Jan. 20, 1959 G. R. SCHAER 2,870,068

ELECTROFORMED SCREENS

Filed Jan. 30, 1956 2 Sheets-Sheet 1

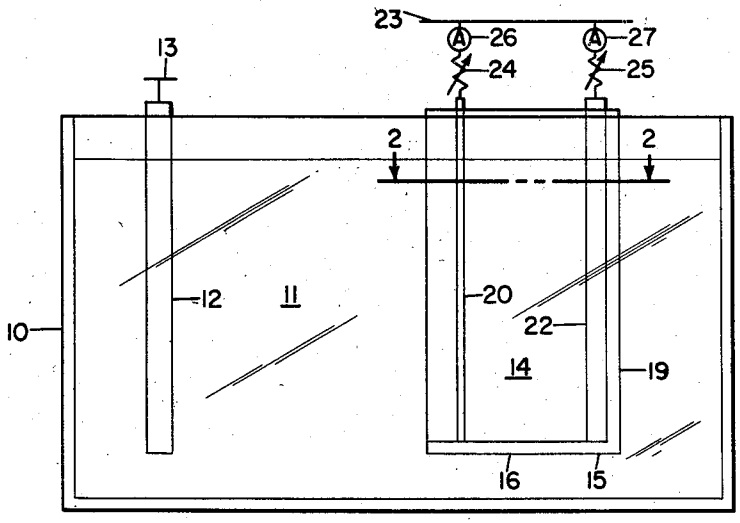


Fig - 1

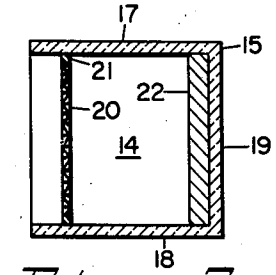


Fig - 2

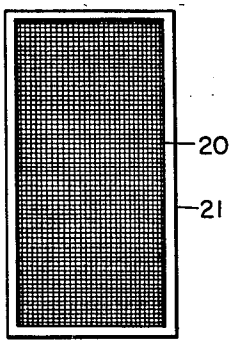


Fig - 3

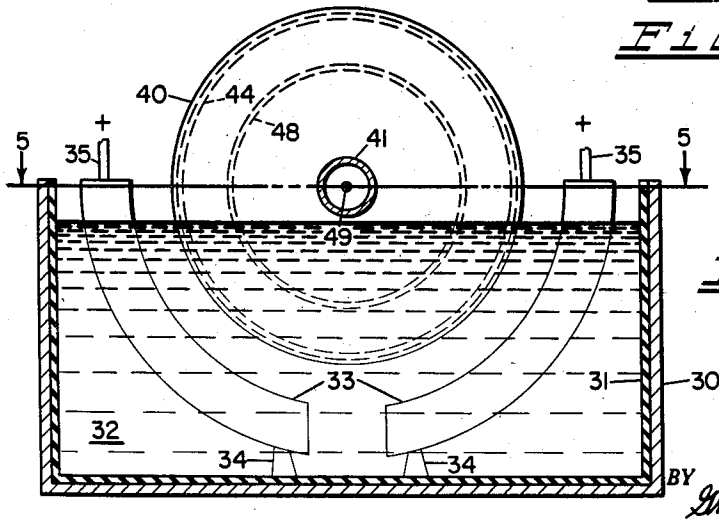


Fig - 4

INVENTOR.
Glenn R. Schaer

BY Gray, Mase and Dunson

ATTORNEYS.

Jan. 20, 1959 G. R. SCHAER 2,870,068

ELECTROFORMED SCREENS

Filed Jan. 30, 1956 2 Sheets-Sheet 2

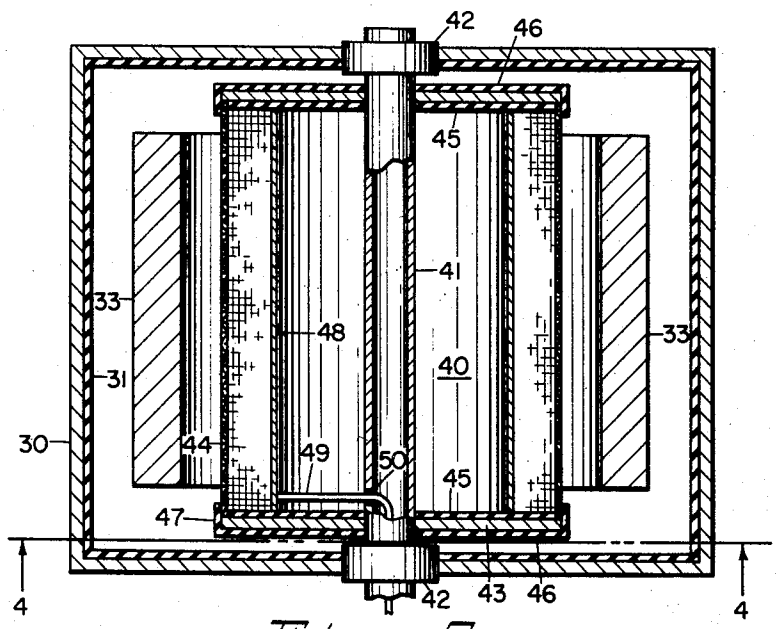


Fig - 5

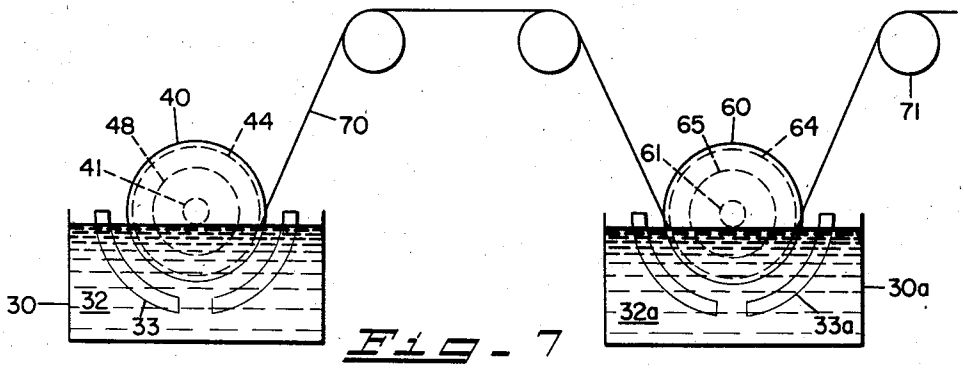


Fig - 7

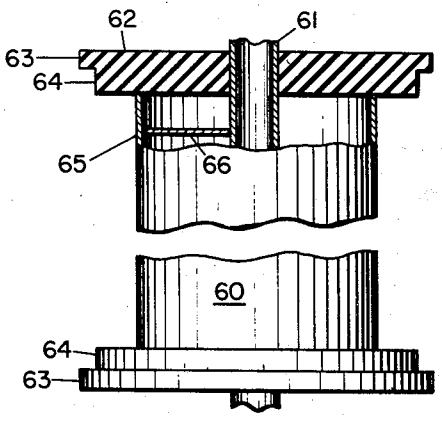


Fig - 6

INVENTOR.
Glenn R. Schaer

BY
Gray, Mase and Duncan

ATTORNEYS.

United States Patent Office 2,870,068 Patented Jan. 20, 1959

2,870,068

ELECTROFORMED SCREENS

Glenn R. Schaer, Columbus, Ohio, assignor, by mesne assignments, to Diamond Gardner Corporation, a corporation of Delaware

Application January 30, 1956, Serial No. 562,151

6 Claims. (Cl. 204—11)

This invention relates to electroformed screens and to processes for preparing the same.

Screens have been formed previously by electrodeposition on a mandrel having metallic portions corresponding to the screen wires and nonconductive portions corresponding to the holes of the screen. A difficulty with electrodeposition of screens on mandrels of this type to any appreciable thickness is that the holes in the electroformed screen are smaller than the corresponding nonconductive portions of the mandrel. This is because the electroplate is not confined to the metallic area of the mandrel but extends over the nonconductive areas as well, whenever a screen of appreciable thickness is electroformed. The hole size decreases with increasing thickness of the plate, so that the holes become entirely closed when the screen thickness exceeds the radius of the nonconducting areas of the mandrel. It is impossible to form screens of greater thickness according to prior methods. Thus, the holes of a screen plate on a mandrel having nonconductive areas of .020-inch diameter substantially are closed when the plate thickness exceeds .010 inch, and a screen of greater thickness than .010 inch cannot be formed.

According to the present invention, screens having a high ratio of hole size to wire size can be electroformed to desired thickness sufficient for mechanical strength. To accomplish this, the screens are electroformed on conductive members which have holes extending through their entire thickness. The conductive member constitutes the primary cathode in an electroplating bath, which also has a secondary cathode. The primary cathode is located between the anode and the secondary cathode so that current flowing from the anode to the secondary cathode must pass through the perforations in the primary cathode. The use of a foraminous primary cathode in conjunction with a secondary cathode in this manner results in electroformed screens in which the hole size can be controlled independently of plate thickness. This makes it possible to produce screens having thicknesses greater than the radii of the nonconducting areas of the mandrel with holes the same size as those in the primary cathode before any metal is plated. The holes in screens formed according to this invention may be of any desired shape and spacing. Openings which are round, square, or any other desired shape may be formed.

The primary cathode is located between the anode and a secondary cathode for electrodeposition according to this invention. The voltage drop between the anode and primary cathode is less than the voltage drop between the anode and secondary cathode. The useful plating current passes from the anode to the primary cathode, and current also passes from the anode to the secondary cathode.

The present invention is susceptible of several embodiments. It may be used to increase the thickness of thin screens prepared by previously known methods. It may also be used to electroform screens by nonadherent plating on mandrels. A further use is to prepare mandrels for electroforming the screens of this invention. In whatever embodiment the invention takes, the term "mandrel" may be considered to be the foraminous primary cathode on which metallic deposition takes place.

Thin fine-mesh screens presently known may be plated to form much thicker screens having appreciable mechanical strength. This is done by electroplating an adherent metal layer on a clean metal surface of the original screen. The original screen may be formed in any manner desired, as, for example, by a conventional photoengraving process. The screen may be any metal or alloy on which an adherent electroplated layer can be formed, such as nickel, copper, and brass.

Fine-mesh screens may be electroformed according to the present invention by nonadherent plating on a mandrel which has a hole and land pattern substantially the same as that desired in the screen. The screen is electroformed on a surface of the mandrel and is then stripped off mechanically. The adherence of the screen to the mandrel is sufficient for it to remain in position during electroforming, and weak enough that it may be readily removed mechanically.

A perforated mandrel for use in this invention may be prepared by conventional fabricating techniques, such as hole drilling or punching. It may also be prepared by first forming a screen according to conventional photoengraving methods, and then electrodepositing the mandrel metal or alloy to desired thickness by the process of this invention.

The mandrel may be made of any one of various electrically conductive materials on which a nonadherent screen plate is normally formed. Such materials are known in the art. Various metals and alloys, such as stainless steel, lead-coated steel, chromium-plated steel, aluminum, molybdenum, and titanium are suitable as mandrels.

Metals and alloys to which electrodeposited metals normally adhere firmly are also suitable for mandrels. Examples of such materials are brass, copper, and nickel. When the screen metal is one which normally adheres firmly to the mandrel metal, the mandrel surface is covered with a thin film of a parting medium to reduce adherence. Such parting media are known in the art, and include wax, plastics, resins, asphalt, graphite, and mixtures of these materials.

It is necessary for some materials to provide an insulating coating on the mandrel surface nearest the secondary cathode to prevent anodic dissolution, since the mandrel is anodic with respect to the secondary cathode. A coating is not necessary in the case of titanium and other materials which are not anodically dissolved.

Any metals and alloys, and laminates thereof, which can be electroplated satisfactorily by conventional means to thicknesses equal to the desired screen thicknesses may be used as materials for electroforming screens according to this invention. Examples of such materials are nickel, copper, brass, and bronze. Screens according to the present invention may be made of either one or more metals.

There is a net current flow from the anode to the cathodes, and direct current may be used. In lieu of direct current, various current cycles which are known in the electroplating art, such as periodic reversal of current, pulsating current, and superimposition of alternating current on direct current, may be used to obtain smooth electroplates.

This invention will now be described further with reference to the accompanying drawing, in which:

Fig. 1 is a front elevation of one form of apparatus according to the present invention;

Fig. 2 is a top plan view of the cathode assembly illustrated in Fig. 1;

Fig. 3 is a plan view of a mandrel which forms part of the cathode structure illustrated in Figs. 1 and 2;

Fig. 4 is a front elevational view of a modified form of the invention, shown partly in section taken along line 4—4 of Fig. 5, with the front wall of the tank removed; and

Fig. 5 is a sectional view taken along line 5—5 in Fig. 4;

Fig. 6 is a top elevational view, shown partly in section, of a modified cathode assembly for use in the apparatus shown in Figs. 4 and 5;

Fig. 7 is a diagrammatic view of an apparatus for a continuous two-step electroforming process according to the invention.

Referring now to Figs. 1 through 3, inclusive, of the drawings, and particularly to Fig. 1, **10** is a tank containing electrolyte **11**. In the embodiment shown, tank **10** is an open-top rectangular prism made of glass. Tank **10** may be made of any suitable material which does not react with the electrolyte. For instance, tank **10** may be made of a suitable plastic, or a metal such as steel. With most electrolytes, it is desirable to insulate steel tanks with a lining of rubber, plastic, or the like. Anode **12** is located in tank **10** and is connected to the positive side **13** of a direct-current power supply.

The electroplating apparatus also includes a cathode assembly **14**. Cathode assembly **14** includes a container **15** having a bottom **16**, side walls **17** and **18** as shown in Fig. 2, and back **19**. The top and front of housing **15** are open. Housing **15** is illustrated as being made of a transparent plastic, although it may be made of opaque plastic or other suitable nonconducting material. Located in housing **15** is a foraminous mandrel or screen **20**, having a screen wire grid which constitutes the primary cathode in the electroplating cell. As shown in Fig. 3, the mandrel **20** preferably has an imperforate border **21**. The holes extend through the entire thickness of mandrel **20** so that electrolytes can pass therethrough. In a typical embodiment, the holes have a diameter of about .010 to .015 inch and are spaced apart about .020 to .025 inch, center to center. As shown in Fig. 3, the holes are arranged in a rectangular pattern. However, the holes in mandrel **20** may be of any desired shape, for example, square, round, or any other desired shape, and may be arranged in any pattern desired. Secondary cathode **22**, which is imperforate, is placed inside housing **15** adjacent back wall **19**. As shown, secondary cathode **22** is located behind mandrel or screen **20**, so that all current which reaches cathode **22** must pass through the holes in mandrel **20**.

Cathodes **20** and **22** are both connected to the negative side of a direct current power supply **23** through its resistances **24** and **25**, respectively, which preferably are variable. Ammeters **26** and **27**, respectively, may be located in the primary and secondary cathode circuits to indicate the amount of current flow in each.

The apparatus illustrated in Figs. 1 to 3 is suitable for either building up the thickness of screens by adherent plating or for electroforming screens on mandrels by nonadherent plating. It is particularly suited to the former. When the apparatus is used for building up the thickness of screens, **20** is the the screen to be built up. Screen **20** is cleaned before plating to remove all oxide film and nonconducting materials on the surface. This may be done by known means, such as emery polishing, acid or caustic cleaning, or a combination of both.

The plating metal is electrodeposited on both screen **20** and secondary cathode **22** by passage of current to these cathodes from anode **11**. Ions of the plating metal are dissolved in electrolyte **11**. Anode **12** may be either soluble or insoluble. Suitable materials for both soluble and insoluble anodes are known in the art. Soluble anodes consist essentially of the metal or alloy to be plated.

Current is passed through electrolyte **11** primarily from anode **12** to screen cathode **20**, and additional current is passed from anode **12** to secondary cathode **22** through the holes in screen **20**. Nonconductive casing **15** prevents current from reaching secondary cathode **22** by bypassing primary cathode **20** around the edges, as has been pointed out. Preferably the back side of mandrel or screen **20**, that is, the side adjacent cathodes **22**, is coated with a nonconducting material to prevent dissolution of metal from this surface. The nonconducting material may be an impervious layer of material, such as paint, lacquer, wax, resin, ceramic, or other insulator.

The potentials of cathodes **20** and **22** and the ratio of current to these electrodes is controlled by the amount of resistance in resistors **24** and **25**. The potential difference between anode **12** and primary cathode **20** is less than the potential difference between anode **12** and secondary cathode **22**. Electroforming according to this invention is most satisfactorily carried out when the potentials of cathodes **20** and **22** are such that the ratio of primary to secondary cathode current is about the same as the ratio of screen-wire area to hole area in screen or mandrel **20**. In other words, the current density on both the lands and holes of mandrel **20** is about the same. When this ratio is maintained, the screen can be plated to substantial thickness with the size of holes and wires substantially the same as that in the original screen. Use of a perforated primary cathode with proper control of primary and secondary cathode currents, as indicated, makes it possible to obtain screens of substantial thickness, with well-defined holes of uniform diameter. Control of the ratio of primary and secondary cathode currents as indicated also results in substantially no deplating of metal from the surface of screen **20** facing secondary cathode **22**, even when that screen surface is not coated with nonconductive material.

The hole diameter in the plated portion of screen **20** may be made either larger or smaller than the original screen by proper control of primary and secondary cathode currents. When the ratio of current in the primary and secondary cathode circuits exceeds the ratio of wire area to hole area in screen **20**, the holes in the electrodeposited portion of the screen are smaller than those in the original screen, and become entirely closed when the screen is built up to sufficient thickness. An advantage of a ratio of primary to secondary cathode current in excess of the ratio of wire area to hole area in screen **20** is that a greater portion of the electrodeposit is formed on the screen **20** and less on secondary cathode **22**. When the ratio of primary cathode current to secondary cathode current is less than the ratio of wire area to hole area in screen **20**, the holes in the plated portion are larger than the holes on the original screen. Control of the relative amounts of current flowing to cathodes **20** and **22** thus provides a convenient method for controlling the hole size of screens.

While the embodiment of the invention illustrated in Figs. 1 to 3 has been particularly described with reference to building up screens by adherent electroplating, it is understood that this apparatus is also suitable for electroforming screens on foraminous mandrels by nonadherent electroplating. In that case **20** constitutes the foraminous mandrel on which the screen is electroplated. Mandrel **20** is coated on its entire surface with a nonconductive coating, such as an oxide film. This coating is thin enough on the outer surface so that the flow of current from anode **12** to mandrel **20** is not prevented or even greatly impeded. A screen of substantial thickness having hole diameters the same as the hole diameters in mandrel **20** may be electroformed by maintaining the ratio of current to mandrel **20** to current to secondary cathode **22** about the same as the ratio of wire area to hole area in mandrel **20**. The holes in the electroformed screen may be made smaller or larger than those in mandrel **20** by use of larger or smaller ratios of primary to secondary cathode current. After the screen has been electroformed to desired thickness, it is mechanically removed from the mandrel.

The potential difference between the anode and primary cathode, primary cathode current density (based on wire area), and other conditions, such as temperature, bath composition, etc., are in the same range as the corresponding conditions in conventional electroplating process using a single cathode.

Figs. 4 and 5 illustrate a modified form of the present invention which is particularly adapted for commercial production of screens. This apparatus makes it possible to electroform screens continuously on a rotating mandrel. In this apparatus, tank 30 is preferably made of metal, such as steel, with an insulating lining 31 of rubber or the like. For plating of certain metals, such as copper or tin, a steel tank without any lining may be used. It is also understood that tank 30 may be made of an insulating material, such as plastic or glass, in which case no lining is necessary. Tank 30 is filled with a body of electrolyte 32. Also shown are a pair of anode segments 33, each segment of which is a cylindrical surface of about one-quarter of a cylinder. Anodes 33 are supported in tank 30 by suitable supports 34. Anodes 33 are connected to the positive side of a direct current power supply through conductors 35. Conductors 35 may be of any suitable construction, as for example metallic bars with the ends embedded in cathodes 33.

Rotatable cathode assembly 40 includes a shaft 41 which is journaled for rotation in bearings 42 supported by the side walls of tank 30 and insulated thereform. The details of the bearings 42 are not illustrated, as they are conventional and form no part in the present invention. Shaft 41 is preferably hollow, as shown. Metallic disks 43 are rigidly attached to shaft 41. Primary cathode 44 is fixedly joined to disks 43. Primary cathode 44, which constitutes a mandrel for electroforming screens, is of screenwire construction, having holes which extend therethrough. The primary cathode circuit includes primary cathode 44, disks 43, and hollow shaft 41. Suitable conductors not shown and located exteriorly of the plating tank 30 connect shaft 41 to a direct current power supply. To protect the metal surfaces of disks 43 from attack by the electrolyte, these surfaces are protected by insulating films 45 and 46, located on the inside and outside surfaces, respectively. As shown in Fig. 5, insulating films 46 include flanges 47 which overlie disks 43 and the edges of primary cathodes 44. This construction is desirable to prevent excessive plating on the edges of screen cathode 44, where otherwise the electroplated layer would be thicker than on the greater portion of the surface area of cathode 44. To minimize further the tendency to thicker plating along the edges of screen cathode 44, this cathode is of greater length than anodes 33. By these two expedients, the electrodeposit on mandrel 44 is of substantially uniform thickness along the entire surface.

Cathode assembly 40 also includes a hollow cylindrical secondary cathode 48, which is rigidly secured to flanges 43 but insulated therefrom by suitable insulating means. All current from the anode which reaches cathode 48 must pass through the holes in foraminous mandrel 44. A conductor 49 passes from secondary cathode 48 through an opening 50 in hollow shaft 41, and runs on the interior of said hollow shaft 41. Suitable connectors, not shown, are arranged to connect conductor 49 to the direct current power supply.

The electric current power supply which provides current to anode 33 and to cathodes 44 and 48 may be of the same type as indicated in Fig. 1. In other words, anode 33 is connected to the positive side of a direct current power supply, while cathodes 44 and 48 are placed in series with resistances, not shown, and connected to the negative side of a common direct current power supply.

The apparatus illustrated in Figs. 4 and 5 is particularly desirable for electroforming screens on a large scale. The operation will be described below with reference to Fig. 7.

The apparatus shown in Figs. 4 and 5 can also be used with slight modification, as shown in Fig. 6, for building

up the thickness of screens by the electroforming process of this invention. All of the apparatus is the same, except for cathode assembly 60, which is of slightly different construction from cathode assembly 40 illustrated in Figs. 4 and 5. Cathode assembly 60 has a hollow shaft 61 which may be supported in bearing housings 42, as shown in Figs. 4 and 5. Disks 62, which preferably are made of plastic or other suitable insulating material, are rigidly secured to shaft 61. Each disk has along its periphery a flange 63 along its outer face, and a cylindrical land 64 located adjacent to and radially inwardly from flange 63. In operation, flanges 63 guide and lands 64 support a screen web which is to be thickened by electroplating according to this invention. A hollow metal cylinder 65 which serves as a secondary cathode is rigidly secured to disks 62. Cylinder 65 is electrically connected to shaft 61 by conductor 66.

Fig. 7 illustrates diagrammatically a continuous process for both electroforming a continuous screen web on a mandrel and for building up the thickness of said screen web by electroforming according to the present invention. The apparatus used is shown in Figs. 4, 5, and 6.

A continuous screen web 70 is electroformed in left-hand tank 30 in Fig. 7. The apparatus in this tank is identical to that shown in detail in Figs. 4 and 5. Current flows simultaneously from anodes 33 to mandrel 44, which is the primary cathode, and to secondary cathode 48. As cathode assembly 40 continuously rotates, an electrodeposit is formed on mandrel 44. The pattern of holes and lands in the screen corresponds to that of mandrel 44. When the desired hole size in the screen is the same as that in mandrel 44, the ratio of primary cathode current to secondary cathode current is about the same as the ratio of land area to hole area on mandrel 44. Smaller or larger screen holes are obtained by increasing or decreasing, respectively, the ratio of primary to secondary cathode current. Control of hole size is thus effected in the same way as has already been described with reference to Figs. 1 to 3. The electrodeposited screen adheres sufficiently to mandrel 44 to retain its position during electroforming, but weakly enough to permit mechanical removal. As cathode assembly 40 rotates, screen 70 is separated from mandrel 44 by a doctor blade not shown.

Screen web 70 passes through right-hand electroplating tank 30*a* in Fig. 7. This tank includes cathode assembly 60 as shown in Fig. 6; otherwise the construction is as shown in Figs. 4 and 5. An adherent metal layer is electroplated on screen 70 to increase it to desired thickness as it passes through tank 30*a*. Screen 70 engages guide surfaces 62 of cathode assembly 60, which rotates continuously. Current flows simultaneously from anodes 33*a* through electrolyte 32*a* to screen 70 and to secondary cathode 65, which is part of cathode assembly 60. Screen 70 may be connected to a source of power through conventional means located outside tank 30*a*, as for example a brush connection forming part of roller 71. The ratio of primary to secondary cathode current determines the hole size in the electroplate as previously described. After screen 70 has been electroplated to desired thickness in tank 30*a*, it is ready for further operations, such as cutting into desired lengths.

Although both tank 30 and tank 30*a* are illustrated as the same size, it is understood that in actual practice they may be of different sizes, depending upon the thickness of the electrodeposit to be formed in each instance. For instance, if a screen web is to be electroformed to an initial thickness of .005 inch in tank 30, and then plated with an adherent metal layer of .010-inch thickness in tank 30*a* so as to form a total screen thickness of .015 inch, the cathode assembly 60 and tank 30*a* would be approximaetly twice the size of cathode assembly 40 and tank 30.

The invention will now be illustrated by reference to the following specific examples.

Example I

A nickel screen which had been electroformed according to the present invention was electroplated with nickel to increase its thickness. A screen 1⅛ by 1¾ inches was made the primary cathode in an electroplating bath which also had an anode and a secondary cathode. The apparatus used is shown in Figs. 1 to 3. This screen had an initial thickness of 0.0045 to 0.005 inch, except for a slightly greater thickness around the edges, and original hole diameters ranging from .011 to .013 inch with a spacing of 0.020 inch from the center of one hole to the center of the nearest adjacent hole. The surface of this screen was cleaned beforehand to remove all metal oxide and other material and leave a metallic surface. The electroplating bath had the following composition, pH and temperature:

Nickel sulfamate, $Ni(NH_2SO_3)_2$	g./l.	300
Nickel chloride, $NiCl_2 \cdot 6H_2O$	g./l.	30
Boric acid, H_3BO_3	g./l.	30
pH		3.1
Temperature	° F.	140

The cathode current density on the face of the screen, making no allowance for holes, was 100 amperes per square foot. The total current was 1.5 amperes, of which 1.4 amperes flowed to the screen and 0.1 ampere to the secondary cathode. Plating was continued for 125 minutes, during which time an adherent electrodeposit nickel layer having a thickness ranging from .007 to .010 inch and holes ranging from .0035 to .005 inch in diameter were plated.

Example II

A nickel screen was electroformed on a nickel mandrel according to the process of the present invention. The mandrel constituted the primary cathode in the electroplating cell which was like that shown in Figs. 1 to 3. This mandrel was a thin nickel screen, about .005 inch thick, having holes ranging from .011 to .013 inch in diameter with a center-to-center spacing of .023 inch.

The composition, pH, and temperature of the electroplating bath were as follows:

Nickel sulfamate, $Ni(NH_2SO_3)_2$	g./l.	300
Nickel chloride, $NiCl_2 \cdot 6H_2O$	g./l.	30
Boric acid, H_3BO_3	g./l.	30
pH		3.1
Temperature	° F.	140

The total current passing through the cell was 1.9 amperes, of which 1.42 amperes flowed to the screen and the balance to the secondary cathode. The potential difference between the anode and the screen was 3.25 volts, and the potential between the anode and the secondary cathode was 4.6 volts.

Plating was continued for 130 minutes. The electroformed screen weighed 3.413 grams, and the mandrel initially weighed 2.723 grams. The combined weight of screen and mandrel was 6.136 grams. The weight increase of the secondary cathode was 2.178 grams, from an initial 7.921 grams to a final 10.099 grams. This represents 61 percent of the total nickel electrodeposit on the nickel mandrel and 39 percent on the secondary cathode. The thickness of the electrodeposited layer ranged from .010 to .016 inch in addition to the initial thickness of the mandrel. The electroformed layer or screen adhered loosely to the original layer or mandrel, and the two layers could be separated by hand. A thin oxide film on the surface of the mandrel prevented tight adherence. The holes in the screen had an initial diameter of .011 to .013 inch and a center-to-center spacing of .023 inch and a final diameter of .009 to .011 inch. The reduction of hole diameter was considerably less than that in Example I. This is attributed to the higher ratio of secondary cathode current to total current in the present example.

While the present invention has been described with reference to flat screens, it is understood that this invention may also be used to electroform and build up shaped screens. Other modifications will be apparent to those skilled in the art. The scope of the present invention is limited only by the appended claims.

What is claimed is:

1. A process for electroforming screens in an electrolytic cell having an anode and primary and secondary cathodes with the primary cathode between the anode and secondary cathode and having a plurality of holes therethrough, comprising non-adherently electroplating a layer of screen material on said primary cathode maintaining the ratio of primary cathode current to secondary cathode current substantially no greater than the ratio of solid area to hole area of the primary cathode, maintaining the potential difference between the anode and the secondary cathode greater than between the anode and the primary cathode, and mechanically removing said layer from said cathode as an entity.

2. A process for electroforming screens in an electrolytic cell having an anode and primary and secondary cathodes with the primary cathode between the anode and secondary cathode and being a foraminous mandrel having a surface from which electrodeposited metal can be removed, comprising electroplating a layer of screen material on said primary cathode, maintaining the ratio of primary cathode current to secondary cathode current substantially no greater than the ratio of solid area to hole area of the primary cathode, maintaining the potential difference between the anode and the secondary cathode greater than between the anode and the primary cathode, and mechanically removing said layer from said cathode as an entity.

3. A process for electroplating a foraminous mandrel comprising forming an electrolytic cell having therein an anode of one substantially pure metal, a secondary cathode and a primary cathode comprising said mandrel therebetween, simultaneously passing current from said anode to said primary cathode and from said anode to said secondary cathode through said primary cathode maintaining the ratio of primary cathode current to secondary cathode current substantially no greater than the ratio of solid area to hole area of the primary cathode, and maintaining the potential difference between the anode and the secondary cathode greater than between the anode and primary cathode.

4. A process for electroplating a foraminous mandrel comprising forming an electrolytic cell having therein an anode, a secondary cathode, a primary cathode therebetween comprising said mandrel, and an electrolyte comprising at least one metallic salt and being substantially free of impurities, and simultaneously passing current from said anode to said primary cathode and from said anode to said secondary cathode through said primary cathode maintaining the ratio of primary cathode current to secondary cathode current substantially no greater than the ratio of solid area to hole area of the primary cathode, and maintaining the potential difference between the anode and the secondary cathode greater than between the anode and primary cathode.

5. A process for forming a screen having substantial thickness and undiminished hole size comprising coating a foraminous mandrel with a parting material, forming an electrolytic cell having therein an anode of one substantially pure metal, a secondary cathode and a primary cathode comprising said mandrel therebetween, simultaneously passing current from said anode to said primary cathode and from said anode to said secondary cathode through said primary cathode maintaining the ratio of primary cathode current to secondary cathode current substantially no greater than the ratio of solid area to hole area of the primary cathode, maintaining the potential difference between the anode and the secondary cathode greater than between the anode and primary cathode, removing said mandrel from said cell, and me-

chanically stripping the screen formed on said mandrel as an entity from said mandrel.

6. A process for forming a screen having substantial thickness and undiminished hole size comprising coating a foraminous mandrel with a parting material, forming an electrolytic cell having therein an anode, a secondary cathode, a primary cathode therebetween comprising said mandrel, and an electrolyte comprising at least on metallic salt and being substantially free of impurities, simultaneously passing current from said anode to said primary cathode and from said anode to said secondary cathode through said primary cathode, maintaining the ratio of primary cathode current to secondary cathode current substantially no greater than the ratio of solid area to hole area of the primary cathode, maintaining the potential difference between the anode and the secondary cathode greater than between the anode and primary cathode, removing said mandrel from said cell, and mechanically stripping the screen formed on said mandrel as an entity from said mandrel.

References Cited in the file of this patent

UNITED STATES PATENTS

1,414,423	Langer	May 2, 1922
1,567,791	Duhme	Dec. 29, 1925
2,287,122	Norris	June 23, 1942

FOREIGN PATENTS

335,161	Great Britain	Sept. 15, 1930