May 13, 1952 G. K. TEAL 2,596,617

INCREASING NUMBER OF HOLES IN APERATURED METAL SCREENS

Original Filed Dec. 29, 1948 3 Sheets-Sheet 1

FIG. 1

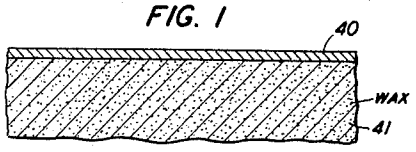

FIG. 2

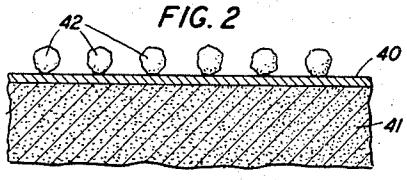

FIG. 3

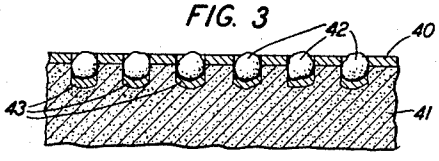

FIG. 4

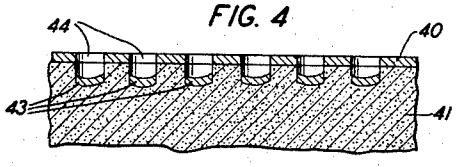

FIG. 5

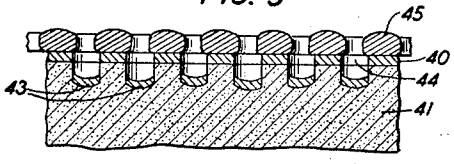

FIG. 6

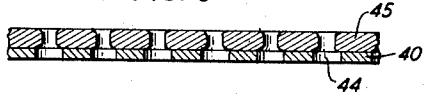

FIG. 7

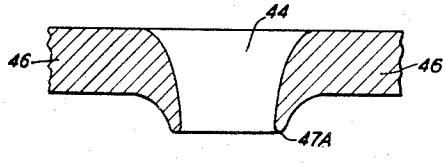

FIG. 8

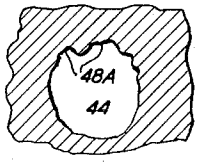

FIG. 9

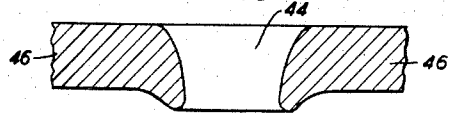

FIG. 10

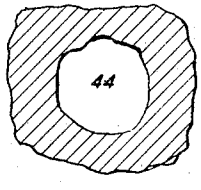

FIG. 11

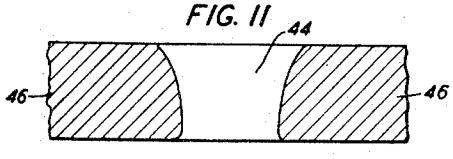

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FIG. 12

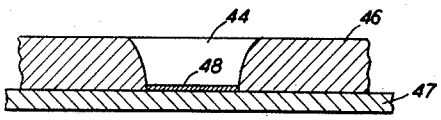


FIG. 13

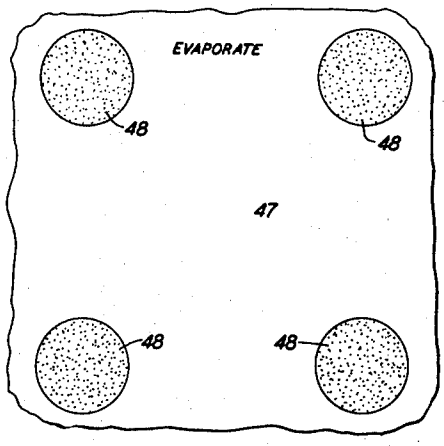


FIG. 14

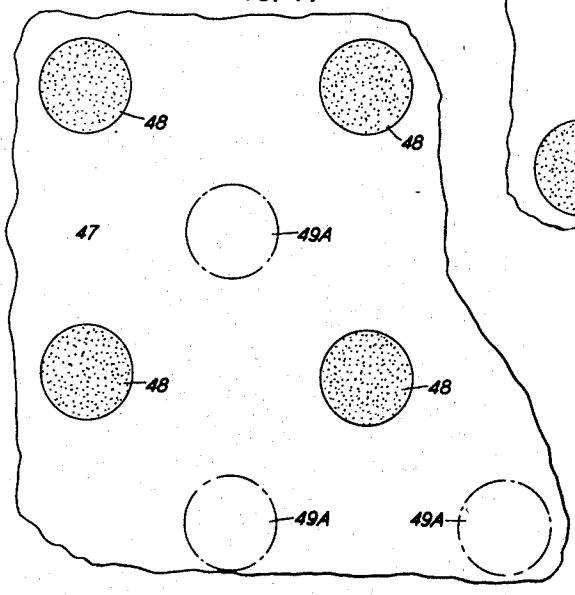
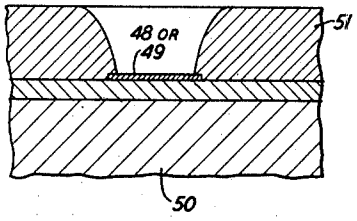


FIG. 15



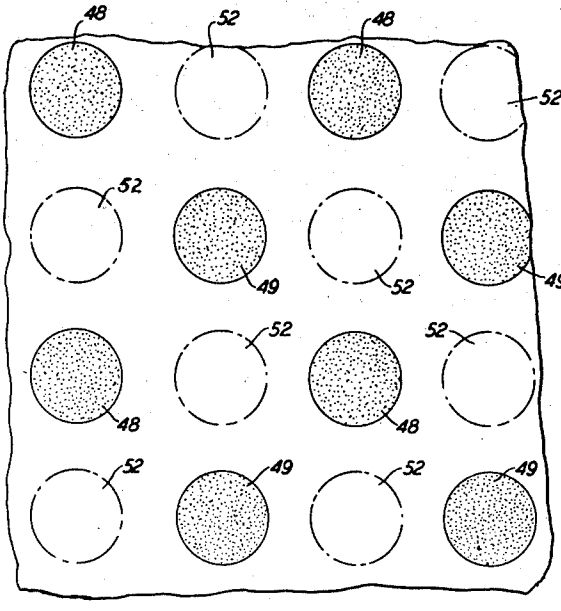


FIG. 16

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INCREASING NUMBER OF HOLES IN APERATURED METAL SCREENS

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FIG. 17

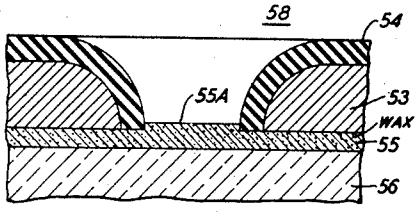


FIG. 18

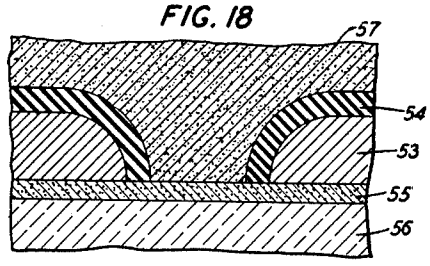


FIG. 19

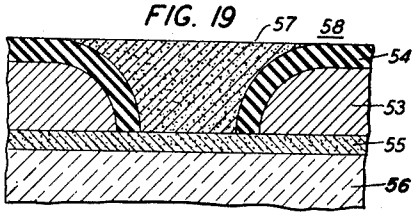


FIG. 20

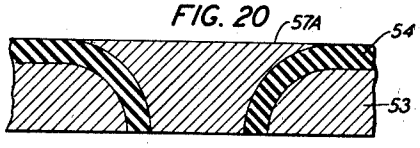


FIG. 21

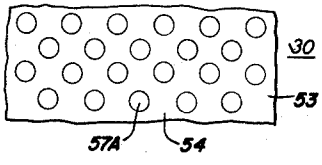


FIG. 22

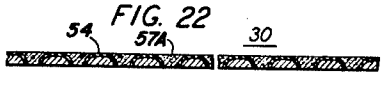
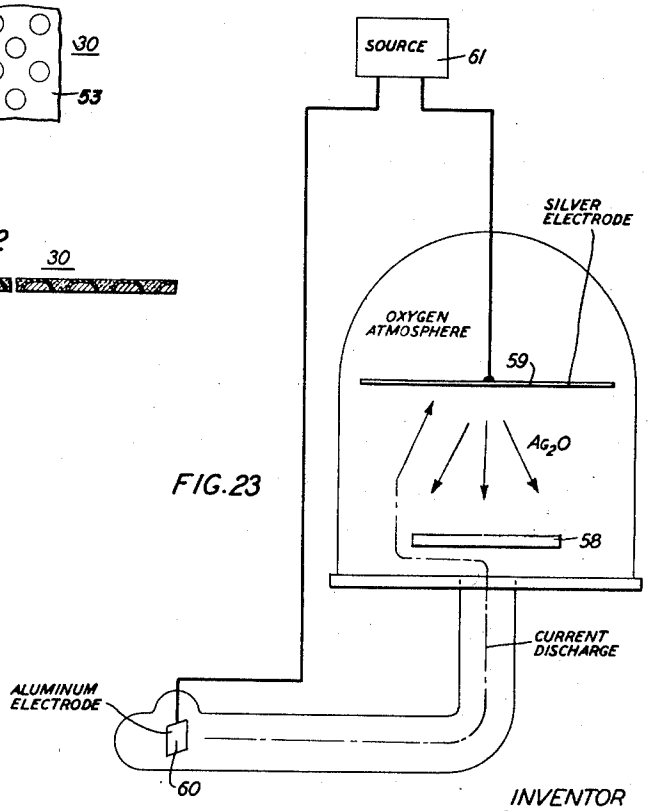


FIG. 23



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Patented May 13, 1952

2,596,617

UNITED STATES PATENT OFFICE

2,596,617

INCREASING NUMBER OF HOLES IN APERTURED METAL SCREENS

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Original application December 29, 1948, Serial No. 67,917. Divided and this application October 27, 1949, Serial No. 123,875

4 Claims. (Cl. 41—43)

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This invention relates to electro-optical devices and more specifically to methods of making target or screen structures for use in television transmitter tubes. This application is a division of application Serial No. 67,917 filed December 29, 1948.

It has long been recognized in the development of electron camera tubes for generating picture signals at a television transmitting station that there are many advantages in projecting an electron image of the object for transmission onto one side of the screen of the tube and scanning the opposite side of the screen with a cathode ray beam formed in the tube. An example of a camera tube employing such a "two-sided" target or screen is the so-called "image orthicon" tube, described in an article entitled "The Image Orthicon—A Sensitive Television Pick-up Tube' by Albert Rose, Paul K. Weimer and Harold B. Law, appearing in the July 1946 issue of the Proceedings of the I. R. E., beginning on page 424. The two-sided target makes possible the separation of charging and discharging processes so that the sensitizing procedures and electric fields appropriate to each can be utilized in the tube without mutual interference. The target must conduct charges between its two sides or surfaces but not along either surface. Moreover, it should have a conducting element therein or nearby to act as the common capacitor plate for the separate picture elements. It has been found very difficult to construct satisfactorily commercial targets of this type.

It is an object of the present invention to provide novel and improved methods for making apertured metal screens which can be used, for example, in the production of two-sided electron camera tube targets which have a large number of elemental discrete conducting elements per square inch.

It is a further object of this invention to provide novel methods of preparing screens having an increased number of holes.

In an exemplary method of making an apertured metal screen in accordance with the invention, which can be used in the production of a two-sided mosaic target for camera tubes and the like, a master apertured metallic screen is used to produce a final screen which has a much larger number of apertures than the master. A pattern of solid dots is formed on a piece of paper by evaporation through the holes of the master screen. The master screen is then shifted so that the holes fall in position between the dots already formed and the evaporation process is repeated. A layer of silver or copper oxide is then produced upon the paper by vacuum filtering and the oxide is reduced to silver or copper. The solid dots are then etched out of the holes, giving a perforated metal screen having twice the number of holes possessed by the master screen. By using the final screen as a "master" in a repetition of the process, the number of holes in the resulting screen is even further increased.

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The invention will be more readily understood by referring to the following description taken in connection with the accompanying drawings forming a part thereof, in which:

Figs. 1 to 6, inclusive, illustrate various steps in a method of producing an apertured metallic screen which can be used in the process in accordance with the invention;

Figs. 7 to 11, inclusive, illustrate steps in the process of electrolytically polishing the screen shown in Fig. 6;

Figs. 12 to 16, inclusive, illustrate a method in accordance with the invention of increasing the number of holes in the screen shown in Fig. 11;

Figs. 17 to 20, inclusive, illustrate a method of filling the apertures in the screen shown in Fig. 16 with insulated plugs;

Fig. 21 is a top view of a schematic representation in greatly enlarged form of a portion of a target utilizing an apertured screen made in accordance with the invention;

Fig. 22 is a sectional side view of portions of such a target; and

Fig. 23 shows apparatus used in making the target.

Referring more specifically to the drawings, Figs. 21 and 22 show, by way of example for purposes of illustrating one use of an apertured metal screen made in accordance with the invention, portions of a two-sided mosaic target **30** suitable for use in certain television transmitting tubes, such as, for example, the image orthicon type of tube briefly referred to above. It will be understood that Figs. 21 and 22 are merely schematic showings and the same applies to the other figures in the drawings. Target **30** comprises a thin metallic screen **53** of a suitable metallic material having a large number of holes to the linear inch, e. g., four hundred per inch or more. One surface, such as the top surface in Fig. 22, and the interiors of all the apertures in the screen **53** are coated with an insulating material **54**. The interiors of all these apertures are filled with metallic plugs **57A**. Successive steps in the preparation of the screen or target **30** will

be easily understood by referring to Figs. 1 to 20, inclusive, in some of which for simplicity in the drawings, the structure around one aperture only has been shown.

The first six figures of the drawings illustrate schematically a method of forming a metallic screen having a number of apertures therein. By way of example, this screen (after it is electrolytically polished in accordance with the process of Figs. 7 to 11, inclusive) can be used as a master in the process of Figs. 12 to 16, inclusive, in accordance with the invention.

Fig. 1 shows a thin conducting layer **40** of platinum or other suitable material which is evaporated, sprayed, sputtered or otherwise deposited on a wax block **41**. Very small particles of uniform diameter are insufflated upon the surface of the film **40**. These particles **42** may be any hard particle, such as diamond, sapphire, iron, nickel or other solid. Fig. 2 shows these particles on the conducting film **40**.

As shown in Fig. 3, the particles **42** are pressed into the metal film **40** with a roller or a smooth flat or curved plate. This breaks small areas of the metal **40** away from the main part of the conducing film leaving thereby a perforated screen on the surface of the wax. Small areas **43** of the screen are pressed into the wax block **41**.

If the particles **42** are conductors such as iron or nickel, they may be dissolved with nitric or hydrochloric acids. If the particles **42** are insulating particles this step can be omitted.

As thick a coat of nickel is applied to the platinum screen **40** as is possible without closing up the holes **44**. The coating **45** is shown in Fig. 5.

Let it be assumed that an enlarged side view of one of the apertures **44** and of its surrounding metal is shown in Fig. 7, and a large cross-section of the aperture **44** is shown in Fig. 8. It is obvious that the actual aperture **44** is by no means as smooth as is represented in Fig. 7. It has been shown in this manner merely for convenience and simplicity in the drawings. It will be noted that the metal screen **46** shown in Fig. 7 has angular projections **47A** around the hole and also small irregular projections **48A** shown in Fig. 8. The screen **46** is then electrolytically polished by making it the anode in a solution of sulfuric acid and water (120 cc. H_2SO_4 to 80 cc. H_2O) at a high current density. This rounds off some of the projections and dissolves part of the nickel screen as indicated in Figs. 9 and 10 which otherwise correspond to Figs. 7 and 8, respectively. A thin film of metal is then electroplated upon the screen **46** and the polishing process is repeated and re-repeated as often as necessary to give the smooth screen **46** shown in Fig. 11. It will be noted that in Figs. 7 to 11, inclusive, no attempt has been made to show the various metal layers (such as, for example, layers **45** and **40**) making up the screen, it being shown for simplicity merely as a solid metal screen **46**.

Figs. 12 to 16, inclusive, illustrate a method in accordance with the invention of increasing the number of holes in the screen **46**. As shown in Fig. 12, the metal screen **46** shown in Fig. 11 is placed upon and in intimate contact with a piece of thin filter material **47**, such as paper, and a metal or other solid is evaporated through the holes **44** in the screen. This gives a pattern of thin solid dots **48** over the entire surface of the paper as indicated in Fig. 13. Obviously the dots are not perfect circles as shown in Fig. 13 but are shown thus for simplicity in the drawings.

The screen **46** is then shifted into position so that the holes **44** fall in the positions indicated by the clear circles **49A** in Fig. 14, and a solid is evaporated through the holes in the screen while it is in this position to produce new thin solid dots **49** (shown in Fig. 16).

The metal screen **46** is then removed and the filter paper **47** upon which aluminum dots **48** and **49** have been superimposed is placed upon a filter cylinder **50** of sintered glass or glass containing a multiplicity of capillary holes and a layer of silver oxide or copper oxide **51** is deposited upon the paper while vacuum is applied to the underside of the cylinder. The entire assembly is then placed in a reducing atmosphere and the silver oxide or copper oxide reduced to silver or copper. The aluminum dots **48** and **49** are now etched out of the holes with concentrated potassium hydroxide solution giving a perforated metal screen having twice the number of holes possessed by the original screen.

The metal screen produced by the process illustrated by Figs. 12 to 15, inclusive, is now used in a repetition of this procedure to produce a metal screen having holes including those shown as **48** and **49** in Fig. 14 and also those shown in the positions of the dotted circles **52** in Fig. 16. This produces a screen shown as **53** in Fig. 17 which contains four times the total number of holes as the screen shown in Fig. 12 and twice the number of holes per linear inch as that shown in Fig. 12.

Figs. 17 to 20, inclusive, illustrate a method of filling the apertures in the screen **53** with insulated metallic plugs. Referring now to Fig. 17, the metal screen **53** is coated with insulating layer **54**. This is obtained by evaporating a suitable substance such as cryolite on the top of the screen or by insufflating glass on the screen and then fusing it to give the coating **54**. A uniform coating of beeswax, asphaltum or other adhesive **55** is applied to a fairly thick stiff piece of metal or glass **56**. The adhesive is flowed on the metal or glass **56** by melting or by use of a solution of the adhesive in a solvent such as carbon tetrachloride. Evenness of spreading can be assured by spinning in a horizontal plane. The coated metal screen **53** is pressed onto the wax film **55** so that a small amount **55A** of the wax is pushed into each hole of the screen as shown in Fig. 17. Silver oxide **57** is then applied to the surface of the unit of Fig. 17 by bombarding silver in oxygen with high voltage discharges. This can be accomplished in the apparatus shown in Fig. 23 wherein the unit **58** shown in Fig. 17 and represented schematically by a rectangle in Fig. 23 is mounted in the path between a silver electrode **59** and an aluminum electrode **60** in an oxygen atmosphere, a source of high direct-current voltage **61** being connected between the two electrodes. Because of the oxygen atmosphere, a multiplicity of silver oxide particles **57** is built up in the apertures of the unit **58**.

The excess silver oxide is then wiped off, leaving the silver oxide plugs **57** in the holes of the screen **53** as shown in Fig. 19. The unit is then heated up and the screen is removed from its supports.

The screen of Fig. 19 is then heated in hydrogen to reduce the silver oxide **57** to silver buttons **57A**. Alternatively, it can be treated with a liquid reducing agent such as one of the ones frequently used in photography, for example. This produces a screen one elemental portion of which is shown in Fig. 20 and another larger portion

thereof to a somewhat smaller scale is shown in Figs. 21 and 22.

Various alternative steps and procedures other than those mentioned above are of course possible without departing from the spirit of the invention, the scope of which is pointed out in the claims. The disclosed over-all process of making mosaic screens of the type shown in Figs. 21 and 22 is claimed in the parent application, Serial No. 67,917, filed December 29, 1948; the methods disclosed herein (Figs. 1 to 6, inclusive) of forming an apertured metal screen of the type shown in Fig. 6 are claimed in a copending application of the present inventor, Serial No. 123,873, filed October 27, 1949; the methods disclosed herein of electrolytically polishing apertured metal screens (Figs. 7 to 11, inclusive) are claimed in a copending application of the present inventor, Serial No. 123,874, filed October 27, 1949; and the sputtering method disclosed herein and the apparatus used therefor (Figs. 17 to 20, inclusive, and 23) are being claimed in still another copending application of the present inventor, Serial No. 123,876, filed October 27, 1949.

What is claimed is:

1. The method of producing a screen with an increased number of holes from a master screen having a smaller number of holes comprising the steps of placing said master screen upon a thin support member, depositing a solid material through the holes of the screen to produce a pattern of solid dots over the entire surface of the support member, shifting the master screen so that the holes fall in position between the dots on the support member, depositing a solid material through the holes in the screen while it is in this position, removing the master screen, depositing a layer of metallic oxide upon the support member, reducing the metallic oxide to metal, and then removing the solid dots.

2. The method of producing a screen with an increased number of holes from a master screen having a smaller number of holes comprising the steps of placing said master screen upon a thin support member, evaporating a solid material through the holes of the screen to produce a pattern of solid dots over the entire surface of the support member, shifting the master screen so that the holes fall in position between the dots on the support member, evaporating a solid material through the holes in the screen while it is in this position, removing the master screen, depositing a layer of metallic oxide upon the support member, reducing the metallic oxide to metal, and then removing the solid dots.

3. The method of producing a screen with an increased number of holes from a master screen having a smaller number of holes comprising the steps of placing said master screen upon a thin support member, depositing a solid material through the holes of the screen to produce a pattern of solid dots over the entire surface of the support member, shifting the master screen so that the holes fall in position between the dots on the support member, depositing a solid material through the holes in the screen while it is in this position, removing the master screen, depositing a layer of metallic oxide upon the support member by vacuum filtering, reducing the metallic oxide to metal, and then removing the solid dots.

4. The method of producing a screen with an increased number of holes from a master screen having a smaller number of holes comprising the steps of placing said master screen upon a thin support member, depositing a solid material through the holes of the screen to produce a pattern of solid dots over the entire surface of the support member, shifting the master screen so that the holes fall in position between the dots on the support member, depositing a solid material through the holes in the screen while it is in this position, removing the master screen, depositing a layer of metallic oxide upon the support member, reducing the metallic oxide to metal, and then removing the solid dots by etching.

GORDON K. TEAL.

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