

UNITED STATES PATENT OFFICE

2,230,868

METHOD OF MANUFACTURING RETICULATED METAL SHEETS

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No Drawing. Application June 26, 1936,
Serial No. 87,589

12 Claims. (Cl. 204—11)

This invention pertains to the manufacture of reticulated metal sheets or other constructions and more particularly to filtering screens for liquids or gases.

5 Reticulated metal sheets and screen constructions, such as copper filtering screens for lubricants, have heretofore been made by weaving wires to form the mesh construction. The object of my invention is to provide a method of forming the mesh construction by photo-etching a mesh design upon a suitable backing plate or foundation and by means of electrolysis deposit the copper mesh over the etched design upon the plate, from which it is peeled or stripped in the form of a finished product.

10 In order to electroplate upon a design that has been photographed and etched upon a plate by the standard photo-etching method, it is necessary to render the portions of the plate between the lines of the design non-conducting or inert to the plating solution before immersing the plate in the electrolytic bath. At the present time a paint, enamel or other non-conducting material is rubbed into the indentations of the etched plate by hand or it is sprayed on and then buffed down to the level of the raised design. The method which I have devised eliminates this manual or mechanical work. By means of electrolysis in the present example, I deposit electrolytically into the etched indentations between the lines of the design a suitable metal which does not react and plate in the customary copper sulphate plating solution. I shall give herewith examples of metals which fail to establish a firm bond with the metal of the solution. I prefer to employ zinc or a zinc alloy as the filling-in material, although lead, aluminum or other suitable materials may be used. This is plated into the indentations while the original ground or protective coating, used while etching the indentations, is still on the plate.

40 The process of manufacturing copper screen material according to my invention will now be evident in a further example. A screen design having a mesh of the size desired, is photo-etched by the standard method upon a copper backing plate and the etched indentations are then filled by electroplating in a suitable electrolyte of zinc or a zinc alloy. After washing off the remaining etching ground, the plate is then chromium plated. The chromium will only plate upon the exposed copper lines of the screen design, and will not adhere to the zinc plated portions between the lines. The backing plate or matrix is now ready for the electrolytic production of copper screens.

55 The plate or matrix, prepared in the manner described, is immersed in the copper sulphate solution to receive a plating of copper on the chrome plated screen mesh design. When the

copper film of the desired thickness has been deposited, the finished copper mesh screen is peeled off of the matrix plate. As pointed out above, the separation of the copper mesh screen from the matrix is greatly facilitated by the preliminary conditioning of the chromium plating.

60 Attention is directed to the statement above to the effect that the oxide coating actually increases the thickness of the piece, and to the result that the interstices are thicker, providing a barrier against the later deposited copper from plating over and filling up the screen holes. It should be understood that if the operator desire, the preceding described sulfuric acid oxidation treatment may be continued until the degree of growth in elevation of the oxide areas is sufficient to satisfy the desire of the operator, to prevent plating over and filling.

20 An example of the use of photo-etching in my process for reproducing a reticulated uniform screen is given herewith.

25 The metal base plate or matrix blank of aluminum or of aluminum alloy is first scrubbed thoroughly and washed when required with a light solution of hydrochloric acid in water, the piece being scrubbed with pumice or other abrasive of fine particle size.

30 An ammonium bichromate albumen solution containing an enamel-forming base is flowed over the surface of the blank and dried. A projection lamp is focused so as to project an image thru a prepared reticulated transparency having opaque areas uniformly distributed thereon. The resulting latent image is developed by immersing in water.

35 The bichromate areas which have received the light remain on the plate, because they are insoluble. Heating at this point renders the non-soluble bichromate coating more resistant.

40 An etching solution, for example, one-half of one percent hydrofluoric acid, two percent nitric acid and three percent hydrochloric acid to 94½ percent water by volume is then used as an electrolyte in a bath having a carbon or lead anode. At a current density of 10 amperes and at 6 45 volts, the operator may allow the electric etching to proceed for from 5 to 15 minutes, with the piece as the cathode,—according to his judgement as to the depth of etch desired.

50 The plate is now washed and oxidized for 15 to 40 minutes with a 10-percent normal solution of sulfuric acid, again as an anode, it being preferred from my experience to attain a degree of oxidation sufficient to render the oxidized areas relatively inert to cathode deposit from a standard acid copper plating bath.

55 There is no fixed rule for the length of time required to create the proper oxide coating, since the factors of density of the aluminum sheet, the character of its alloy, and the purity of the

solution materials obtainable commercially, all affect the result. The workman is required to run a test piece occasionally, especially with a fresh bath, and examine the color and gauge of the piece. The oxide coating actually increases the overall thickness of the piece. It should be added that after oxidation, the piece is immersed in boiling water for from 20 to 40 minutes so as to thoroughly seal the pores, a crystalline reformation of the oxide coat taking place.

The boiling also loosens the bichromate so that it may be readily scrubbed off, leaving clean areas of non-oxidized aluminum. It should be noted that these areas achieve a thin oxide coating by mere atmospheric exposure which facilitates stripping of the screens, the thin oxide not providing a full reject action. If this is not sufficient, I may return the piece for a brief interval to the oxidizing bath for a light coat, afterwards re-washing and dry.

The above examples of the photo-etching and oxidizing processes are provided to furnish a complete and definite disclosure. The photo-etching method is widely used, and the oxidizing process is likewise well known. I make no claims to these except insofar as they are parts of the whole in the demonstration of my specific process.

For the production of long sheets or continuous strips of screen material I make the etched metal plate or matrix, prepared as described, in the form of a drum having the screen design etched upon its outer cylindrical surface. The drum is mounted to be revolved slowly in the plating solution or electrolyte and the strip of copper screen is continuously peeled from its surface. The desired thickness of the screen mesh can be accurately controlled by the speed of the rotating drum.

When my matrix is completed and ready for the manufacture of screens, the following standard acid copper solution is recommended in an electrolytic bath having copper anodes:

	Ounces per gallon
Copper sulfate (blue vitriol)	30
Sulfuric acid C. P.	6.5
(Specific gravity of bath, 1.18)	

For rapid plating, the bath is maintained at a temperature of 120 degrees F., and one may use 10 to 30 amperes per square foot, adjusting by instrument until the particular form of soft pliant copper screen is attained. The finer mesh screen in the thinnest sheets requires careful work on the part of the tank operator, in adjusting the work-to-anode spacing, which with the above solution as described should be maintained within 9 to 18 inches, depending on the shape of the desired screen, and the other qualities known to those skilled in the art. No claims are made to the above solution and procedure since it is well-known and standard in the electroplating commercial technique.

It will be obvious to engineers and technicians skilled in this art that modifications of the structural and processing features may be made without departing from my invention. Instead of a copper foundation plate or matrix, I may employ a plate of stainless steel and in that case the chromium plating may be dispensed with since this form of alloy will tend to reject copper plate bonding under certain electroplating conditions. I also may dispense with the etching and only photo-print the design onto the metal matrix.

The method of applying the fill-in metal may vary, for instance, it may be deposited by immersing the matrix in suitable acid electroplating solution or the metal may be deposited by vapor, using the well-known method of electrically exploding wire in vacuum. I find it expedient to oxidize the fill-in metal afterwards for example, when using aluminum, as aforesaid, whereby a high degree of insulation against the passage of current provides an extremely weak or non-existent bond, facilitating stripping of the screen metal after the final electrodeposit of the screen material, and for leaving proper interstice holes in the strip sheet. When aluminum is employed as the fill-in metal, after the mesh design or other design has been photo-etched upon the base plate and while the ground is still on the plate, I plate aluminum into the recesses between the lines of the design formed by the action of the acid in the process of photo-etching. I then subject the plate to the oxidizing step or process, thereby changing the surface to aluminum oxide, which is a dielectric, almost insoluble and nearly glass hard.

Again I may employ a foundation plate or matrix of zinc, zinc alloy or other suitable material that does not become plated in a copper sulphate solution or electrolyte. A thin coating of copper is plated thereon by means of a suitable cyanid plating solution. The desired screen mesh design is photo-etched upon said thin copper coating, the copper between the lines being eaten away by the etching fluid. The etching ground is then washed off and the plate is chromium plated, the chromium only adhering to the screen lines of copper. The matrix is thus ready for the production of copper mesh screen sheets or strips. As previously described, the plate matrix is immersed in the copper sulphate electrolyte and a film of copper of the desired thickness is deposited upon the chrome plated screen design, which is then stripped off to constitute the finished product. The copper sulphate solution referred to is a standard solution which has been suitably neutralized.

I claim:

1. The process of forming articles consisting of sheets of uniformly reticulated metal which comprises photographing and then etching a reticulated design upon a metal foundation composed of copper receptive to plating in a standard copper sulphate solution, electroplating the portions of said foundation, exclusive of the elements of said design, with a metal normally inert to plating in a standard copper sulphate solution; removing the etching ground from the raised portions, chromium plating the resulting matrix, electro-depositing a copper film from said solution on the raised elements of the design and stripping the resultant reticulated metal sheets from the matrix.

2. The process of forming articles consisting of screens of reticulated metal, comprising the steps of photographing and then etching a reticulated design upon a metal foundation composed of copper, depositing electrolytically upon the recessed portions of the foundation between the raised portions of the etched design, a metallic surface composed of lead which after oxidation is inert to plating in a standard copper sulphate solution, electro-plating a copper coating from said solution upon the raised portions of the reticulated design and stripping the coating from the foundation.

3. The process of forming articles composed

of screens of reticulated metal, comprising the steps of photosensitizing, washing and etching a raised reticulated design upon a metal foundation, electro-depositing upon the etched recessed portions of the foundation between the elements of the etched design a metal surface composed of lead, oxidizing said metal surface to form a dielectric, inert to plating in a copper sulphate solution, electro-depositing a copper coating upon the elements of the reticulated design and detaching the coating from the foundation.

4. The process of forming articles consisting of screens of uniformly reticulated metal, comprising the steps of photographing and etching a reticulated design upon a metal foundation, depositing an aluminum coating upon the recessed portions of the foundation between the elements of the etched design, oxidizing said coating to provide a resisting surface of aluminum oxide rejective of electro-plating in a standard copper sulphate solution, electro-depositing a copper coating upon the raised portions of the reticulated design and stripping the resulting reticulated copper coating from the foundation.

5. A process of manufacturing copper screening for filtering liquids and gases comprising the steps of forming a matrix provided upon its surface with a reticulated screen pattern; of etching the material of the matrix in portions not provided with said pattern; of applying a fill-in metal including aluminum to the said recessed portions of the matrix relatively inert to an electrolyte containing a copper sulfate solution; of electrodepositing from said electrolyte upon the said matrix in the portions not occupied by said fill-in metal; and of mechanically removing the electro-deposited metal from the said portions not occupied by the said fill-in metal.

6. A process of manufacturing metal screening for filtering liquids and gases comprising the steps of; forming a matrix provided upon its surface with a reticulated screen pattern applied photographically; of etching the material of the matrix in portions not photographically sensitized; of applying a fill-in metal including aluminum to the said etched portions of the matrix inert to a given electrolyte containing a metal containing copper in solution; of electrodepositing from said electrolyte upon the said matrix a coating of the said solution metal in the portions not occupied by said fill-in metal; and of mechanically removing the electrodeposited metal from the said portions not occupied by the said fill-in metal.

7. A process of manufacturing porous metallic membranes for filtering liquids and gases, comprising the steps of; first providing upon a metal matrix a photo-etched pattern; of depositing on the interstitial spaces of said pattern a fill-in metal including aluminum while leaving the pattern undeposited; of rendering said fill-in metal relatively inert to the passage of electro-deposition current; of electro-depositing upon said pattern a screen of metal from an electrolytic solution containing a copper sulfate solution; and of stripping said screen from said matrix.

8. A process of manufacturing porous metallic membranes for filtering liquids and gases, comprising the steps of providing on a metal matrix an etched pattern; of depositing on the interstitial

spaces of said pattern a fill-in metal including aluminum while leaving the pattern undeposited; of rendering said fill-in metal relatively inert to the passage of electro-deposition current; of electroplating upon said pattern a coating of metal from a solution consisting of a standard copper sulfate electrolyte; and of stripping said screen from said matrix, the said stripped coating being a metallic representation of the etched pattern aforesaid.

9. A process of manufacturing porous metallic membranes for filtering liquids of gases, comprising the steps of providing upon a metal matrix an etched pattern; of depositing on the interstitial spaces of said pattern a fill-in metal containing aluminum while leaving the pattern undeposited; of rendering said fill-in metal relatively inert to the passage of electro-deposition current; of electroplating upon said pattern a coating of metal from a solution containing ions of the metal deposited; and of stripping said coating from said matrix in a continuous sheet.

10. A method of manufacture of thin metallic sheets having a plurality of perforations therein for filtering liquids and gases, comprising the steps of first forming a matrix having patterned metallic portions inert when acting as a cathode to the passage of anodic current and having adjacent metallic portions conductive to said current; of electrodepositing from a solution on said matrix as a cathode a metal strip having a weak bond with the said conductive portions; and of mechanical removal of said strip at the conclusion of said electrodepositing.

11. A process of manufacture of thin porous electroplated metal sheets comprising the steps of forming a matrix having patterned portions composed of aluminum oxide acting to reject passage of electroplating current said anode being formed on said matrix thru the agency of said acid solutions, and other portions composed of conductive metals for said electroplating current, said conductive metals being normally weak in copper electro-deposition bonding characteristics; of electroplating from a solution of copper salts containing free copper ions upon said formed matrix a coating of copper having perforations at the patterned portions of the aluminum oxide; and of mechanical removal of said perforated coating from said conductive metal portions.

12. A process of manufacture of thin porous electroplated metal sheets comprising the steps of forming a matrix having raised patterned portions composed of a metallic oxide impervious to the passage of electroplating current said oxide being formed on said matrix thru the agency of said acid solution, and other portions composed of conductive metal areas for the passage of the said current, said areas being normally weak in copper bonding characteristics with respect to acid solutions of copper sulfate; of electroplating upon said matrix from a copper sulfate solution a coating of copper having perforations at the patterned portions of the metallic oxide; and of mechanical removal of said perforated copper coating from said conductive areas at the termination of the final electroplating operation.

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