

PATENT SPECIFICATION

(11) 1 442 180



- (21) Application No. 31643/73 (22) Filed 3 July 1973
 (31) Convention Application No. 268802 (32) Filed 3 July 1972 in (19)
 (33) United States of America (US)
 (44) Complete Specification published 7 July 1976
 (51) INT CL² H01J 29/07
 (52) Index at acceptance
 H1D 11X 11Y 4A4 4A7 4G8 4H1A 4HY 4K4 4K7D 4K7Y
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(54) IMPROVEMENTS IN AND RELATING TO CATHODE RAY TUBE DEVICES

(71) We, RCA CORPORATION, a corporation organised under the laws of the State of Delaware, United States of America, of 30 Rockefeller Plaza, City and State of New York, 10020, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a colour television cathode ray tube shadow mask electrode which comprises a thin sheet of metal having a multi-apertured masking portion, an imperforate peripheral portion and a substantially thicker metal reinforcing frame around the periphery of the imperforate portion, to colour television cathode ray tubes including such masks and to a method of fabricating a temporary apertured mask for printing phosphor deposits on the screen of a colour television tube.

A known method of fabricating a temporary apertured mask includes applying to at least one surface of the metal sheet forming a mask electrode a coating formed from a material of which the viscosity is thermally reversible to provide a thin film closing the apertures of the masking portion. The coated mask is heated to a temperature sufficiently high to cause the thin film over each aperture to break and form a rim inside and partially closing each aperture of the metal sheet. The metal sheet is cooled to harden the coating.

Normally the peripheral portions of the mask are of uniform thickness that is substantially equal to the thickness of the masking portion and are of the same material as the masking portion. The apertures are then temporarily reduced in size and the mask electrode is used as a photographic master to prepare the viewing-screen structure. Then the mask electrode is restored for use in the cathode-ray tube.

In one prior method, each of the final-sized apertures is closed with a film of an organic material. The mask electrode with the films closing the apertures is then heated to open the central portion of the films but retaining a desired thickness of coating material on the walls of the apertures to provide temporary apertures smaller than the final-sized apertures.

With this prior method, used with a prior mask electrode, the outer rows of apertures adjacent the skirt portion may remain closed or may only partially open. It is suggested that this occurs because the peripheral reinforcing portion conducts heat away from the edges of the masking portion, leaving the outer rows of closed apertures at too low a temperature for proper opening of temporary apertures. Heating the peripheral reinforcing portion before and/or during the step of opening the apertures has not completely solved this problem.

According to the present invention there is provided a colour television cathode-ray tube shadow mask electrode comprising a thin sheet of metal having a multi-apertured masking portion and an imperforate peripheral portion attached to a substantially thicker metal reinforcing frame, wherein said peripheral portion has a resistance to heat flow which is at least 11% greater than that of a said peripheral portion formed by a solid sheet of thickness equal to that of said masking portion and of the same material, whereby the conduction of heat between said masking portion and said frame is impeded.

The invention also provides a method of fabricating a temporary apertured mask for printing phosphor deposits on the screen of a colour television tube, said method comprising providing a shadow mask electrode as defined in the preceding paragraph, applying to at least one surface of the metal sheet a coating formed from an organic material of which the viscosity is reversibly reduced by heating to provide a thin film closing the apertures of the

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masking portion, heating the coated mask to a temperature sufficiently high to cause the thin film over each aperture to break and form a bead inside and partially closing each aperture, and cooling the mask electrode to harden said coating.

The invention further provides a colour television cathode ray tube including a shadow mask electrode as defined in the penultimately preceding paragraph.

A shadow mask electrode in accordance with one embodiment of the invention includes a multi-apertured masking portion and an imperforate peripheral portion which is attached to a substantially thicker reinforcing frame serving as a heat sink to heat generated due to electron bombardment of the masking portion during operation of the tube. To employ such a mask electrode for screen printing at least the masking portion is coated with organic material so that a thin film of the coating material closes each aperture. The coated mask electrode is then heated to open a central portion of the film at each aperture, and a desired thickness of the coating material is retained on the walls of the apertures. While the mask electrode is being heated, the flow of heat from the masking portion to the peripheral portion and thence to the frame is impeded. When the wall coatings harden, temporary apertures form which are smaller than the final-sized apertures. A viewing-screen structure is then photographically deposited using the coated mask electrode with the smaller temporary apertures as a photographic master. After the viewing-screen structure is deposited, the coating material is removed from the mask electrode to restore the mask electrode with its larger final-sized apertures for use in the cathode-ray tube.

The use of a mask electrode in which the heat flow from the masking portion to the peripheral reinforcing frame is impeded is believed to establish a more uniform temperature distribution over the coated masking portion during the heating. The central portion of the films closing all of the apertures may be opened consistently, particularly the films closing the outer rows of apertures adjacent the skirt portion. In addition, a more uniform opening of the central portions of the films is obtained, providing temporary apertures of the desired sizes. This results in a colour-television picture tube which has good uniformity and brightness and which reproduces images of high fidelity.

The invention will now be further described with reference to the drawings, of which:

Figure 1 is a side view partially in axial section of a colour-television picture tube

including a mask electrode in accordance with the invention and having an image screen structure prepared by the method of the invention;

Figure 2 is a plan view of the mask electrode of the tube shown in Figure 1;

Figure 3 is an enlarged fragmentary view of the multi-apertured masking portion of the mask electrode shown in Figures 1 and 2 illustrating the aperture pattern;

Figure 4 is an enlarged fragmentary sectional view of the mask electrode shown in Figures 1 and 2 illustrating the aperture cross sectional configuration;

Figure 5 is a partial sectional, perspective view illustrating a portion of a known mask electrode;

Figure 6 is a graph of the theoretical mass representation of the known mask electrode shown in Figure 5, including a curve illustrating the theoretical temperature rise produced by uniform heating of the mask electrode;

Figure 7 is a partial sectional, perspective view of a portion of the mask electrode shown in Figure 2 wherein depressions extend over the outer surface of the skirt portion;

Figure 8 is an enlarged, fragmentary, sectional view of the mask electrode of Figure 7 illustrating the skirt portion including the depressions formed by the removal of material;

Figure 9 is a partial sectional, perspective view of an alternate form of the mask electrode shown in Figure 2 illustrating a thin skirt portion;

Figure 10 is a graph of the theoretical mass representation of the mask electrode having a skirt portion of reduced mass and heat flow shown in Figures 7 and 9, including a curve illustrating the theoretical temperature rise by uniform heating of the mask electrode; and

Figure 11 is a graph including comparative curves illustrating the calculated and extrapolated surface temperatures of the mask electrode for the method of the invention and for prior methods.

Figure 1 illustrates a colour-television picture tube 20 comprising an evacuated glass envelope 21. The envelope 21 includes a faceplate panel 22, a funnel 23, and neck 24. A three-colour-phosphor viewing-screen structure 25 is supported on the inner surface of the faceplate panel 22. A mask electrode 26 is positioned in the envelope 21 adjacent and spaced from the viewing-screen structure 25. An electron-gun assembly 27 positioned in the neck 24 is adapted to project three electron beams through the mask electrode 26 to strike the viewing-screen structure 25.

The mask electrode 26, shown in Figures

1 and 2, is of a generally rectangular configuration and comprises a mask member 31 including a multi-apertured masking portion 28, a peripheral skirt portion 32 which surrounds the masking portion 28, and a peripheral reinforcing frame 29 which is embraced by the skirt portion 32 and which serves as a heat sink to heat generated due to electron bombardment of the masking portion 28 during operation of the tube 20. In the embodiments shown in Figures 7 and 9, the mask member electrode 31, 58 includes a peripheral skirt portion 32, 60 adapted for overlapping engagement with a separate peripheral reinforcing frame 29, 59. The masking portion 28, 62 is formed with a convex outer surface 33, 63 and a concave inner surface 34, 64 and includes an array of final-sized apertures 36, 66 therein. The final-sized apertures 36, 66 in the masking portion 28, 62 describe a general hexagonal pattern with a spacing "a" between the apertures and a 60-degree included angle between the rows of apertures, as shown in Figure 3.

In the embodiments shown in Figures 7 and 9, the mask member 31, 58 is formed of a conducting material, such as steel approximately 0.006- to 0.007-inch thick and is attached to the peripheral reinforcing frame 29, 59 by welds 37, 61. The separate peripheral reinforcing frame 29, 59 as shown in Figures 7 and 9 is formed of about 0.93-inch-thick steel in a substantially L-shaped cross section having about a 1.0-inch-high vertical portion for attachment to the skirt portion 32 and about a 0.75-inch-wide horizontal portion. The welds 37, 61 are positioned to fall within the overlapping area of the skirt portion 32, 60 and the peripheral reinforcing portion 29 and are preferably about 0.125 inch from the edge of the skirt portion 32, 60. A typical method of attachment is described in U.S. patent No. 3,368,098.

Referring to Figure 4, each of the final-sized apertures 36 may be of the double truncated-spheroid shape having a large-diameter, spheroid-shaped cup 38 in the convex outer surface 33 and a small-diameter spheroid-shaped cup 39 in the concave inner surface 34. The two cups 38 and 39 intersect at a knife edge 40, which determines the size of the final-sized apertures 36. In Figure 4, the thickness of the mask electrode 31 is shown by the dimension T, and the depth of the large cup 38 is shown by the dimension t. In the 25-inch diagonal colour-television-tube flat apertured mask electrode previously described, the large cups 38 are about 0.021 inch in diameter at the convex outer surface 33 as shown in Figure 4,

and the small cups 39 are in the range of 0.0125 to 0.0113 inch in diameter at the concave inner surface 34. The size of the large cups 38 is substantially uniform over the face of the masking portion 28, and the size of the small cups 39 is graded from center to edge of masking portion 28, as is known. The center-to-center spacing "a" (shown in Figure 3) of the apertures is about 0.0244 inch, and the intersection of the cups at the knife edge 40 is about 0.005 inch from the outer or convex formed surface 33 as shown by the dimension t in Figure 4. It will be understood that the apertures 66 in mask member 58 of Figure 9 will be similarly formed.

Figure 5 illustrates a portion of prior mask electrode 41. The mask electrode 41 includes a peripheral skirt portion 42 which is attached to a peripheral reinforcing portion 43 by welds 44. The mask electrode 41 includes a multi-apertured masking portion 45 formed with a convex outer surface 46 and a concave inner surface 47. The masking portion 45 contains an array of final-sized apertures 49. The skirt portion 42 also includes a face border portion 50 formed with substantially the same curvature as the masking portion 45 and a side border portion 51 formed substantially at right angles to a plane (not shown) of the masking portion 45. The skirt portion 42 is solid and of substantially the same thickness and of the same material as the masking portion 45. The prior mask electrode shown in Figure 5 is the same as the mask electrodes used in accordance with the invention shown in Figures 7 and 9 except for the skirt portion. The prior skirt portion 42 shown in Figure 5 is solid and of a thickness substantially the same as that of the masking portion 45, while the skirt portion 32 shown in Figure 7 has etched dimples or depressions, and the skirt portion 60 shown in Figure 9 is of lesser thickness than the masking portion, as will be described.

Referring to Figure 6, the shaded area illustrates a theoretical mass representation of an ideal cross section of the prior mask electrode shown in Figure 5. The masking portion 45 is shown by the shaded area designated 53, the imperforate skirt portion 42 is shown by the shaded area designated 54, and the peripheral reinforcing portion 43 is shown by the shaded area designated 55. When the mask electrode is uniformly heated as represented by the arrows 52, the temperature of the mask electrode after a predetermined amount of time (typically of the order of 30 seconds) is described by the curve 56. Since the peripheral reinforcing portion 43 is of relatively high mass, the temperature of the mask electrode is not

uniform, and is particularly non-uniform on the masking portion 45 adjacent the skirt portion 42. In prior methods of making a viewing-screen structure for a colour-television picture tube, this non-uniformity in temperature may cause improper opening of the temporary apertures, especially at the apertures 49 adjacent the skirt portion 42.

Referring to the curve 56 in Figure 6, the temperature of the mask electrode is about 200°C at the center and about 150°C at the periphery of the masking portion 45. The temperature is shown to further decrease to about 100°C at the skirt portion, and to about 20°C at the peripheral reinforcing portion. These temperatures are representative temperatures to better illustrate the problem of using a prior mask electrode and are not intended to be limiting of the invention.

In this embodiment the skirt portion 32 includes means providing a greater resistance to heat flow than the prior mask electrode when the mask electrode 26 is substantially uniformly heated. The preferred ideal mass-per-unit area of the skirt portion 32 substantially equals the mass-per-unit area of the masking portion 28. In the novel mask electrode 26, the skirt portion 32 includes a decreased mass-per-unit area or means providing an increased resistance or impediment to heat flow as described in the following examples.

Example 1

Figure 7 illustrates a mask electrode with large-diameter, spheroid-shaped cups continued into the skirt portion 32 in the same geometric pattern as that of the

$$\text{Mass-per-unit area} = (\text{ratio}) \times (\text{density of original material per unit area})$$

The large cups 38 in the skirt portion 32 can be etched at the same time as the final-sized apertures 36 using the standard production process. Since the large cups 38 do not perforate the skirt portion 32 as shown in Figure 8, interception of the scanning electron beam by the skirt portion 32 is not affected; and since the thickness of the skirt portion 32 is not totally reduced, strength and rigidity are substantially retained.

Example 2

Figure 9 shows a mask electrode where the thickness of the skirt portion 60 is about one half the thickness of the masking portion 62, or about 0.003- to 0.0035-inch thick. This also reduces the mass of the skirt portion 60 to substantially that of the mass of the masking portion 62. Although the thinned skirt portion 60 performs satisfactorily in the novel method, it is not

apertures 36 as shown in Figure 3. The pattern of removed large cups is formed substantially over the entire surface area of the skirt portion 32. The size of the large cups 57 (shown in Figure 8) in the skirt portion 32 is about the same as the large cups 38 (shown in Figure 4) in the masking portion 28. Using a large cup 38 of 0.0229-inch diameter, a small cup 39 of 0.0139-inch diameter, a depth t of 0.005 inch and a masking portion 28 thickness T of 0.007 inch, the final-sized apertures 36 leave about 57 percent of the metal volume of the masking portion 28, and the large cups in the array extended into the skirt portion 32 leave about 62 percent of the metal volume of the skirt portion 32. With a reduced amount of material in the same volume and for the same area, this approaches the desired near equal mass-per-unit-area of the masking portion 28 and the skirt portion 32. There is some increase in aperture dimensions disclosed above from those previously disclosed for flat masking portions because of the stretching of the flat masking portions during the forming process.

Uniform portions of the masking portion 28, the skirt portion 32 and the peripheral reinforcing portion 29 for a 25V flat multi-apertured mask electrode were weighed to provide the following mass ratios:

Masking portion	0.565:1
Skirt portion	0.625:1
Peripheral reinforcing portion	11.700:1

The actual mass-per-unit area can be determined from the ratios given above by the following formula:

as desirable for use in a cathode-ray tube as the skirt portion 32 with the extended large-cup 38 pattern since the rigidity of the skirt portion 60 is substantially reduced, and it is more difficult to weld the thin skirt portion 60 to the peripheral reinforcing portion 59.

Example 3

The skirt portion 32 of a mask as described in Example 1 is increased in length by about 0.125 inch, and the mask 28 is moved away from the peripheral reinforcing portion 29 by about 0.125 inch. Since the preferred position of the welds 37 with respect to the skirt portion 32 is retained, the distance (dimension x in Figure 7) on the skirt portion 32 between the masking portion 28 and the welds 36 is also increased by about 0.125 inch, thereby providing a skirt portion 32 having further resistance to heat flow. In a 25-inch

diagonal colour-television picture tube the prior dimension χ measured on the major axis of the tube is about 0.750 inch, while in the skirt portion 32 of the novel mask electrode the new dimension χ is about 0.875 inch. This may also eliminate the contact of the masking portion 28 with the top of the peripheral reinforcing portion 29 at some points which may be caused by uneven or improper assembly of the overlapping portions of masking portion 28 and peripheral reinforcing portion 29.

Referring to Figure 10, the shaded areas illustrate a theoretical mass representation of the preferred cross section of a mask electrode 26 described in Examples 1 and 2. The masking portion 28 or 62 is shown by the shaded area designated 65, the skirt portion 32 (Figure 7) or 60 (Figure 9) is shown by the shaded area designated 66, and the peripheral reinforcing portion 29 or 59 is shown by the shaded area designated 67. When the mask electrode 26 is uniformly heated as represented by the arrows 64, the temperature of the mask electrode after a predetermined amount of time is described by the curve 68. The non-uniformity in temperature at the edge of the masking portion 45 (shown by the curve 56 in Figure 6) is substantially eliminated as shown by the curve 68 in Figure 10.

The temperature of the masking portion 28 is maintained at about 200°C as shown by curve 68, and it does not rapidly decrease at the rows of apertures adjacent the skirt portion 32 as in the prior mask electrode. Since the temperature of the masking portion 28 can be maintained substantially uniform, the temperature will change uniformly with a uniform change in applied heat as required to open the temporary apertures. This provides a more reliable opening of temporary apertures, at least at the apertures 36 adjacent the skirt portion 32, as will be described in the novel method.

To prepare a cathode ray tube by the method of the invention, at least the masking portion of the mask electrode is coated with an organic material so that a thin film of the coating material closes each final-sized aperture 36.

In the preferred embodiment the organic material comprises a solution of about 24 liters of demineralized water, 180 grams LO-529 wetting agent marketed by General Aniline and Film Corp., Johnson City, N.Y. under the Trade Mark "Gafac", 18 liters 10-percent polyvinyl alcohol water solution, such as Vinol 540 marketed by Airco Chemical Division of Air Reduction Co., N.Y., N.Y., and 4.9 liters of ethylene glycol. It is preferred that the coating is applied by projecting a limp stream of the material in an upward trajectory over the

mask electrode as described in Patent Specification No. 1,374,723.

The mask electrode 26 with the thin films closing each aperture (not shown) is then heated to open a central portion of the film at each aperture 36, but retaining a desired thickness of the coating material on the walls of the apertures 36, thereby providing temporary apertures that are smaller than the final-sized apertures.

It is preferred that the mask electrode be heated at two different rates, a first rate in the range of about 30°C per minute until a temperature of about 95°C is reached to form the thin films closing each aperture. Then the mask electrode is rapidly heated at a second rate of about 450°C per minute to a temperature of about 195°C to open the central portion of the film to provide the smaller temporary apertures. A preferred method of heating the coated mask electrode to form the smaller temporary apertures is described in Patent Specification No. 1,374,723.

During the heating in a prior method, the prior skirt portion 42 and the prior peripheral reinforcing portion 43 act as a heat sink conducting the heat away from the apertures 49 adjacent the skirt portion 42. This produces a critical temperature differential across the masking portion 45, particularly at the apertures adjacent the skirt portion 42, which causes some of the films in the apertures 36 adjacent the masking portion 45 to not open or to only partially open resulting in improperly formed temporary apertures. This problem generally occurs for about 5 to 10 rows of apertures adjacent the skirt portion 42.

One solution to achieve a substantially uniform temperature across the masking portion 45 at all process temperatures is to selectively heat portions of the mask electrode 41, skirt portion 42 and peripheral reinforcing portion 43. This solution has proven difficult because of the need to rotate the mask electrode during the process and the rectangular configuration of the mask electrode. In selective heating, it is very difficult to maintain a uniform temperature for all stages of the process, particularly at the apertures adjacent the skirt portion 42. Temperature differentials may be caused by the peripheral reinforcing portion 43 and skirt portion 42 remaining at a different temperature as compared to the masking portion 45, the temperature difference appearing as improperly opened temporary apertures around the periphery of the masking portion 45 displaced 1/4 to 3/8 inch inside the edge of the masking portion 45 or adjacent the skirt portion 42. This temperature difference is believed to cause the apertures, at a temperature boundary or

interface between heat applied to the peripheral reinforcing portion 43 and heat applied to the masking portion 45, to only partially open.

5 The method of the invention includes providing a mask electrode 26 as described in Examples 1 through 3, which exhibits increased resistance to heat flow thereby impeding heat flow between the masking
10 portion 28 and the attachment position of the skirt portion 32 on the peripheral reinforcing portion 29 during heating.

In one embodiment, the skirt portion 32 includes etched dimples or depressions therein such as described in Example 1. In
15 another embodiment the skirt portion 60 is of lesser thickness than the masking portion, as described in Example 2. With the skirt portions 32 or 60 as previously
20 described, the heat conduction loss from the masking portion 28 to the peripheral reinforcing portion 29 is limited to 70 to 90 percent of the heat loss, measured at the boundary between the masking portion and
25 the skirt portion, obtained from a prior mask electrode including a solid skirt of a uniform thickness that is substantially equal to the thickness of the masking portion and of the same material as the masking
30 portion. In other words, the resistance to heat flow of the peripheral portion is 11% greater than that of the solid sheet.

It is believed that heat loss substantially occurs by conduction from the skirt portion
35 32 through the welds 37 to the heavier peripheral reinforcing portion 29 or in the case of a one-piece mask electrode (not shown) by conduction directly to the heavier peripheral reinforcing portion (not
40 shown). Therefore, additional resistance to heat loss is also achieved by increasing the length of the skirt portion 32 or conductive path between the masking portion 28 and the peripheral reinforcing portion 29 of the
45 above described embodiments. When a mask electrode 26 with the increased skirt length is used, the length of the heat conduction path is thus increased and consequently the rate of heat conduction to the welds 37 and the peripheral reinforcing
50 portion 29 is reduced.

A graph illustrating the comparative temperature curves of the prior mask
55 electrode and of the mask electrode of the invention comprising the skirt including means providing reduced resistance to heat flow is shown in Figure 11. The curve 69 illustrates the temperature of the coated mask electrode during the opening of
60 temporary apertures using the prior skirt portion 42, and the curve 70 illustrates the temperature of the coated mask electrode during the opening of temporary apertures using the skirt portions 32 or 60 having
65 increased resistance to heat flow. Referring

to the curves 69 and 70, it can be observed that the temperature of the masking portion 45 of the prior mask electrode 41 decreases at the edge of the masking portion 45 particularly at the apertures 36 adjacent the skirt portion 42, while the temperature of the masking portions 28 or 62 of the mask
70 electrode 26, having increased resistance to heat flow, does not increase at the edge of the masking portion 28 or 62, but is maintained at a substantially uniform temperature.

It is preferred that the temperature of the mask electrode during the opening of temporary apertures be in the range of 200 to 220°C as shown by the temperature
75 range 71 in Figure 11.

The graph shown in Figure 11 also illustrates curve portions 72 and 73. These curves illustrate heating of the peripheral reinforcing portion 29 to a temperature of about 150°C. With the peripheral reinforcing portion 29 at some higher temperature such as 150°C, a larger part of the skirt portion 32 or 60 adjacent the masking portion 28 or 62 respectively can be maintained at the same temperature as the masking portions 28 or 62 thereby providing greater latitude in the method. It is noted that this graph is included as an estimate (including calculations and
85 extrapolations) for purposes of better describing the method and is not intended to be limiting of the method. The actual temperature values in the method may vary with particular designs of mask electrodes, heating schedules, and coating formulations.

Although the resistance to heat loss is described in the preferred embodiments as thinning the skirt portion or removing portions of the skirt portion in a large-cup pattern similar to the aperture pattern, the resistance to heat loss may be obtained by other means such as, for example, by making the masking portion of the mask electrode of a high-conductive metal such as copper, and the skirt portion of a low-conductive metal such as steel.

WHAT WE CLAIM IS:—

1. A colour television cathode-ray tube shadow mask electrode comprising a thin sheet of metal having a multi-apertured masking portion and an imperforate peripheral portion attached to a substantially thicker metal reinforcing frame, wherein said peripheral portion has a resistance to heat flow which is at least 11% greater than that of a said peripheral portion formed by a solid sheet of thickness equal to that of said masking portion and of the same material, whereby the conduction of heat between said masking portion and said frame is impeded.

interface between heat applied to the peripheral reinforcing portion 43 and heat applied to the masking portion 45, to only partially open.

5 The method of the invention includes providing a mask electrode 26 as described in Examples 1 through 3, which exhibits increased resistance to heat flow thereby impeding heat flow between the masking portion 28 and the attachment position of the skirt portion 32 on the peripheral reinforcing portion 29 during heating.

10 In one embodiment, the skirt portion 32 includes etched dimples or depressions therein such as described in Example 1. In another embodiment the skirt portion 60 is of lesser thickness than the masking portion, as described in Example 2. With the skirt portions 32 or 60 as previously described, the heat conduction loss from the masking portion 28 to the peripheral reinforcing portion 29 is limited to 70 to 90 percent of the heat loss, measured at the boundary between the masking portion and the skirt portion, obtained from a prior mask electrode including a solid skirt of a uniform thickness that is substantially equal to the thickness of the masking portion and of the same material as the masking portion. In other words, the resistance to heat flow of the peripheral portion is 11% greater than that of the solid sheet.

It is believed that heat loss substantially occurs by conduction from the skirt portion 32 through the welds 37 to the heavier peripheral reinforcing portion 29 or in the case of a one-piece mask electrode (not shown) by conduction directly to the heavier peripheral reinforcing portion (not shown). Therefore, additional resistance to heat loss is also achieved by increasing the length of the skirt portion 32 or conductive path between the masking portion 28 and the peripheral reinforcing portion 29 of the above described embodiments. When a mask electrode 26 with the increased skirt length is used, the length of the heat conduction path is thus increased and consequently the rate of heat conduction to the welds 37 and the peripheral reinforcing portion 29 is reduced.

55 A graph illustrating the comparative temperature curves of the prior mask electrode and of the mask electrode of the invention comprising the skirt including means providing reduced resistance to heat flow is shown in Figure 11. The curve 69 illustrates the temperature of the coated mask electrode during the opening of temporary apertures using the prior skirt portion 42, and the curve 70 illustrates the temperature of the coated mask electrode during the opening of temporary apertures using the skirt portions 32 or 60 having increased resistance to heat flow. Referring

to the curves 69 and 70, it can be observed that the temperature of the masking portion 45 of the prior mask electrode 41 decreases at the edge of the masking portion 45 particularly at the apertures 36 adjacent the skirt portion 42, while the temperature of the masking portions 28 or 62 of the mask electrode 26, having increased resistance to heat flow, does not increase at the edge of the masking portion 28 or 62, but is maintained at a substantially uniform temperature.

It is preferred that the temperature of the mask electrode during the opening of temporary apertures be in the range of 200 to 220°C as shown by the temperature range 71 in Figure 11.

The graph shown in Figure 11 also illustrates curve portions 72 and 73. These curves illustrate heating of the peripheral reinforcing portion 29 to a temperature of about 150°C. With the peripheral reinforcing portion 29 at some higher temperature such as 150°C, a larger part of the skirt portion 32 or 60 adjacent the masking portion 28 or 62 respectively can be maintained at the same temperature as the masking portions 28 or 62 thereby providing greater latitude in the method. It is noted that this graph is included as an estimate (including calculations and extrapolations) for purposes of better describing the method and is not intended to be limiting of the method. The actual temperature values in the method may vary with particular designs of mask electrodes, heating schedules, and coating formulations.

Although the resistance to heat loss is described in the preferred embodiments as thinning the skirt portion or removing portions of the skirt portion in a large-cup pattern similar to the aperture pattern, the resistance to heat loss may be obtained by other means such as, for example, by making the masking portion of the masking electrode of a high-conductive metal such as copper, and the skirt portion of a low-conductive metal such as steel.

WHAT WE CLAIM IS:—

1. A colour television cathode-ray tube shadow mask electrode comprising a thin sheet of metal having a multi-apertured masking portion and an imperforate peripheral portion attached to a substantially thicker metal reinforcing frame, wherein said peripheral portion has a resistance to heat flow which is at least 11% greater than that of a said peripheral portion formed by a solid sheet of thickness equal to that of said masking portion and of the same material, whereby the conduction of heat between said masking portion and said frame is impeded.



* C L M S *

2. A shadow mask electrode in accordance with claim 1 wherein the mass per unit area of said peripheral portion is substantially equal to the mass per unit area of said masking portion.

3. A shadow mask electrode in accordance with claim 1 or claim 2 wherein said peripheral portion is thinner than said masking portion.

4. A shadow mask electrode in accordance with claim 1 or claim 2 wherein said peripheral portion includes an array of depressions therein.

5. A method of fabricating a temporary apertured mask for printing phosphor deposits on the screen of a colour television tube, said method comprising providing a shadow mask electrode in accordance with any one of the preceding claims, applying to at least one surface of the metal sheet a coating formed from an organic material of which the viscosity is reversibly reduced by heating to provide a thin film closing the apertures of the masking portion, heating the coated mask to a temperature

sufficiently high to cause the thin film over each aperture to break and form a bead inside and partially closing each aperture, and cooling the mask electrode to harden said coating.

6. A method of fabricating a temporary apertured mask for printing phosphor deposits on the screen of a colour television tube substantially as described with reference to Figures 1—4 and 7—10 of the accompanying drawings.

7. A colour television cathode ray tube shadow mask electrode substantially as described with reference to Figures 1—4 and 7—10 of the drawings.

8. A colour television cathode ray tube including a shadow mask electrode in accordance with claim 7.

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Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1976.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.



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