

Feb. 18, 1958

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2,824,249

STORAGE GRID FOR DIRECT-VIEWING STORAGE TUBES

Filed Feb. 9, 1954

2 Sheets-Sheet 1

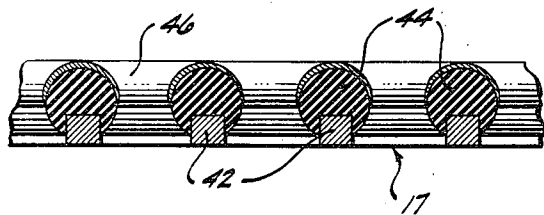


FIG. 1.

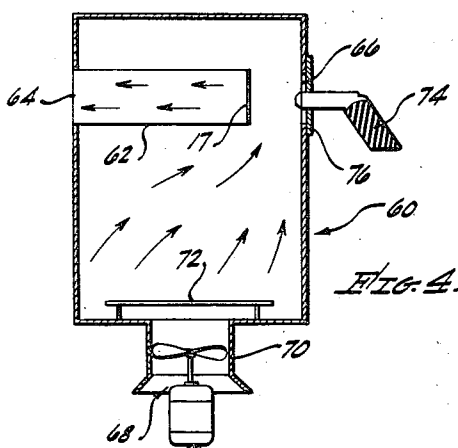


FIG. 4.

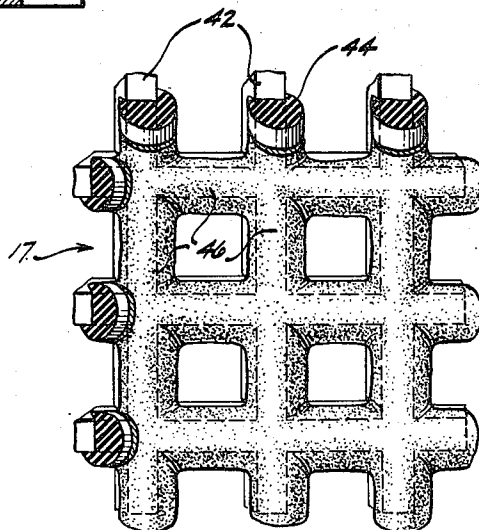
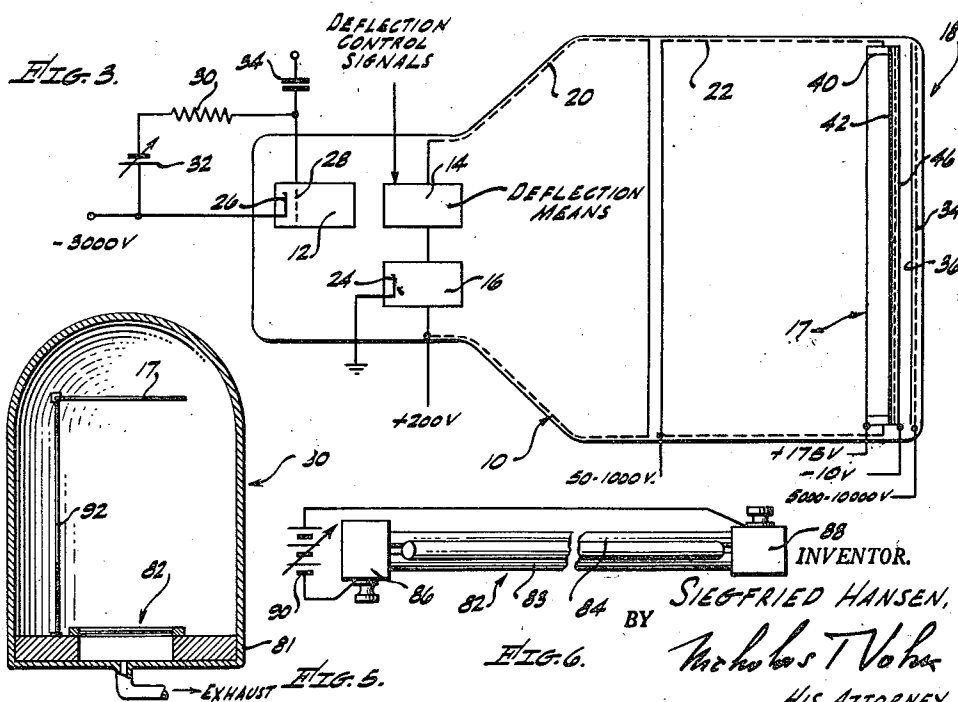


FIG. 2.



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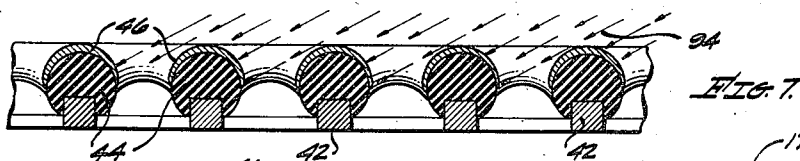
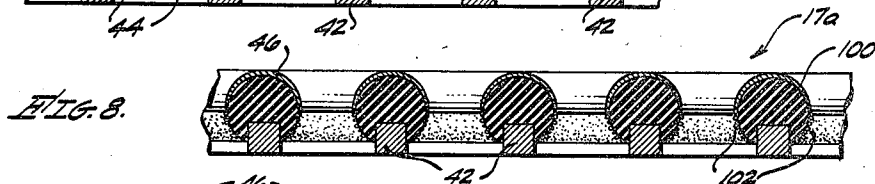
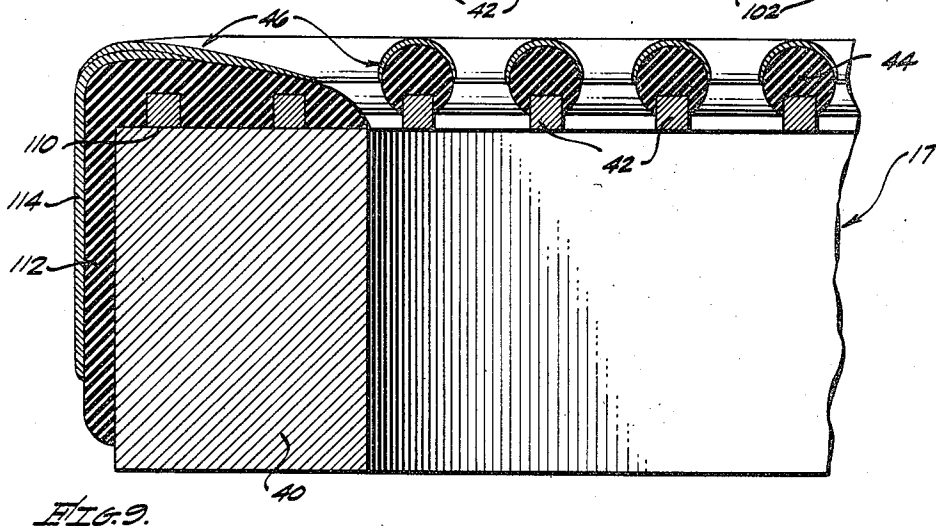
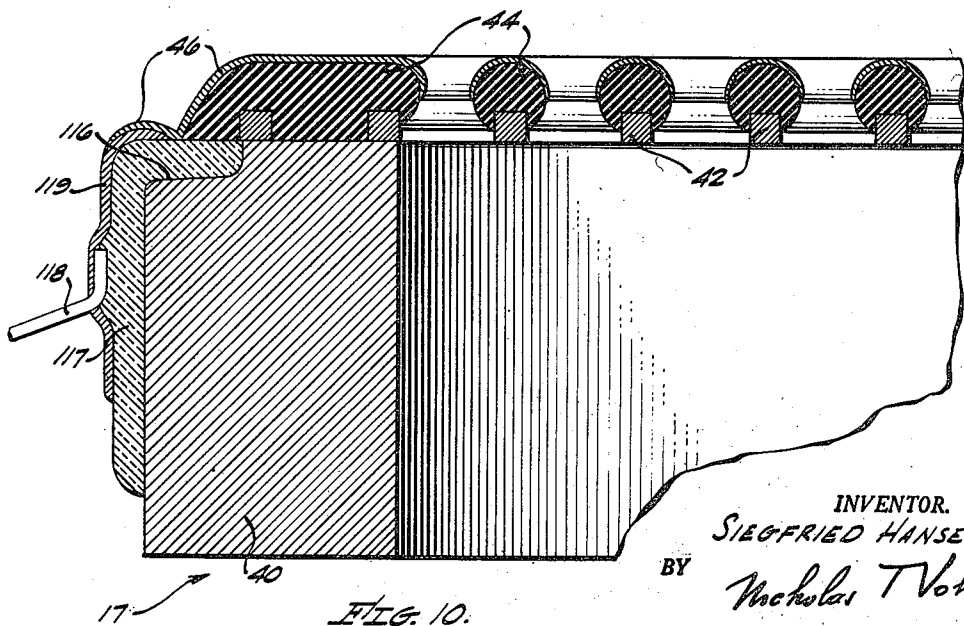
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2 Sheets-Sheet 2



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STORAGE GRID FOR DIRECT-VIEWING STORAGE TUBES

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Application February 9, 1954, Serial No. 409,025

8 Claims. (Cl. 313—68)

This invention relates to direct-viewing storage tubes and more particularly to an improved storage grid assembly for such tubes.

The storage grid assembly hereinafter described is of the same general type as the target element disclosed in United States patents by Siegfried Hansen, Patent No. 2,788,466, issued April 9, 1957, entitled Direct-Viewing Storage Tube, and by Henry M. Smith, Patent No. 2,788,467, issued April 9, 1957, entitled "Direct-Viewing Storage Tube." The target element disclosed in the Hansen application comprises a contrast control grid, a layer of dielectric material disposed uniformly over the contrast control grid, and a collector grid disposed in actual contact with the layer of dielectric material. The storage surface of the target element is provided by the exposed surface of the dielectric material within the interstices of the collector grid.

In the operation of this target element, the collector grid is maintained positive with respect to a reference potential level so that it may collect secondary electrons from the storage surface. Flood electrons, emanating from a source at the reference potential level, are directed uniformly over the entire area of the target element to initially charge its storage surface to the reference potential, thus producing a positive potential gradient from the storage surface to the collector grid. The contrast control grid is maintained at a sufficiently negative potential to allow the flood electrons to penetrate through only those interstices within areas of the target element which are charged positive relative to the reference potential. These electrons then reach a viewing screen disposed contiguous to the target element and maintained at a high positive potential.

Positively charged areas on the storage surface are produced by directing a modulated electron writing beam over the target element in a manner consistent with the charge pattern that it is desired to produce. Each high energy electron incident on the storage surface releases numerous electrons which are attracted to the collector grid by the potential gradient to charge the storage surface in a positive direction. Subsequent action of the flood electrons charges any portion of the storage surface more positive than the critical potential of the dielectric storage surface material to the potential of the collector grid and retains these portions at this potential for a period of time dependent on the applied potentials. The remaining portions of the storage surface are discharged to the aforementioned reference potential.

A positive charge on the storage surface effects field penetration through the interstices within the charged portions of the target element to the viewing screen. This enables flood electrons incident on the positively charged portions of the storage surface to penetrate through these interstices to the viewing screen to produce a visual image of these portions.

In its actual operation, the target element in the aforementioned Hansen application was found to have disadvantages in that extensive areas of dielectric material,

not exposed to the flood electrons, become positively charged due to the presence of positive ions in the tube. This positive charging allowed some flood electrons to penetrate through the target element even when the storage surface was at the reference potential. Such penetration of the flood electrons produced a substantial decrease in the contrast of the visual image. Further, the different pitch of the collector and contrast control grids produced a varying density in these flood electrons penetrating through the interstices of the target element which in turn produced a series of light and dark regions on the viewing screen similar to a moire pattern. The above effects, obviously, are objectionable in the practical applications of the tube.

The storage grid assembly of the present invention represents a substantial improvement over the target element in the aforementioned Hansen application in that it has improved contrast and produces no moire pattern. This improved storage grid assembly comprises an electroformed nickel mesh having a dielectric storage surface material such as, for example, talc sprayed uniformly over one side of the mesh with suitable precautions being taken to keep the interstices of the mesh from becoming clogged, and a thin coating of metal evaporated on the surface of the dielectric material that would be illuminated by light from a direction opposite from the nickel mesh and normal thereto.

An alternate embodiment of the storage grid assembly is also disclosed wherein a fired glaze is employed for the main body of the dielectric material for greater durability. In this case, a thin spray coat of talc is applied to the exposed surfaces of the glaze. In addition, means for mounting the nickel mesh and for making electrical contact to the evaporated metal coating is provided. In the above described storage grid assembly, the collector grid is provided by the electroformed nickel mesh; the storage surface is provided by the surface of the dielectric material that is exposed within the interstices of the nickel mesh; and the contrast control element is provided by the evaporated metal coating.

Thus, in the operation of the improved storage grid assembly, as is evident from the above description, the uncoated side of the nickel mesh is exposed to the action of the flood and writing electrons. In this assembly no moire pattern is produced in that there is perfect registration between the collector grid and the contrast control element. Further, all exposed portions of the dielectric storage surface material are exposed to the action of the flood electrons so that there are no erroneously charged surface areas which reduce the contrast in the visual image produced by the tube.

It is therefore an object of this invention to provide an improved storage grid assembly for a direct-viewing storage tube.

Another object of this invention is to provide a storage grid assembly for a direct-viewing storage tube that effects an improved contrast and produces no moire pattern in the resulting visual presentation.

Still another object of this invention is to provide a storage grid assembly having a collector grid and a contrast control grid in perfect registration to eliminate any moire effect in its control of flood electrons.

A further object of this invention is to provide a direct-viewing storage tube incorporating a storage grid assembly that has no uncovered areas of dielectric material that are not exposed to the action of flood electrons thereby improving the contrast in the resulting visual presentation of the tube.

A still further object of this invention is to provide a storage grid assembly that includes improved apparatus for mounting and making electrical contact to the elements thereof.

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The novel features which are believed to be characteristic of the invention, both as to its organization and method of operation, together with further objects and advantages thereof, will be better understood from the following description considered in connection with the accompanying drawings in which several embodiments of the invention are illustrated by way of example. It is to be expressly understood, however, that the drawings are for the purpose of illustration and description only, and are not intended as a definition of the limits of the invention.

Figs. 1 and 2 are enlarged cross section and plan views, respectively, of portions of the storage grid assembly of the present invention;

Fig. 3 is a schematic cross sectional diagram of a direct-viewing storage tube embodying the storage grid assembly of the present invention;

Figs. 4, 5 and 6 are diagrams of apparatus used in fabricating the storage grid assembly of the present invention;

Figs. 7 and 8 are enlarged cross sectional views of portions of alternate embodiments of the disclosed invention and;

Figs. 9 and 10 are enlarged cross sectional diagrams of the mounting apparatus together with the electrical connections for the disclosed storage grid assembly.

Referring to Fig. 3, there is shown a schematic diagram of a direct-viewing storage tube of the type disclosed in the aforementioned Hansen application. This direct-viewing storage tube comprises an evacuated envelope 10 having a neck portion, disposed as shown in the drawing, for housing an electron gun 12 to produce an electron writing beam, deflecting means 14 for this electron writing beam, and a flood gun 16 for producing a flood beam of electrons. Deflecting means 14 is disposed about the path of the electron beam produced by gun 12 and is energized by appropriate beam deflection control signals to cause the electron beam to trace a desired raster on a storage grid assembly 17 disposed adjacent to and in front of a viewing screen 18 at the opposite extremity of envelope 10. Conductive coatings 20 and 22 are disposed concentrically about the inner surface of envelope 10 in the intervening space between flood gun 16 and storage grid assembly 17.

In the preferred mode of operation of the direct-viewing storage tube, flood gun 16 has a cathode 24 which is maintained at a reference potential such as, for example, ground. The electron gun 12 has a cathode 26 which is maintained at a potential of the order of -3000 volts with respect to ground, and an intensity grid 28 which is maintained at from -50 to -100 volts negative with respect to cathode 26 by means of a connection thereto through a resistor 30 and an adjustable source of potential 32. The electron beam produced by electron gun 12 is intensity-modulated by varying the potential impressed on intensity grid 28. This may be effected, for example, by impressing an input signal on grid 28 through a capacitor 34 which is connected thereto. Conductive coatings 20 and 22 are maintained at +200 volts and at from +50 to +100 volts, respectively. The viewing screen 18 comprises a transparent conductive coating 34 and a phosphor coating 36 disposed in the order named on the inner surface of envelope 10. A voltage of the order of from +5000 to +10,000 volts with respect to ground is impressed on the transparent conductive coating of viewing screen 18.

The storage grid assembly 17 of the present invention is disposed adjacent to and coextensive with the viewing screen 18. One embodiment of the storage grid assembly 17 comprises an annular ring 40 which supports a collector grid constituting a metallic mesh 42, a coating of dielectric material 44 on the side of the mesh 42 nearest viewing screen 18, whereby the exposed surfaces within the interstices of mesh 42 provide a storage surface, and a contrast control grid constituting a metallic coating

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46 evaporated on the surface of dielectric material 44 nearest to the viewing screen 18. An enlarged cross section and plan view of a portion of this embodiment of the improved storage grid assembly 17 is shown in Figs. 1 and 2, respectively. Referring to these figures, the electroformed nickel mesh 42 constituting the collector grid has of the order of 250 openings per inch and a light transparency of 40 percent. This mesh is approximately 0.001 inch thick.

The coating 44 of dielectric material 20 is disposed uniformly over the side of the nickel mesh 42 to be oriented nearest viewing screen 18 with suitable precautions being taken to keep the interstices of the mesh from becoming clogged. This is accomplished by forcing air through the interstices of the mesh while spraying it with a suspension of the dielectric material.

An apparatus for accomplishing this result is shown in Fig. 4 and comprises a chamber 60 having a tubular member 62 of a diameter substantially equal to that of the storage grid assembly 17. This member 62 extends inwards from one wall to about 2 inches from the opposite wall. Conformal openings 64 and 66 are provided in the wall of chamber 60 to which the tubular member 62 is attached and in the opposite wall, respectively. Air pressure is provided within the chamber 60 by means of a blower 68 which is disposed concentrically within a cylindrical extension 70 attached to the chamber 60. Turbulence in the chamber is decreased by a baffle 72 disposed over and spaced from the entrance of extension 70 into the chamber 60. A "De Vilbiss" spray gun 74 is provided with a transparent plastic plate 76 that is substantially larger than the opening 66, and is mounted about the nozzle of the spray gun to enable a liquid suspension to be sprayed through the opening 66 without undue amounts of air escaping. The mesh 42 on which the dielectric coating 44 is applied is mounted across the opening of tubular member 62 nearest the opening 66. Thus, when in position, a continuous stream of air is forced through the interstices of the nickel mesh.

Talc has been found to be a satisfactory dielectric material for providing the storage surface of the grid assembly 17. A quantity of talc is first ball milled for twenty-four hours and then employed in the preparation of a suspension having the following proportions:

Talc	-----grams--	2.5
Acetone	-----do-----	100.0
Collodion	-----drops--	10

The collodion is added to the mixture to serve as a binder for the talc when applied to the nickel mesh.

The above mixture is loaded in the spray gun 74, its pressure regulated to 20 pounds per square inch and the nozzle adjusted to give a slightly fan shaped spray. The nickel mesh 42 is then sprayed with this mixture simultaneously with the forcing of air through its interstices. After spraying several passes of the talc mixture over the mesh, its position at the opening of tubular member 62 is reversed and a solvent such as, for example, acetone, is sprayed over its back side to clean the exposed nickel and to open any holes that may have become clogged.

The position of the nickel mesh at the opening of tubular member 62 is again reversed and an additional several passes of the mixture is sprayed over the side of the mesh 42 to be coated with dielectric. This process is repeated until the thickness of the talc layer on the nickel mesh is of the order of 0.002 inch. The light transmission of the mesh with a 0.002 inch layer of talc applied in this manner is of the order of from 20-23% as measured by a photometer. Subsequent to coating the nickel mesh 42 with the talc, it is placed in an oven and subjected to a temperature of 500° C. for 15 minutes.

The next stage in the process of making storage grid assembly 17 is to evaporate the metallic coating 46 on the side opposite from the side where the nickel mesh 42 is exposed. This evaporation process is critical insofar as

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there should be no electrical contact between the metallic coating 46 and nickel mesh 42 in that approximately 200 volts is maintained therebetween. A preferred manner in which this possibility may be minimized as to have the evaporated metal approach the grid assembly 17 from a direction substantially normal thereto. This requires that the mean free path of the evaporated metal molecules be of substantial length which, in turn, requires that a "cloud" of the metal vapor be prevented from forming about the source where they are produced.

An apparatus 80 for evaporating metal on the grid assembly 17 in the desired manner is shown in Fig. 5. Referring to the figure, apparatus 80 comprises an evacuated chamber 81 together with means for reducing the pressure in the chamber to 5×10^{-5} millimeters of mercury.

A device 82 for melting a six inch length of metal wire is incorporated in apparatus 80 in order that the evaporated metal molecules emanate from a line source rather than a point source so as to avoid as far as possible the formation of a vapor cloud about the molten metal which would greatly reduce the mean free path of the evaporated metal molecules.

As viewed in the drawing, heating device 82 appears at the bottom of evacuated chamber 81 in Fig. 5. Also, for the purpose of explanation, an enlarged plan view of device 82 is shown in Fig. 6. Referring to this figure, heating device 82 comprises two lengths of tungsten wire 83 and 84 mounted parallel to and spaced from each other in metal blocks 86 and 88. Metal blocks 86 and 88 constitute an electrical connection between the two lengths of tungsten wire 83 and 84 thus forming a parallel electrical circuit. This circuit is connected across an adjustable potential source 90 to enable the tungsten wires 83 and 84 to be heated to a desired temperature.

Returning to Fig. 5, an apparatus 92 is provided for mounting grid assembly 17 in a horizontal plane approximately ten inches above the heating device 82, the talc coated side being faced downwards. In evaporating the metal coating 46 on the talc coating 44, aluminum is preferably used, although the metals such as gold, silver, or copper are satisfactory. Evaporation of the metal coating is effected by placing a six inch length of 0.060" diameter aluminum wire 85 between tungsten wires 83 and 84; evacuating chamber 81 to 5×10^{-5} millimeters of mercury; and regulating potential source 90 so as to completely evaporate all of the aluminum in from three to four minutes.

An alternate manner in which the metal coating 46 may be evaporated on to the talc coating 44 is by directing the vaporized metal molecules towards the coating 44 at an acute angle as shown by lines 94 in Fig. 7, so that the dielectric material on one side of a hole throws a "shadow" on the other side and thereby prevents a coating from being formed that would come in electrical contact with nickel mesh 42. A coating of this type could be applied by mounting the grid assembly 17 at the appropriate acute angle within the evaporating apparatus 80 with additional means for rotating the assembly 17 in its own plane to uniformly subject all sides of each hole to the evaporated metal molecules. In this case, the metal coating 46 comes closer to mesh 42 in the corners because of the longer length of the diagonals relative to the width of the holes.

An alternate embodiment of the grid assembly 17 is designated as grid assembly 17a in Fig. 8. This embodiment is the same as that illustrated in Fig. 1 except that the talc coating 44 is replaced with a layer of glaze 100 and its exposed surfaces sprayed with a thin spray coat of talc 102 so as to provide a storage surface composed of material that exhibits secondary electron emission when bombarded by high energy electrons. The substitution of the layer of glaze 100 for the talc coating 44 has the added advantage that it is more rugged and more resistant to electrical short circuits between the nickel mesh 42 and the metal coating 46. Furthermore, the

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glaze coating 100 provides a much smoother surface on which to evaporate the metal coating 46 which results in a storage grid assembly 17a having more uniform characteristics than those of the prior embodiment.

In fabricating the latter improved embodiment storage grid assembly 17a, powdered glass having expansion characteristics somewhat similar to that of the nickel mesh 42 is first pulverized and then coated on the mesh with a binder in the same manner as before for the talc coating 44. The pulverized glass coating is then fired on in an oven to produce the layer of glaze 100.

The metal coating 46 is then evaporated on the side of the layer of glaze 100 opposite from the exposed side of mesh 42 in the manner hereinbefore described. Since the glaze provides a very poor storage surface, the thin spray coat of talc 102 is applied to the exposed surfaces within the interstices of the mesh 42 to provide a storage surface composed of dielectric material of suitable characteristics. The excess talc on the nickel mesh 42 is brushed off and the grid assembly put in an oven and subjected to a temperature of 500° C. for fifteen minutes, as before.

In order to constructively employ the described embodiments of storage grid assembly 17 in direct-viewing storage tubes as intended, it is necessary to make electrical contact to the collector grid 42 (i. e. the nickel mesh) and to the contrast control grid 46 (i. e. the evaporated metal coating). Since the evaporated metal coating 46 is very fragile, conventional means cannot be employed. One manner in which electrical contact may be made to the coating 46 is shown in Fig. 9 where a greatly enlarged view of a portion of the edge grid assembly 17 is illustrated. Referring to the figure, the nickel mesh 42 is spot welded to the annular supporting ring 40 at the points of contact 110 around the outer periphery of the assembly 17 where the mesh 42 and the annular ring 40 come in contact. A coating of insulating paste 112 such as, for example, "Sauerizen" cement is applied over the outer periphery of annular ring 40 and over the edge thereof in contact with the nickel mesh 42 as shown in the drawing.

The next operation is to apply a thin coating 114 of silver paste on the exposed surface of the insulating paste 112 about the outer periphery of the annular ring 40 and over the area where contact is made between the nickel mesh 42 and ring 40. The talc coating 44 is applied next to the nickel mesh 42 in the manner hereinbefore described. The final operation is to evaporate on the aluminum to provide the metal coating 46 which is disposed on the layer of talc 44, extends over the insulating paste 112, and overlaps the coating of silver paste 114 to make electrical contact thereto. An external connection may then be made to the silver paste coating 114 by means of a spring contact or by means of a wire soldered thereto with "Easy Flo" solder.

An alternate, more rugged and gas-free manner of making electrical contact to the evaporated metal coating is shown in Fig. 10. In this instance, "7052" glass is substituted for the Sauerizen cement and an annular ring 40 made of "Kovar" or other metal having expansion characteristics similar to that of this glass is employed. It is necessary to apply the 7052 glass to ring 40 at a red heat so it must be done before the nickel mesh 42 is welded on. For this reason, a shoulder 116 is cut on the ring so that the glass may be kept flush with the welding surface. The first operations then are to cut shoulder 116 in the ring 40 and to apply a thin coating 117 of 7052 glass in the shoulder 116 and about the outer periphery of annular ring 40, as shown in the drawing. The nickel mesh 42 is then welded on the annular ring 40 and a lead 118 is tacked on to the glass coating 117 with a bead of glass so that one side is exposed as shown in the figure. Silver paste 119 is then applied over and around the exposed side of lead 118

on top of the glass coating 117 and extended over the shoulder of the ring 40.

The coating of talc 44 is applied next as before. In this case, however, it is essential that all of the nickel mesh 42 be covered with talc and that the talc is made to overlap the glass disposed in shoulder 116, so as to insulate ring 40 and mesh 42 from the evaporated metal coating to be applied to the surface of talc coating 44. The final operation is to evaporate on the aluminum to provide the metal coating 46 which extends over the glass coating 117 to the silver paste 119 to make electrical contact therewith. Thus, lead 118 is connected through silver paste 119 to the evaporated metal coating 46.

Returning again to Fig. 3, in the preferred mode of operation of the direct-viewing storage tube, the collector grid constituting nickel mesh 42 is maintained at a potential of the order of +175 volts with respect to ground and the evaporated metal coating 46 which provides the contrast control grid is maintained at a potential of the order of -10 volts with respect to ground.

The functioning of the direct-viewing storage tube in this preferred mode of operation is the same as previously described for the tube in the aforementioned Hansen application. As previously mentioned, however, the storage grid assembly 17 has no moire effect on the flood electrons penetrating therethrough. Further, the grid assembly 17 more completely controls the flow of flood electrons in that all surface areas of dielectric material not exposed to the action of the flood and writing electrons are covered with the evaporated metal coating 46 which is maintained at a potential for effecting optimum contrast in the image produced.

What is claimed as new is:

1. In a direct-viewing storage tube including a source of electrons, a storage grid assembly comprising an electroformed nickel mesh having first and second sides supported to expose said first side to said electrons and a light transparency of 40%, an annular metallic ring for supporting said mesh, said ring being attached to the periphery of said mesh on said first side thereof; a coating of dielectric material having secondary electron emission characteristics disposed uniformly over said second side of said mesh and overhanging the interstices thereof to the extent that said light transparency is reduced by 50% to expose portions of the surface of said coating of dielectric material within the interstices of said mesh to said source of electrons without completely coating said mesh on said first side, a layer of insulating material disposed around said annular ring on the outer surface thereof and extending in over said second side of said mesh to overlap said coating of dielectric material; a thin layer of silver paste on said layer of insulating material, said layer being disposed on the outer surface of said annular ring and extending in over the second side of said mesh; and a thin continuous layer of aluminum coated on the entire portion of that surface of said coating of dielectric material which would be illuminated by parallel light directed perpendicularly toward said second side and on the portion of the layer of silver paste disposed on said second side of said mesh whereby said thin coating of aluminum is in electrical contact with said thin layer of silver paste.

2. An electronic storage tube and supported to expose said first side to said electrons including a source of electrons, a storage grid assembly having a conductive mesh, a dielectric material having secondary electron emission characteristics disposed uniformly over said second side of said mesh and overhanging the interstices thereof to expose portions of the surface of said dielectric material within the interstices of said mesh to said source of electrons without completely coating said mesh on said first side, and a thin continuous layer of metal coated on the remaining entire portion of that surface of

said dielectric material which would be illuminated by parallel light directed perpendicularly toward said second side; means for maintaining a positive potential gradient from said storage surface to said conductive mesh; and means for bombarding selected areas of said storage surface with high energy electrons from said source to liberate numerous electrons, said liberated electrons being attracted to said conductive mesh by said potential gradient to establish positive charges on said selected areas of said storage surface.

3. In an electronic storage tube including a source of electrons, a storage grid assembly having a first side and a second side and supported to expose said first side to said electrons comprising a conductive mesh screen, a coating of dielectric material having secondary electron emission characteristics coated over said second side of the meshes of said screen and overhanging the interstices thereof, to expose portions of the surface of said coating of dielectric material to said source of electrons without completely coating said meshes on said first side, a continuous conductive layer coated on the entire portion of that surface of said coating of dielectric material which would be illuminated by parallel light directed perpendicularly toward said second side, and conductive connections to said mesh screen and said conductive layer.

4. In an electronic storage tube, the storage grid assembly as defined in claim 3 wherein said coating of dielectric material overhanging the interstices of said conductive screen decreases the transparency of said conductive screen by from 25 to 75 percent.

5. In a direct-viewing storage tube including a source of electrons, a storage grid assembly comprising an electroformed metallic mesh having first and second sides supported to expose said first side to said electrons; a coating of dielectric material having secondary electron emission characteristics disposed uniformly over said second side of said mesh and overhanging the interstices thereof, the portions of the surface of said coating of dielectric material within the interstices of said mesh to said source of electrons without completely coating said mesh on said first side, and a thin continuous layer of conductive material disposed coated on the entire portion of that surface of said coating of dielectric material which would be illuminated by parallel light directed perpendicularly toward said second side.

6. A storage tube in accordance with claim 5 in which said dielectric material is a glaze coating and further comprising a coating of a thin layer of dielectric material of higher secondary electron emission characteristics covering the remaining surface portion of said glaze dielectric material not coated by said continuous layer of conductive material.

7. In a direct viewing storage tube, a storage grid assembly as defined in claim 6 wherein said dielectric material of higher secondary emission is talc.

8. A storage tube in accordance with claim 3 in which said dielectric material is a glaze coating and further comprising a coating of a thin layer of talc covering the remaining surface portion of said glaze dielectric material not coated by said continuous conductive layer.

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U. S. DEPARTMENT OF COMMERCE
PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,824,249

Siegfried Hansen

February 18, 1958

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 7, line 63, strike out "and supported to expose"; line 64, strike out "said first side to said electrons"; line 65, after "a", second occurrence, insert -- first side and a second side and supported to expose said first side to said electrons comprising a --; line 73, before "entire" strike out "remaining"; column 8, lines 14 and 25, strike out "mesh", in each occurrence; line 38, strike out ", the" and insert instead -- to expose --; line 42, strike out -- disposed --.

Signed and sealed this 27th day of May 1958.

(SEAL)

Attest:

KARL H. AXLINE

Attesting Officer

ROBERT C. WATSON
Commissioner of Patents