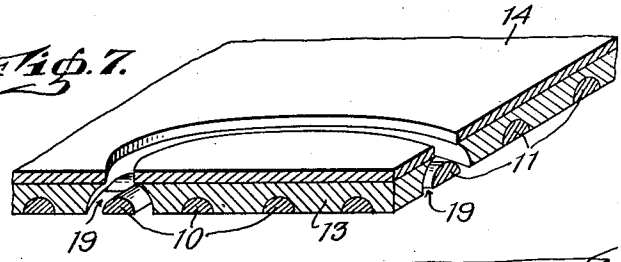


Fig. 8.

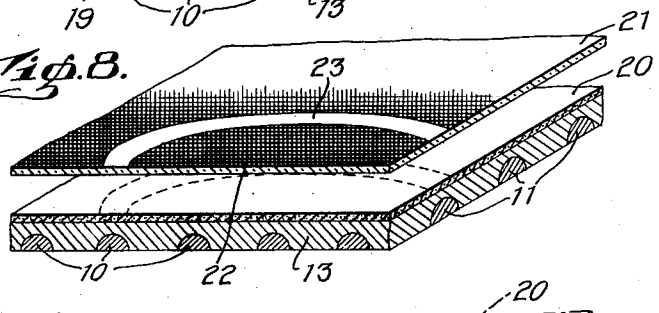


Fig. 9.

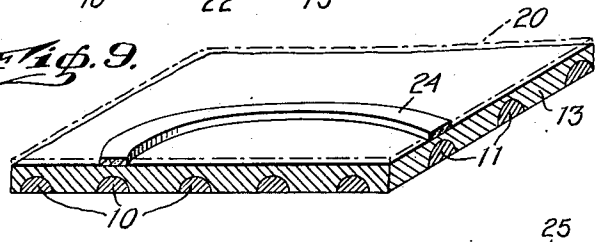


Fig. 10.

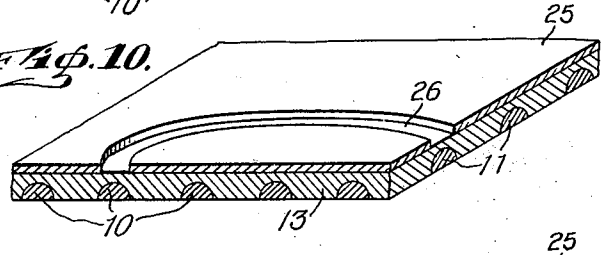
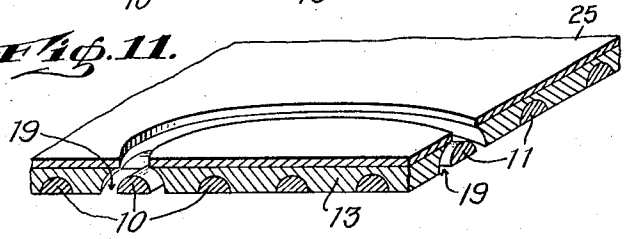


Fig. 11.



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2,419,028

PROCESS OF PRODUCING MESH FABRIC STENCILS

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Application May 16, 1941, Serial No. 393,731

9 Claims. (Cl. 204—11)

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This application is a continuation-in-part of my copending application Ser. No. 376,769, filed January 31, 1941, now Patent No. 2,282,203, granted May 5, 1942.

The invention relates to screen stencils such as are used for making ink and paint impressions of designs, depositing adhesive in the form of a design for flock-printing, applying dyes to form a design, and in general making impressions of a large variety of materials. More particularly, it relates to processes of producing stencils of the general character just described, so constructed that fine lines of the design to be impressed or printed are clearly defined and unbroken, and the edges of larger areas are clearly demarked and are free from the ragged or "saw-toothed" appearance which often characterizes work done with the ordinary screen stencil. In referring to "fine" lines "dots" are included.

The objects will be presently more clearly brought out as the stencil itself and the mode of constructing it are explained in connection with the drawings.

Referring to the drawings,

Fig. 1 is an isometric view showing a portion of stencil base which consists preferably of electroformed foraminous sheet. On the sheet is indicated an area in the form of an annulus which may be taken for purposes of illustration as the design that is to be printed or impressed;

Fig. 2 is an isometric view of a portion of the screen of Fig. 1 showing the screen of Fig. 1 covered with three layers of materials partly broken away;

Figs. 3, 4, and 5 show successive steps in the production of the final stencil;

Fig. 6 illustrates a further step whereby the design is "opened up" through the stencil to permit free passage of the printing agent;

Fig. 7 shows the completed stencil;

Figs. 8, 9, 10, and 11 show a modified process of producing the stencil of Fig. 7.

It is to be realized that the drawings are on a vastly larger scale than would be employed in practice. Usually the base screen would have in the order of from 25 to 100 meshes to the linear inch, and as much as possible of the area would be open, the limit of open area obviously being fixed by the strength of the material, the nature of the use to which the stencil is to be put, etc. In most cases the design wou'd be of a more elaborate nature than what I show in the drawings. However, the principle involved in my invention is the same regardless of the elaborateness of the design, and so I have selected a very simple one by which to explain the process and the final product.

Referring specifically to the drawings,

Fig. 1 shows a portion of an electroformed screen consisting of the wires 10 intersected normally by the wires 11. Preferably, as stated above, the open areas 12 are as large as possible consistent with suitable structural strength. Such a screen and a method of producing it are illustrated and described in my United States Patent No. 2,166,366 issued July 18, 1939, and therefore it is not necessary to go into details as to how the screen itself is produced.

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In using the term "wires" to describe the component parts of the screen structure, I am aware that the word is used in a sense somewhat beyond the usual. However, it is a fact that a true wire structure, such as woven wire screen, would serve my purposes, although, as I have found, not as satisfactorily as does the electroformed screen. In screen of the electroformed type, what I have termed wires are frequently known as "lands." In general, such screen structures may be termed "mesh fabric," which includes, in the ordinary accepted meaning of the term, not only woven fabric but also that which is punched, etched or electroformed as well.

To make the process clear, I have shown on Fig. 1 in dotted lines an annular area which will correspond with the open area of the completed stencil, the remaining areas of the stencil of course being blocked out, as will be presently described, by imperforate sheet superimposed thereon.

In order to make clear the description it should be explained that it involves selective etching—i. e., the employment of etching agents that corrosively react on one material to the exclusion of another, and to avoid complicated language it will be assumed that the material of the base screen is of nickel. On the nickel screen which will eventually serve as a backing for the layers of imperforate material to be laid thereon, is deposited a layer 13 of copper, the copper completely covering the base screen itself to a substantial thickness which, however, is not critical. This copper is applied preferably by electroplating, the "bottom" (with reference to the orientation of the screen as shown in the drawing) being suitably masked by covering it with adherent waxed paper or by other methods well-known in the electroplating art. As an incident to the electroplating step (unless the holes are first filled with electrically non-conductive material), the copper not only overlies the base screen but it also extends into the holes. As will be apparent however, as the description goes on, it is merely necessary that the copper overlie the screen.

As an alternative to masking the bottom face of the screen and then applying the copper layer, the copper layer may be applied to the screen before the latter has been removed from the matrix on which it has been electroformed. To explain, the matrix on which the electroforming

operation takes place consists of a plate of metal to the surface of which is applied a multitude of "dots," preferably in rows and columns, of electrically non-conductive material which correspond in pattern to the apertures in the screen, the exposed metal areas corresponding to the lands of the screen. The "dots" are thick enough to prevent deposition on the areas covered by them. Prior to the depositing step the screen is covered with a thin stripping layer—for example, wax, which while it does not prevent electrodeposition renders the entire surface of the matrix non-adherent to the deposit. If the screen be made in this fashion, the copper layer may obviously be applied to it before it has been removed from the matrix, and therefore no masking is necessary since the copper deposit cannot reach the bottom face of the screen but, on the other hand, will fill the apertures in the screen and overlie the face of the screen.

The copper having been deposited, there is next laid on the copper, also preferably by electroplating, a layer 14 of nickel. To the layer 14 of nickel is then applied a coating 15 of glue or shellac rendered light-sensitive by the presence of ammonium bichromate. The well-known coatings known as "Coldtop" and "Gluetop" serve the purpose very well. The particular type of coating is not however important as long as it is resistant to the etching agent which is employed to etch the nickel, as will be explained.

The next step (see Fig. 3) is to photoprint the design on the light-sensitive coating, which is done by the plate 16 exhibiting a positive of the design indicated by shading in Fig. 3. In other words, the shaded portion is opaque to light and the remaining portion is transparent. The printing being completed, the result is that the area of the light-sensitive coat protected by the shaded area of the plate 16 from the light source is unaffected, while the remaining area is hardened and insoluble to the developer. The light-sensitive coat is then "developed" by washing in water if the glue top be used, consequently exposing the nickel 14 as indicated at 17 (see Fig. 4), where previously covered by the design area. If light-sensitized shellac be used, it would be washed out with an alcoholic preparation sold under the trade name of "Chemco Glascote Developer." The steps of producing the design on the sensitized coat and the steps of developing and exposing the nickel to correspond with it are well-known and need no detailed or further description.

It might be added, however, that the developed coat 15, if of the glue type, may be further hardened by baking, although that has not been found to be necessary.

The next step is to etch through the nickel layer 14 where it is exposed as a result of the developing step, as indicated at 17a. A suitable etching agent for the purpose is ferric chloride for the reason that, while it attacks the nickel, it does not affect the developed coating 15, and therefore the area of its corrosive action is accurately delimited by the edges of the latter. Since this nickel layer will constitute the face of the completed stencil that contacts with the material to be printed upon, it should be thick enough to be not only self-supporting but thick enough to withstand the printing pressure. It is found that, if this layer be roughly one-third of the total thickness of the stencil itself, it is sufficient. Such a nickel layer is thin enough however so that, in etching, the area of corrosive action does not materially spread beyond the confines of the coating. This etching process is of course arrested as soon as it has continued long enough to etch through to the copper layer 13 or perhaps when it has progressed very slightly into the copper. The result of the foregoing etching step is shown in Fig. 5, where the nickel has been etched completely through and the area 18 of the copper surface below it is exposed.

The next step is to continue the etching with an agent that will act corrosively on the copper of the layer 13 but will not affect the material of the layer 14 or the material of the base screen. A suitable etching agent for this purpose is chromic acid or a dilute mixture of sulfuric and chromic acids which actively etches copper but which, since it has not effect or appreciable effect on nickel, will not attack either the layer 14 or the base screen itself. This etching operation is continued until passages are opened from the open areas of the nickel through to the rear surface of the screen, the course of these passages being around the wires of the screen and through the apertures therein; so that ink or other substance to be forced through the stencil to print the desired design will freely travel through the conducting passages between the screen and the copper and emerge in uniform volume and in a solid continuous mass on to the surface being printed. The general conformation of the ink passage is shown in Fig. 6, the spacing between the copper and the screen lands being indicated by the numeral 19. As an incident to this etching step the copper is undercut (see Fig. 6) slightly beneath the marginal area of the nickel leaving these areas overhanging, which makes apparent the necessity as before noted that the nickel layer be thick enough to withstand the printing pressures.

After removing the masking material, if any, from the bottom, the result is that in printing the design appears in a continuous unbroken line, the ink or other substance passing through the stencil unobstructed by the lands of the screen. Prior to actually employing the stencil for printing purposes, the developed coating 15 is removed by the application of a suitable agent, such, for example, as caustic potash. The completed stencil is shown in Fig. 7, its printing face—i. e., the face that contacts with the work being uppermost as shown in the drawing.

The advantages of the stencil can now be brought out more clearly than before. By referring back to Fig. 1, it will be seen that, when the design includes fine lines such as the annular figure which I am using as an illustration, the ordinary process of simply blocking out the stencil to form the design leaves these fine lines in many cases overlying and blocked by portions of the lands. This is brought out in Fig. 1, where, for example, a portion of the annular design traverses for a short distance the land 10a as indicated. It also crosses various other lands and is blocked out by the land 11a. Consequently, when a stencil of this simple form is used for printing fine line figures, especially where the lines are about the width of a screen unit or less, the lines, when printed, appear broken, for the reason that the ink is not delivered at those portions where the design is blocked out by the screen lands. By the term "screen unit" I mean the total width of a screen land and an adjacent aperture. My stencil, however, is distinguished from the standard construction which I have described in that in the former the fine line discharge orifice for

the ink is open at all points to the source of supply on the opposite or rear side of the stencil, and thus the ink or the like comes through freely, passing around the lands of the screen and thence through the discharge orifice in uniform volume and in an unbroken mass. The stencil also has definite advantages even where an area covering many meshes of screen is open, in that the edges of the printed design do not present a ragged or saw-tooth appearance as they would and do where they are partially cut into the screen lands.

Figs. 8–11, both inclusive, show a modification of the process. In this case, as in the previous case, the base screen may be assumed to be of nickel with the copper deposit **13** completely filling the holes and covering the screen itself. From then on the process varies from the process previously described. Instead of applying to the copper a coat of nickel, then a sensitized coat, and printing with a positive of the design, the light-sensitized layer **20** is laid directly on the copper **13**. Printing is then done by a plate **21** which is a negative of the design, the shaded areas **22** being opaque and the unshaded area **23** in the form of the desired design being transparent. The result after printing and developing is shown in Fig. 9 in which the copper surface of the layer **13** is exposed and there is superimposed thereon the hardened sensitized coat **24** conforming to the design. The structure of Fig. 9 is then subjected to an electroplating operation, whereby the layer **25** of nickel is adherently laid on the copper. This layer of nickel, like the layer of nickel in the previous case, is preferably in the order of one-third of the thickness of the stencil, the point being that an unsupported marginal area shall be heavy enough to be not only self-supporting but strong enough to withstand printing pressures after the layer beneath it has been undercut, as will presently be described. The hardened coat **24** is then removed by the application of a suitable agent such as caustic potash, leaving the area **26** of the copper surface exposed in the form of the design. The structure of Fig. 10 is then subjected to an etching process, the etching agent being of a character that does not affect the nickel of the layer **25** or the material of the screen itself. As in the process of Figs. 1–7, this agent may be chromic acid and the etching is carried through to the "bottom" of the plate, creating a free passage for ink or the like from the rear face to and out of the orifices in the nickel plate **25**. As an incident to this etching operation, the copper is undercut beneath the marginal areas of the nickel as shown in Fig. 11. The ultimate result is the stencil of Fig. 11 in all essential respects similar in construction and mode of operation to the stencil of Fig. 7.

In explaining the invention I have up to this point preferred, for the sake of clarity, to name a combination of specific materials in describing ways in which it may be carried out. However, it will be seen that the underlying principles do not necessarily involve the use of the specific materials that I have named. For example, if the base screen were of copper instead of nickel, the layer **13** could be of zinc instead of copper and the layer **14** of copper in place of nickel. In such case, however, the selection of etching agents would need to be adapted to bring about the selective actions that are necessary. In the case just supposed, for example, the photographic printing might be through a positive transparency of the design as shown in Fig. 3. The first etching agent could be ferric chloride as before, for the reason that, while it attacks the copper, it does not affect the developed coating **15**. This first etching would remove or dissolve the copper and perhaps, to a very slight depth, the zinc. The next etching must, however, be of such a nature as to etch the zinc but not affect the copper, for the reason that the base screen, which is of copper, must be preserved and also the edges of the copper layer must remain intact. A suitable etching agent for this purpose is sulphuric acid diluted with water, which actively attacks zinc but does not affect copper.

If other combinations of metals than nickel or zinc and copper or other types of sensitized coating are used, it is necessary to select etching agents that will act selectively in accordance with the foregoing principles. As to the combination of nickel and copper, I have selected them as preferable because they are adaptable for stencil purposes, are readily etched selectively, are comparatively inexpensive, and lend themselves readily to electroforming process.

In applying the successive layers of metal in my several methods, electroplating acts most satisfactorily. Where etching is referred to, electrolytic deplating is included wherever the process is applicable.

I have described above certain embodiments of my invention and a preferred process for producing it 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 the process of manufacture, including the order in which the several steps shall be carried out, falling within the spirit and scope of my invention as set forth in the claims.

I claim:

1. The process of producing mesh fabric stencil, which comprises superimposing on a sheet of metal screen a solid adherent layer of material, superimposing on the said layer a second adherent layer of material substantially thinner than the first layer, the first layer being reactive to an etchant to which the screen and the second layer are passive, blocking a design on the second layer by means of a resist passive to an etchant that reacts on the second layer, some of the areas of said design being narrower than the lands of the screen, etching the design through the second layer to the first layer by means of said etchant, etching through the first layer by means of an etchant that is passive to the screen and to the second layer until communicating passages are established from the uncovered face of the screen through the interstices thereof and through the second layer to the open areas of the first layer.

2. The process of producing mesh fabric stencil, which comprises superimposing on a sheet of metal screen a solid adherent layer of material and filling the interstices of the screen with the same, superimposing on the said layer a second adherent layer of material substantially thinner than the first layer, the first layer being reactive to an etchant to which the screen and the second layer are passive, blocking a design on the second layer by means of a resist passive to an etchant that reacts on the second layer, some of the areas of said design being narrower than the lands of the screen, etching the design through the second layer to the first layer by means of said etchant, etching through the first layer by means of an

etchant that is passive to the screen and to the second layer until communicating passages are established from the uncovered face of the screen through the interstices thereof and through the second layer to the open areas of the first layer.

3. The process of producing mesh fabric stencil, which comprises superimposing on a sheet of metal screen a solid adherent layer of metal, superimposing on the said layer a second adherent layer of metal substantially thinner than the first layer, the first layer being reactive to an etchant to which the screen and the second layer are passive, blocking a design on the second layer by means of a resist passive to an etchant that reacts on the second layer, some of the areas of said design being narrower than the lands of the screen, etching the design through the second layer to the first layer by means of said etchant, etching through the first layer by means of an etchant that is passive to the screen and to the second layer until communicating passages are established from the uncovered face of the screen through the interstices thereof and through the second layer to the open areas of the first layer.

4. The process of producing mesh fabric stencil, which comprises superimposing on a sheet of nickel screen a solid adherent layer of copper, superimposing on the copper layer a layer of nickel substantially thinner than the copper layer, blocking a design on the layer of nickel by means of a resist that is passive to an etchant that reacts on the nickel, some of the areas of said design being narrower than the lands of the screen, etching the design through the nickel layer to the copper layer by means of said etchant, etching through the copper layer by means of a second etchant that is passive to nickel until communicating passages are established from the uncovered face of the screen through the interstices thereof and through the copper layer to the open areas of the nickel layer.

5. The process of producing mesh fabric stencil, which comprises superimposing on a sheet of nickel screen a solid adherent layer of copper, superimposing on the copper layer a layer of nickel substantially thinner than the copper layer, blocking a design on the layer of nickel by means of a resist that is passive to ferric chloride, some of the areas of said design being narrower than the lands of the screen, etching the design through the nickel layer to the copper layer by means of ferric chloride, etching through the copper layer by means of a dilute mixture of sulphuric and chromic acids until communicating passages are established from the uncovered face of the screen through the interstices thereof and through the copper layer to the open areas of the nickel layer.

6. The process of producing mesh fabric stencil, which comprises superimposing on a sheet of nickel screen a solid adherent layer of metal other than nickel, then superimposing on the said layer a second layer of material differing from that of the first layer substantially thinner than the first layer, blocking a design on the said second layer by material resistant to an etchant that acts on the second layer, some of the areas of said design being narrower than the lands of the screen, etching the design through said second layer by means of said etchant, then etching through the first layer by means of a second etchant to which the second layer and the screen

are resistant until passages from the uncovered face of the fabric about the wires of the fabric and thence to the etched areas of the second layer are established.

7. The process of producing mesh fabric stencil, which comprises superimposing on a sheet of screen of non-cuprous metal a solid layer of copper, then superimposing on the copper layer a second layer of non-cuprous metal substantially thinner than the first-mentioned layer, blocking a design on the said second layer by material resistant to an etchant that acts on the second layer, some of the areas of said design being narrower than the lands of the screen, etching the design through said second layer by means of said etchant, then etching through the copper layer by means of a second etchant to which the second layer and the screen are resistant until passages from the uncovered face of the fabric about the wires of the fabric and thence to the etched areas of the second layer are established.

8. The process of producing mesh fabric stencil, which comprises superimposing on a sheet of nickel screen a solid adherent layer of metal other than nickel, filling the interstices of the screen with the same metal, then superimposing on the said layer a second layer substantially thinner than the first layer and of metal differing from the first layer, blocking a design on the said second layer by material resistant to an etchant that acts on the second layer, some of the areas of said design being narrower than the lands of the screen, etching the design through said second layer by means of said etchant, then etching through the first layer by means of a second etchant to which the second layer and the screen are resistant until passages from the uncovered face of the fabric about the wires of the fabric and thence to the etched areas of the second layer are established.

9. The process of producing mesh fabric stencil, which comprises superimposing on a sheet of nickel screen a solid adherent layer of copper, superimposing on said layer of copper a solid adherent layer of nickel substantially thinner than the first layer, blocking a design on the said layer of nickel, some of the areas of said design being narrower than the lands of the screen, etching said design through said layer of nickel by means of ferric chloride, then etching through the copper by means of chromic acid until the liquid conveying passages leading from the uncovered face of the fabric, then about the wires of the fabric, and thence to the open areas of the layer of nickel are established.

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