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W. BEEBE

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PROCESS FOR THE ELECTROLYTIC PRODUCTION OF METAL SCREENS

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Fig. 1

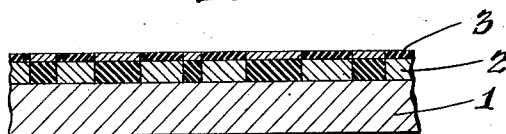


Fig. 2

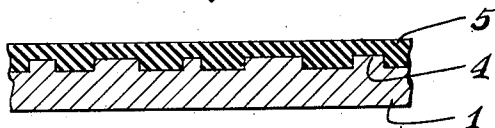


Fig. 3

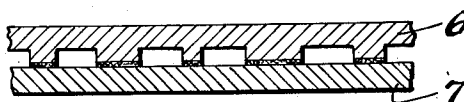
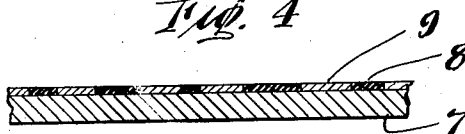


Fig. 4



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PROCESS FOR THE ELECTROLYTIC PRODUCTION OF METAL SCREENS

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2 Claims. (Cl. 204—11)

This invention relates to electro-deposition and more particularly to the formation of screens or other apertured members by electrolytic deposition of metal to form the desired member.

5 The invention is adapted for use in forming a wide variety of articles and is especially well adapted for forming fine, accurate screens or members having screen portions suitable for such various uses as photo-engraving screens, artists' retouching screens, classifying screens, filter screens, protective screens and others.

10 In accordance with one embodiment of the invention, a member, such as a plate, is provided with non-conductive areas forming a pattern corresponding to the apertures of the member which is to be formed, and metal is deposited on the conductive areas of the plate to form the screen, whereafter the electro-deposited screen is removed from the plate.

15 The pattern of non-conductive areas may be formed in various ways and in accordance with one embodiment of the invention, a master plate is provided with a sensitized surface coating and the pattern produced thereon by exposure of the sensitized coating through a suitable screen. The sensitized coating is developed and the unexposed portions removed. The master plate is suitably etched to form an intaglio having raised portions corresponding to the desired pattern. A matrix is formed from the etched master plate and is used to mold a rubber printing plate. The printing plate is employed in printing the desired pattern in non-conductive material onto a plate which is to form a cathode on which the metal screen is deposited. The design is treated to render it adherent to the cathode plate. The cathode plate is arranged as a cathode in an electric cell and the metal is electrolytically deposited on the conductive areas thereof. The plate with the adherent non-conductive material and deposited screen may be treated to render the non-conductive material adherent to the plate whereafter the deposited screen is stripped from the plate.

20 A feature of the invention is the forming of fine, accurate screen or members having screen portions of integral construction and having apertures of predetermined size and arrangement and which retain such arrangement during use.

25 Another feature of the invention is the forming of screen or like members having predetermined metallic structure which is uniform throughout all portions of the structure or which varies in a predetermined manner.

Still another feature of the invention is the deposition of metal directly upon the cathode of an electrolytic cell and the subsequent stripping of the deposited member without the adherence of foreign matter of any kind.

5 The invention further consists in the new and novel features of operation and the new and original arrangements and combinations of steps in the process hereinafter described and more particularly set forth in the claims.

10 The invention also consists in forming a product having the general characteristics, the new and useful applications, and the several original features of utility hereinafter set forth and claimed.

15 It will be understood that the present invention is capable of wide application, but for the purposes of illustration, it is described in connection with the formation of the screen suitable for use as an artist's retouching screen.

20 For the purpose of illustrating the novel process it is described hereinafter in connection with one form of apparatus suitable for carrying out the several steps and operations and illustrated in the accompanying drawing, wherein

25 Fig. 1 is an enlarged, fragmentary, cross-sectional view, indicating diagrammatically the initial step in the process; and

30 Figs. 2, 3 and 4 are similar views indicating respectively subsequent steps in the process.

A plate 1 (Fig. 1) (hereinafter called a master plate) is formed from material of sufficient rigidity and surface hardness which can be conveniently etched either electrically or chemically. This plate can be formed from a single material or from a material having a suitable metal coating. Preferably, the plate is formed from copper, but other metals may be used, such for example, as zinc, the so-called "Jem metal" (which consists principally of zinc) or others. The material should be one which is not affected by temperatures employed in vulcanizing rubber.

35 The master plate is provided with a light sensitive coating 2 (Fig. 1) capable of being hardened on exposure to light. Such coating may be formed from chromated fish glue, as will be understood by those skilled in the art. The light sensitive coating is exposed through one or more photo-engraving screen plates 3 (Fig. 1), or an enlargement or reduction thereof, in order to form in said coating a light-hardened pattern corresponding to the apertures to be provided in the screen. The coating is then developed, as by washing in water, to remove the unexposed, unhardened portions of the coating material.

The pattern may comprise minute areas of so-called "dots" having various shapes, such as square, rectangular, circular, elongated and many others and various combinations thereof.

5 Preferably, it is desirable to provide a non-conductive border adjacent the edges of the cathode plate whereby to facilitate stripping of the screen from the cathode. A suitable area may be provided for electrical connection of the plate; preferably, the area is adjacent the edge to permit a clip connection to be engaged thereover.

10 The master plate is then suitably etched to form therein a relief or intaglio design having raised portions 4 (Fig. 2) corresponding to the aperture pattern which is to be produced in the screen. Although the plate may be etched by a known chemical method, I prefer to carry out the etching electrolytically by connecting the master plate as an anode in an electrolytic cell and thereby removing the portions of the plate which are not protected by the insulating coating. The plate preferably is etched to a depth of from 0.006 inch to 0.008 inch.

25 The master plate is removed from the cell and the light-hardened material may be removed therefrom as by washing in a sodium cyanide solution or by mechanical abrasion. However, in certain cases it is not necessary to remove the light-hardened material before proceeding to the next step.

30 The master plate is employed as a mold to produce a matrix 5 (Fig. 2) from suitable moldable material which will accurately reproduce in the form of a negative the relief pattern of the etched master plate. Preferably, the matrix is formed from balata by the application of suitable heat and pressure, as will be understood by those skilled in the art. The matrix is employed in molding a printing plate 6 (Fig. 3) from suitable flexible material, such as soft rubber by the application of suitable heat and pressure.

45 The rubber printing plate preferably is secured on a roll of a cylinder printing press (not shown) and inked with a suitable acid-proof, non-conducting liquid material capable of being hardened and treated to cause it to firmly adhere to a plate 7 (Fig. 3) which is to form a cathode, as hereinafter described. The cathode plate is run through the press and a design 8 (Fig. 4) printed thereon which corresponds to the design originally formed in the master plate. If desired, the printing plate may be used in an offset printing press, as will be understood, to print the cathode plate.

55 The rubber printing plate may be used repeatedly to print the pattern on additional cathode plates. If desired, the same cathode plate can be cleaned and reprinted after one or more screens have been formed thereon as herein-after described.

60 The cathode plate 7 is formed from a rust-proof, non-corrodible material of sufficient rigidity and surface hardness and has at least its faces formed of a conductive material, such as a suitable metal or alloy which permits the electrolytic deposition of metal directly thereon and the subsequent stripping of the deposited member without the necessity for using a parting agent. The face or faces which are to receive the deposited metal are made sufficiently smooth and level to permit accurate printing of the design thereon and preferably are provided with a satin finish in order to insure adherence of the deposited metal. It will be understood that the

term "cathode plate" is intended to mean any suitable form or shape and is not limited to a member of plate form.

The cathode plate is provided with a non-conducting border (not shown) adjacent the edges, which may be printed simultaneously with the design or pattern. This prevents deposition of the metal adjacent the edges of the plate and thus facilitates stripping of the deposited screen; a suitable conductive area may be provided adjacent a portion of one edge to permit connection of the plate in an electrical circuit.

15 The cathode plate 7 with the printed pattern 8 (Fig. 4) is treated in order to render the non-conducting material adherent. Preferably, this is accomplished by baking the plate and non-conducting material at a temperature of from 300° F. to 400° F., and preferably around 350° F., in order to harden the non-conductive material and cause it to adhere firmly to the cathode plate.

20 Where the deposition is to be made on one side only of the cathode plate, the latter is now ready for insertion in the electrolytic cell. However, it is often desirable to form a similar deposit on both faces of the plate or in certain cases, dissimilar deposits. Where a deposit is to be made on both faces of the plate, the other face of the plate is provided with a non-conducting pattern as above described.

25 The cathode plate and a suitable anode or anodes (not shown) are supported in an electrolyte corresponding to the material to be deposited. The anode and cathode plate are connected in a suitable electric circuit and current is passed through the cell thus formed.

30 The screen may be formed from a material, such as copper, nickel, chromium, lead, tin, or other non-ferrous metals or alloys or combinations thereof depending upon the characteristics desired. It will be understood that, where the term "metal" is used herein, it is to be taken as meaning metal, one or more metals, alloys, or one or more alloys and is not limited to a single, elementary metal. I have found that screens suitable for a large number of uses may be formed from copper which may, if desired, be provided with a plated coating or another metal.

35 Where a copper screen is to be formed, a copper anode is provided and the electrolyte consists of copper sulphate, sulphuric acid and water in suitable proportions.

40 The circuit is energized and copper is electrolytically deposited on the exposed, conducting areas of the cathode plates. I prefer to employ a cathode plate of suitable composition and characteristics and to dispense with the use of a separating or parting agent, such as is usually employed. Thus the deposition can be effected directly onto the bare surfaces of the cathode plate.

45 Deposition is continued until the desired thickness of material is built up on the cathode plate to form a screen 9 (Fig. 4) corresponding exactly to the exposed areas of the cathode and having an aperture pattern corresponding to the non-conductive pattern on the cathode plate. Where the screen to be formed is to have a thickness exceeding about 0.004 or 0.005 inch, it is preferable to halt the deposition at a thickness of about 0.004 or 0.005 inch in order to prevent the apertures "capping over" by reason of the deposition of material which fills up the apertures. Further deposition may be carried out after 75

stripping from the cathode plate, as hereinafter explained.

The various operating factors such as current density, ratio of anode to cathode area, spacing between the anode and cathode, composition of the electrolyte, temperature of the electrolyte, and agitation of the electrolyte are carefully controlled to provide a deposit of material having the desired hardness, density, grain structure, tensile strength, brightness and the like.

Where it is desired to produce a screen having uniform metallic structure, the several operating characteristics should be kept uniform throughout the entire period of deposition. I have also found that it is important that the cathode plate be brought to and remain at the temperature of the electrolyte. For this reason, I prefer to bring the cathode plate to the temperature of the electrolyte before connecting in the electrical circuit. Thus, it is possible to avoid non-uniformity in metal structure, which would otherwise occur owing to the formation of bubbles and other causes.

When the desired thickness of metal is deposited, the cathode plate is disconnected from the circuit, removed from the electrolyte, and washed in water. Thereafter, the plate, with the pattern of non-connecting material and the deposited metal, is baked at a temperature of from 300° F. to 400° F., and preferably around 350° F. for a suitable period, for example, approximately three minutes. Thus, when the deposited screen is stripped from the cathode plate, the non-conducting material adheres to the plate with great tenacity and is not removed with the deposited member.

The deposited member is then stripped from the cathode plate by any suitable means, as for example, either manually or by suitable mechanical or semi-mechanical means.

Where it is desired to form a screen exceeding 0.004 or 0.005 inch in thickness, the screen after removal from the cathode may be returned to the bath and metal deposited on both sides of the screen to build such screen to the desired thickness. Thus, a screen can be formed with apertures of substantially uniform diameter throughout the thickness of the screen and having side walls extending substantially perpendicular to the faces of the screen.

Preferably, the screen is secured in a suitable frame, as for example, a frame formed from wood or synthetic resin or other suitable material, the screen being drawn taut in the frame to prevent uneven deposition of metal thereon. The screen is immersed in the electrolyte, connected as a cathode in the electric circuit and the further deposition made of either the same or a different metal.

It will be understood that screens may be formed by the present process ranging in thickness from 0.00025 inch up to any desirable and practical thickness. Generally, screens for photographic purposes will range in thickness from 0.0015 to 0.002 inch; filter and classifying screens will usually range from 0.003 to 0.012 inch; screens for other purposes may be formed considerably thicker if desired.

Where the screen is to be used for certain purposes, it is often desirable to provide a plated coating of another material, as for example, nickel, chromium or the like, which can be done by supporting the screen in a suitable electrolyte and subjecting it to an electroplating operation.

The present invention provides a method of

forming an integral, apertured member, such as a screen, wherein the apertures are accurately formed and provided with sharp, clean-cut rims. Each face of the screen, including the rims or edges of the apertures, lies in a single plane and the screen may be made so thin that both faces in effect lie in a single plane. The side walls of the apertures may be made substantially perpendicular to the faces of the screen.

The screen may be formed from any one of a number of metals or alloys having characteristics suitable for various uses. The screen may have a uniform metal structure, or if desired, the operating conditions may be suitably controlled so that various areas of layers of the metal may have different characteristics. For example, the screen may have any desired degree of flexibility or hardness, and may be made harder in one area and softer in others.

The invention permits the production of a screen having apertures of which the size and spacing may be absolutely uniform or may vary in accordance with a predetermined design, but which, in any event, remain the same during the use and do not vary under the conditions of the intended use.

Since the electro-deposited metal may be deposited in an extremely thin coating and thus the contours of the plate and non-conductive pattern can be faithfully reproduced, and since an accurate pattern can be produced by printing on the plate, it is possible to produce very fine screen. Both the apertures and the spacing between the apertures may be made extremely small. For example, it is possible to produce a screen having up to 100 apertures per lineal inch.

Since the printing plate, when once formed, can be employed to print the design on a large number of cathode plates or repeatedly on the same plate, the process can be carried out very economically. Also, all of the screens produced from a single printing plate will be uniform.

By the use of a cathode plate of suitable composition and characteristics it is possible to deposit metal directly on the plate without the use of a separating or parting agent, such as has heretofore been considered necessary. The screen is thus deposited evenly and has a surface corresponding to the conductive surface of the cathode plate and when stripped is bright and clean. The deposited member can be stripped or peeled from the cathode plate readily and without the use of great force or the danger of injury to the deposited member or the surface of the plate.

While certain novel features of the invention have been disclosed and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. The method of forming fine mesh metal screens which comprises depositing a light-hardenable coating on a metal plate, exposing said coating to light through a screen to form a predetermined pattern of light-hardened material, washing the coating to remove the unexposed portions of light-hardenable material, electrolytically etching the uncoated areas of said member to form a relief pattern corresponding to said first pattern, molding a balata matrix constituting a negative of said member, molding from said matrix a rubber printing plate having a pattern corresponding to said first pattern, employing

said printing plate to print said last pattern in non-conducting material on a cathode plate, electrolytically depositing metal on the conductive areas of said cathode plate to form a screen
5 and stripping said screen from said cathode plate.

2. The method of forming fine mesh metal screens which comprises depositing a light-hardenable coating on a member, exposing said coating to light through a screen to form a pre-
10 determined pattern of light-hardened material, removing the unexposed portions of light-hardenable material, etching the uncoated areas of

said member to form a relief pattern corresponding to said first pattern, molding a matrix constituting a negative of said member, molding from said matrix a rubber printing plate constituting a positive and having a pattern corresponding
5 to said first pattern, employing said plate to print said last pattern in nonconducting material on a plate, electrolytically depositing metal on the unprinted conductive areas of said plate to form a screen and stripping said screen from said plate. 10

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