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MANUFACTURE OF METAL MESH SCREENS

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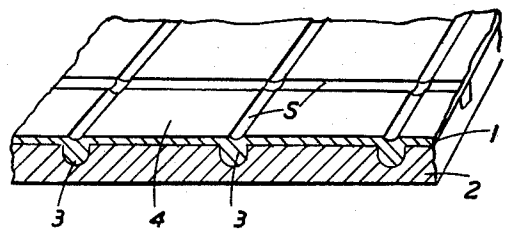

FIG. 1.

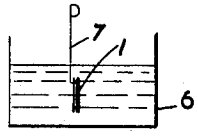

FIG. 2.

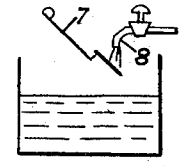

FIG. 3.

FIG. 4.

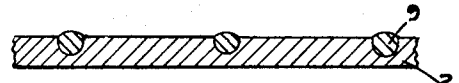

FIG. 5.

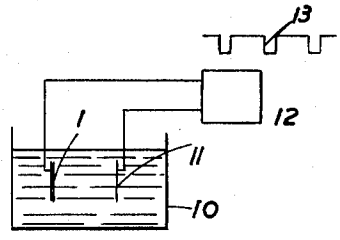

FIG. 6

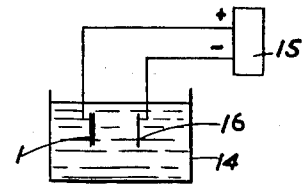

FIG. 7.

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MANUFACTURE OF METAL MESH SCREENS

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6 Claims. (Cl. 41—42)

This invention relates to the manufacture of metal mesh screens such as are employed, for example, in television pick-up tubes, thermionic valves, etc., the screens having apertures ranging from 200 to 2,000 or more per linear inch.

In the specification of United States Patent No. 2,115,855 a method of manufacturing a metal mesh screen is described which employs a matrix having grooves corresponding to the pattern of the screen to be manufactured, the matrix being coated with a layer of metal, after which the metal is removed from portions of the matrix between the grooves, the matrix being then removed from the metal mesh thus formed. The matrix may be formed by ruling a wax blank, rendering said ruled surface electrically conducting by anodic bombardment or by other means and then electrolytically depositing metal on to the electrically conducting surface. A negative impression of the ruled surface is thereby obtained and from this negative impression a metallic positive forming said matrix is obtained by deposition of further metal electrolytically. In the method described in the aforesaid specification, after the matrix is coated with the metal to form the mesh (which then has the configuration shown in Figure 3 of said specification) the metal is removed so as to expose the matrix between the grooves and thus form the perforations by grinding or lapping. It might appear that the metal which is to be removed could be removed by etching or dissolving the metal in a suitable reagent but it is found that when a metal is immersed in an etching solution the etching is by no means uniform and certain areas of the metal are attacked by the etching solution in an indiscriminate manner. In attempting to make a screen from the aforesaid metal coated matrix by immersion in an etching solution, it was found that the indiscriminate etching was such that over some areas portions of the ribs formed by the deposition of metal in the grooves of the matrix were completely etched away before some of the thinner areas of metal on other parts of the matrix were perforated.

The object of the present invention is to provide an improved method of manufacturing a metal mesh in which the metal to be removed to provide the perforations is removed by decomposing the metal in a controlled manner.

According to the present invention there is provided a method of making a metal mesh screen from a metal member formed with ribs corresponding to the mesh to be formed and continuous with thinner areas lying between said ribs which consist in subjecting said member intermittently to a decomposing action, whereby the metal lying between said ribs is decomposed more rapidly than said ribs and continuing said intermittent decomposing action until the areas between said ribs are perforated.

In the preferred form of the invention the metal member which is to form said mesh is not removed from the metal matrix until after the decomposing process has been completed although if desired in some cases said member

may be removed from the matrix by dissolving the matrix prior to the decomposing operation according to the invention. Preferably the intermittent decomposing action is effected by immersing said member in an etching liquid for a predetermined period, removing said member from the etching liquid, washing said member and thereby cooling it and then again immersing the member in the etching liquid and repeating these operations until a perforated mesh is ultimately formed. Alternatively, the etching operation may be in a liquid which renders the areas of metal which are required to be removed to perforate the member more rapidly passive than other areas and employing an electric current to remove the passivity intermittently. According to a further alternative, the metal may be decomposed by electrolysis.

It is, of course, known to make meshes by providing a pattern of the mesh in resist material on a plate which can be etched and then etching to dissolve those areas which are not covered by the resist. The method according to the present invention is, however, quite distinct from such known methods, since the member to be etched is not provided with a pattern of the mesh in resist material and, moreover, the whole exposed area of the member is subject to chemical decomposition.

In order that the said invention may be clearly understood and readily carried into effect it will now be more fully described with reference to the accompanying drawings, in which—

Figure 1 illustrates a cross-sectional view of a metal member provided on a matrix,

Figure 2 illustrates said member and matrix in an etching solution,

Figure 3 illustrates the washing process,

Figure 4 illustrates a cross-sectional view of the member shown in Figure 1 after partial decomposition has been accomplished,

Figure 5 shows the mesh after completion of the decomposing process, and

Figures 6 and 7 illustrate alternative methods of carrying the invention into effect.

As shown in Figure 1 the reference numeral **1** indicates the metal member from which the mesh is formed, this metal member being made by depositing silver electrolytically on to a copper matrix **2** which is provided with grooves formed in the manner described in the specification of the aforesaid patent. The metal member **1** is thus formed with ribs **3** with intervening areas **4** which are thinner than the ribs **3**, the surface of the member **1** having indentations or grooves **5** which are inevitably formed during the electro-deposition of the metal member **1**. Preferably the metal member **1** is treated in accordance with the method of the invention, whilst supported on the matrix **2** and the member **1** and matrix **2** are placed in an etching bath **6** shown in Figure 2 and allowed to remain suspended in the bath **6** by a suitable support **7** for approximately 15 seconds. The areas **4** between the ribs **3** may have a thickness of 2 to $\frac{3}{10,000}$ of an inch, whilst the copper matrix **2** may have a maximum thickness of from 10 to $\frac{15}{1,000}$ of an inch. The etching liquid contained in the bath **6** may comprise 19 parts by volume of concentrated sulphuric acid and one part by volume of concentrated nitric acid. Such a liquid mainly decomposes the silver and causes only little decomposition of the copper. After immersing the member in the etching liquid for about 15 seconds it is removed, washed under running water from a tap **8** (Figure 3) and thereby cooled and after drying is immersed again in the etching liquid and after a further period of etching of about 15 seconds it is again removed, washed, dried and re-immersed. It is found that during the etching process as above described the areas **4** of metal lying between the ribs **3** are more rapidly etched than the

areas in proximity to the ribs 3 so that after a few immersions the areas 4 between the ribs become perforated, leaving a configuration somewhat as shown in Figure 4. As soon as the areas 4 have become perforated the etching again becomes more rapid as the etching liquid has access to the other side of the areas between the ribs 3. After about 12 to 13 immersions the areas 4 become sufficiently removed and the mesh then has the cross-sectional shape shown in Figure 5. The copper matrix 2 can then be removed by dissolving the copper in a suitable medium which dissolves the copper but not the silver. It will be observed from Figure 5 that the mesh which is ultimately formed has a slightly convex upper surface 9 which is advantageous since it somewhat strengthens the mesh compared with the method of making such a mesh as described in the specification of the aforesaid patent, in which as a result of the grinding or lapping operation the upper surface of the mesh is flat. The time taken for the repeated immersions and washing processes may occupy a total period of 10 to 15 minutes.

The manner in which the method according to the invention operates to produce a more rapid etching action of the areas 4 is not fully understood but it is believed that the thinner areas 4 allow a more rapid temperature rise compared with the thicker parts constituted by the ribs 3 and since the rate of etching is dependent on temperature these areas are more rapidly etched than the other areas. Thus, by removing the member 1 from the etching solution before washing and re-immersing in the etching solution the thinner areas are more rapidly decomposed than the other areas. The decomposing action is preferably interrupted before the temperatures of all parts of the member 1 are equalised. The washing of the member equalises the temperature of all parts of the member 1.

Figure 6 of the drawings illustrates an alternative method of making a mesh in which the member 1 and copper matrix 2 are immersed in a bath 10 containing an etching liquid which rapidly renders the surface of the member 1 passive. This passivity causes the decomposing action to cease and the passivity is removed by applying an electric current to the member 1 at intervals. The member 1 is made the cathode in the bath 10 and a further electrode 11 is provided, the member 1 and the electrode 11 being connected to a source 12 of negative electric pulses 13 which are applied intermittently to the member 1. For example, it may be arranged that there is applied to the member 1 a pulse of about 12 volts every minute for 1 to 5 seconds. It is found that with such an arrangement the areas 4 are more rapidly decomposed than the other areas so that a mesh is ultimately formed having the configuration shown in Figure 5. It is again believed that the more rapid etching action of the areas 4 occurs as a result of a more rapid rise in temperature of these areas compared with the areas of the ribs 3 and as soon as these areas 4 are rendered passive they become cooled and the application of the current pulses almost instantaneously removes the passivity allowing further etching of the areas 4 to occur.

It may be desired in the methods described above to maintain the baths 6 and 7 cool as by the provision of some suitable refrigerating means. Alternatively, the member 1 can be moved from different positions in the baths so as to effect the cooling operation which it is thought is necessary.

In an alternative method in accordance with the invention the areas 4 are decomposed by electrolysis. As shown in Figure 7 the member 1 is arranged in a bath 14 containing a silver cyanide solution having an excess of cyanide and is connected to the positive terminal of a current source 15, the negative terminal of which is connected to a stainless steel cathode 16. With the arrangement shown in Figure 7, electrolysis of the surface of the member 1 becomes inhibited and the inhibition is automatically removed by the constant electric current and the process repeats itself automatically. In this method the current density employed is suitably chosen depending on the area of the member 1.

Although the invention has been described above as applied to the manufacture of a metal mesh formed of silver on a copper matrix, it will be understood that other metals may be used.

What we claim is:

1. A method of making a metal mesh screen from an unperforated metal member formed with ribs corresponding to the mesh to be formed and continuous with thinner areas bridging said ribs, which consists in effecting chemical decomposition of said ribs and thinner areas by subjecting said member to a decomposing action in a liquid for intervals during which the metal bridging said ribs is decomposed more rapidly than said ribs, discontinuing said decomposing action before the areas between said ribs are perforated and thereafter repeatedly subjecting said member to said decomposing action until the areas bridging said ribs are perforated to provide ribs of substantially the same thickness and apertures of substantially the same size.

2. A method of making a metal mesh screen from an unperforated metal member formed with ribs corresponding to the mesh to be formed and continuous with thinner areas bridging said ribs, which consists in exposing said ribs and thinner areas to a chemical decomposing action in a liquid for a time during which the thinner areas of said member are more rapidly decomposed than the thicker areas due to the thinner areas increasing in temperature more rapidly than said ribs, cooling said thinner areas to equalise the temperatures of said thinner areas and said ribs, and subjecting said member repeatedly to said decomposing and equalizing cycles whereby the thinner areas are more rapidly reduced in thickness compared with the thicker areas, and continuing said decomposing and equalizing cycles until the areas bridging said ribs are perforated to provide ribs of substantially the same thickness and apertures of substantially the same size.

3. A method of making a metal mesh screen from an unperforated metal member formed with ribs corresponding to the mesh to be formed and continuous with thinner areas bridging said ribs, which consists in effecting chemical decomposition of said ribs and thinner areas by subjectng said member intermittently to a decomposing action in a liquid for a time during which the metal bridging said ribs is decomposed more rapidly than said ribs, interrupting the decomposing action before the rate of decomposition of said thin and thick areas is equalized, and continuing said intermittent decomposing action until the areas between said ribs are perforated to provide ribs of substantially the same thickness and apertures of substantially the same size.

4. A method of making a metal mesh screen from an unperforated metal member with ribs corresponding to the mesh to be formed and continuous with thinner areas bridging said ribs, which consists in exposing said ribs and thinner areas to a chemical decomposing action in a liquid for a time during which the thinner areas of said member are more rapidly decomposed than the thicker areas, due to the thinner areas increasing in temperature more rapidly than said ribs, and interrupting the decomposing action before the rate of decomposition of said thinner areas and said ribs is equalized, cooling said thinner areas to equalize the temperature of said thinner areas and said ribs, and subjecting said member repeatedly to said decomposing and temperature equalizing cycles, whereby the thinner areas are more rapidly reduced in thickness compared with said ribs, and continuing said decomposing and temperature equalizing cycles until the areas between said ribs are perforated to provide ribs of substantially the same thickness and apertures of substantially the same size.

5. A method of making a metal mesh screen from an unperforated metal member formed with ribs corresponding to the mesh to be formed and continuous with thinner areas bridging said ribs, which consists in effecting chemical decomposition of said ribs and thinner areas by subjectng said member to a decomposing action in an etching liquid to render the surface passive, applying an electric current to said member to remove said passivity, thereby causing the metal lying between said ribs to be decomposed more rapidly than said ribs, and intermittently supplying said current until the areas between said ribs are perforated to provide ribs of substantially the same thickness and apertures of substantially the same size.

6. A method of making a metal mesh screen from an unperforated metal member formed with ribs corresponding to the mesh to be formed and continuous with thinner areas bridging said ribs, which consists in effecting chemical decomposition of said ribs and thinner areas by subjectng said member to electrolysis in an electrolyte containing an excess of cyanide to cause electrolysis of said

member to become inhibited intermittently, and continuing said electrolysis until the areas between said ribs are perforated to provide ribs of substantially the same thickness and apertures of substantially the same size.

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