Aug. 27, 1963 K. SCHLESINGER 3,102,212

CATHODE RAY TUBE WITH LOW VELOCITY DEFLECTION AND POST DEFLECTION BEAM ACCELERATION

Original Filed July 31, 1956 2 Sheets-Sheet 1

FIG. 1

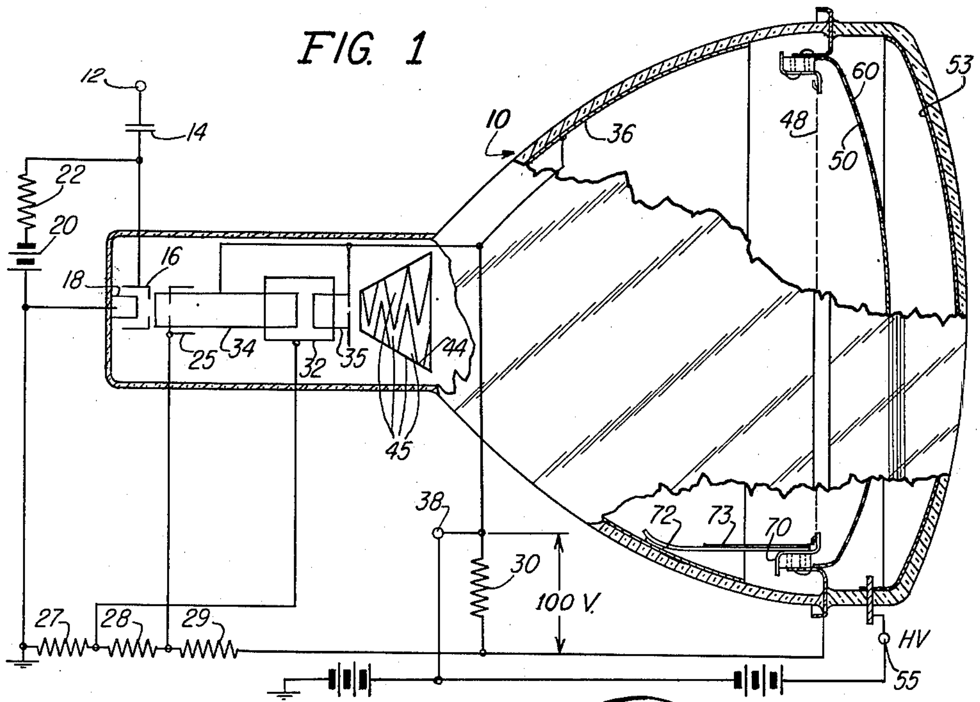

FIG. 3

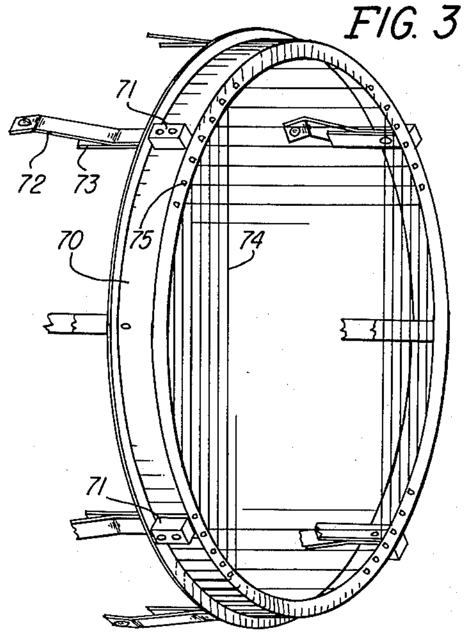

FIG. 2

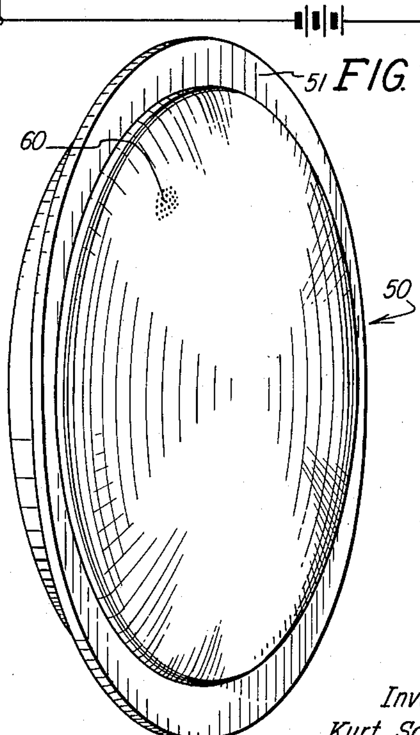

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FIG. 7

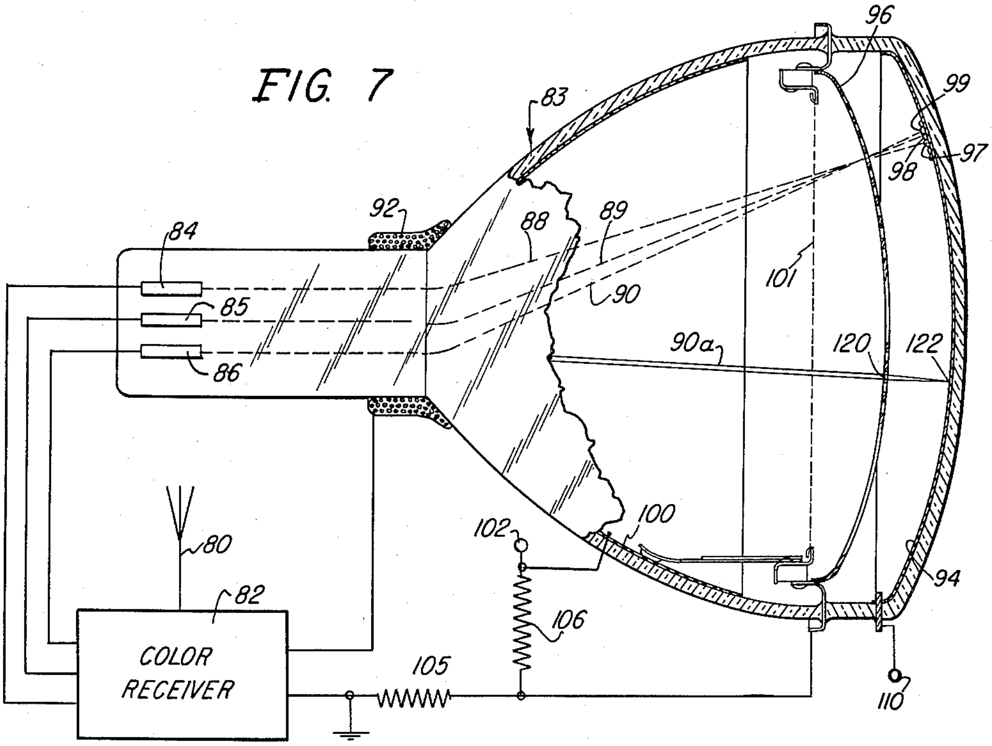


FIG. 5

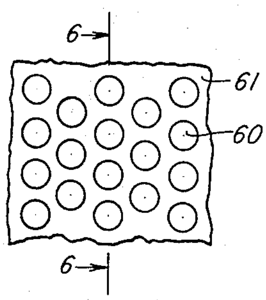


FIG. 6

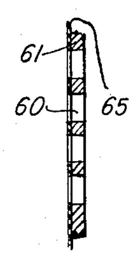
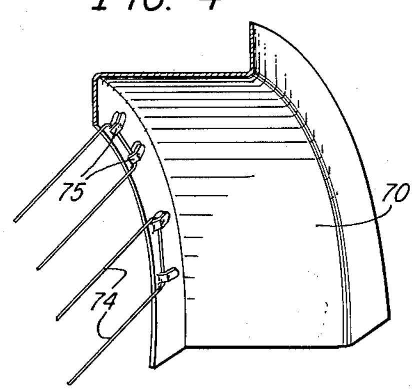


FIG. 4



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CATHODE RAY TUBE WITH LOW VELOCITY DEFLECTION AND POST DEFLECTION BEAM ACCELERATION

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Continuation of application Ser. No. 601,204, July 31, 1956. This application Apr. 24, 1959, Ser. No. 808,846

6 Claims. (Cl. 315—12)

This invention relates to cathode ray display tubes such as are used in television, radar and other applications and more particularly to such a tube wherein deflection of the beam is provided at low velocity and the display is produced at high velocity for increased brightness. This application is a continuation of my application Serial No. 601,204, filed July 31, 1956, now abandoned.

In the cathode ray tube art, effort has been made to shorten the tube length to render the apparatus in which the tubes are used more compact. This calls for increasingly wide deflection of the beam to effect coverage of a screen of large area, and to provide such wide deflection requires susbtantial power. In addition to reduction of phyical length of cathode ray tubes, there is also a need in many applications for increased brightness or beam intensity. However, to provide increased brightness requires the use of high voltage which requires still additional deflection power. It is obvious that if brightness can be maintained while lowering voltages in the region of deflection, this would be advantageous in simplifying associated circuits and reducing insulation and power problems in circuit design.

As a means of lessening the potential necessary for wide beam deflection, it has been proposed to utilize a post acceleration system wherein the beam travels through the deflection apparatus at a comparatively low velocity so that it is not very "stiff" and may be deflected by small fields supplied by the deflection apparatus. After deflection, the beam may be accelerated by a large potential gradient adjacent the viewing screen so that the beam impinges the screen at a high velocity and energy level, Such a system may include the provision of an apertured electrode spaced from the tube screen and maintained at a comparatively low potential compared to that of the screen which may be maintained at a high potential to accelerate the beam to the desired velocity after passing through the electrode. The beam is, of course, deflected while it is at the low energy level and associated low velocity existing in the drift space on the input side of the low potential electrode. Difficulty has been experienced, however, with such a post acceleration system because of the tendency thereof to produce a bright ghost image on the screen due to the emission of secondary electrons from the low potential electrode. My copending application Serial No. 528,404 filed August 15, 1955, now abandoned, discloses and claims a post-deflection tube and system wherein the effect of secondary emission is eliminated, and this application is directed to a further construction for producing this result.

Accordingly, it is an object of this invention to provide an improved cathode ray tube in which substantial post acceleration, or increase of beam intensity may be effected after deflection.

Another object of the invention is to provide a cathode ray tube incorporating an electrode structure therein to permit substantial post acceleration of the electron beam and which prevents secondary emission from striking the screen to produce undesired spurious patterns thereon.

A further object of the invention is to provide an improved cathode ray tube for producing an image display of high intensity wherein deflection is effected while

the beam producing the display is at low intensity to thereby permit reduction of the deflecting power.

A still further object of the invention is to provide a cathode ray tube for color television receivers wherein a mask within the tube serves as a focus mask for the beams producing different colors and simultaneously as a barrier mask for separating high and low intensity areas within the tube and preventing secondary emission therefrom.

A feature of the invention is the provision of an improved cathode ray tube in which the aperture electrode disposed in the beam path to define low and high velocity areas includes a double layer with the layer on the output side of the electrode being at a slightly lower potential than the layer on the input side so that a negative going potential gradient is presented to the beam through the mask thus forming a barrier to the passage of secondary electrons to the screen. The spacing between the apertured electrode and the screen of the tube must be sufficiently large with respect to the potential difference therebetween so that this positive potential gradient does not override the negative potential gradient available and thereby cause secondary electrons to strike the screen.

Another feature of the invention is the provision of such a cathode ray tube as described in the preceding paragraph in which the low potential anode includes an inner conductive coating on the tube wall and the barrier mask electrode comprises a conducting plate with a coating supported on and insulated therefrom, which coating is composed of material having high secondary emission properites and is positioned on the side of the mask facing the drift space henceforth called "first surface" so that this coating assumes the potential of the drift space when scanned by the beam. The metal base of the mask is maintained at a potential of the order of 100 volts below that of the drift space, the potential assumed by the coating thus forming a barrier to secondary electrons from the first surface.

Still another feature of the invention is the provision of a cathode ray tube having a barrier mask electrode separating low potential and high potential spaces within the tube, with the barrier electrode having an insulating coating of high secondary emission on the first surface, and in addition a wire mesh maintained at drift space potential being spaced from the coating to receive secondary emission therefrom. The conducting grid may be formed of fine wires spaced at substantial distance with respect to the diameter of the wires so that it has substantially no masking effect on the beam.

A further feature of the invention is the provision of a cathode ray tube for color television of the three-gun type having a mask with openings therein for providing registry of the beam with phosphor dots on a fluorescent screen, with the mask being of the double layer construction previously described to form a barrier to the emission of secondary electrons therefrom. The openings in the mask may be large because of the focussing effect between mask and screen. This increases the beam current reaching the screen.

Further objects, features, and the attending advantages of the invention will be apparent upon consideration of the following description when taken in conjunction with the accompanying drawing in which:

FIG. 1 is a diagrammatic representation of a cathode ray tube incorporating the invention;

FIG. 2 is a perspective view of the apertured mask electrode;

FIG. 3 is a perspective view of the collector grid structure;

FIG. 4 is an enlarged detail view of the collector grid construction;

FIGS. 5 and 6 are enlarged views of the apertured mask electrode used in the cathode ray tube; and

FIG. 7 is a sectional view of a cathode ray tube utilized in a color television receiver incorporating the invention.

In practicing the invention, there is provided a cathode ray tube for producing an image display on an associated viewing screen. The tube includes a beam source and associated means for deflecting the beam. An anode maintained at comparatively low potential is used to energize the beam as it passes through a drift space in which it is deflected. The beam then passes through the "barrier mask," formed by an apertured electrode of the double layer type, after which it enters a high velocity region produced by the viewing screen which is at high potential. Accordingly, maximum beam velocity is developed after the beam has been deflected and for the purpose of producing maximum intensity as it impinges the screen. The apertured electrode positioned between the drift space and the high intensity field is of the double layer type with the first layer through which the beam passes being maintained at the potential of the drift space and the second layer being held at a potential slightly below this potential. Accordingly, the beam passes through a negative-going potential gradient which forms a repetitive barrier to the passage of secondary electrons from this electrode to the viewing screen. The first layer of the electrode may comprise an insulating coating having high secondary emissive properties supported on the metallic body of the mask which forms the second layer. A collector grid is provided adjacent the coating and is maintained at the potential of the anode of the tube to collect electrons emitted from the coating. By spacing the collector grid relatively close to the secondary emissive coating, this coating will quickly establish itself at the potential of the conducting grid when scanned. The potential gradient between the barrier mask and the screen of the tube must be held below a predetermined limit in order to permit the double layer to form an effective barrier so that the secondary emission does not pass to the screen.

The invention may be used in a three-gun color television tube with the barrier mask replacing the conventional shadow mask and further providing focussing action. The openings in the mask separate the rays by angle of approach. Because the mask is at a lower potential than the screen, a focussing effect is put into effect so that the openings in the mask can be larger than the dots, with the result that the beam current density at the screen is increased. Accordingly, in the color television application the required deflection power is reduced as explained above, and the picture brightness is also increased.

The system shown in FIG. 1 includes the cathode ray tube **10** to which a signal is applied at input terminal **12** which is coupled through capacitor **14** to the control grid element **16** of the tube. Cathode element **18** constitutes an electron beam source and is coupled to ground and through biasing battery **20** and grid leak resistor **22** to the grid element **16**. A first anode electrode **25** is coupled to the junction of resistors **28** and **29** which are part of a potential dividing system comprising resistors **27—30** coupled between ground and a potential source of 3,000 volts in the specific example of the invention being described. The potential applied to anode electrode **25** may for example, be of the order of 400 volts. The focussing element **32** is coupled to the junction of resistors **27** and **28**, so that a suitable potential applied from this point will cause focussing of the beam. An accelerating anode electrode comprising elements **34** and **35** is coupled to the Aquadag coating **36** which is supported on the flared inner surface of tube **10**. Electrodes **34**, **35** and coating **36** are coupled to terminal **38** which is maintained at a potential of the order of 3,000 volts. Disposed between electrode **35** and coating **36** is an electrostatic deflection electrode **44** to which a deflection signal is supplied by means of terminals **45**. Deflection electrode **44** may comprise a conical shaped insulating form upon which is plated a plurality of interleaved metallic patterns of zig-zag shape to provide desired deflection of the beam which may be over 70°. Such deflection apparatus is described in greater detail and claimed in my Patents Nos. 2,617,076, 2,617,077 and 2,681,426.

The electron beam provided by element **18** is controlled by the signal applied to element **16**, passes through electrode **25**, is accelerated by eelctrodes **34** and **35** and focussed by element **32**. The proper signals applied to terminals **45** cause the development of a suitable deflection field by electrode **44** which deflects the beam across the screen in a predetermined pattern. The beam then proceeds through the area surrounded by coating **36**, which area may be described as a "drift space" in which the beam will maintain constant velocity since the coating **36** is at the same potential as the electrodes **34** and **35**. The beam thereafter passes through collector grid **48** which is electrically connected to coating **36** and is maintained at the same potential therewith. The beam next passes through apertured electrode **50** which is coupled to the junction of resistors **29** and **30** so that this electrode is at a potential just below that of the coating **36** and the collector grid **48**. Further explanation of the potential of electrode **50** will be given below. The beam then is accelerated to high velocity by the field produced by viewing screen **53** coupled to terminal **55** to which is applied a high potential. As an example, this high potential may be of the order of 25,000 volts. Screen **53** is back-metallized so as to be a conductor and would include a suitable phosphor coating so that an image is produced by the beam as it is scanned thereacross. Electrode **50** may be spaced one or two inches from screen **53** and may have a configuration concentric with that of a curved screen as shown, or may be parallel to a flat screen.

In the system as described thus far, it should be noted that at deflection the beam has only one-eighth to one-tenth of the final anode potential, thus providing substantial post acceleration. In a constructed embodiment of the system as described, it has been found that for a post acceleration ratio of eight to one, and a deflection angle of about 70°, only about one-tenth of the deflection potential need be applied to deflection electrode **44** as would be required in the usual system where post acceleration is not utilized. Furthermore, the system displays very small deflection loss as well as minimum pattern distortion and minimum loss of resolution. Accordingly, it may be seen that the system will permit the use of simpler and less complicated deflection signal producing circuits which may operate at greatly reduced voltages. Such deflection signals may of course be of the type to produce linear deflection as used in television or of the type to produce circular deflection as used in other applications.

It has been found, however, that post acceleration systems, not in accordance with the invention, tend to produce a bright ghost image along with the desired image produced by the electron beam as it traces across screen **53**. This causes the display to be entirely unsuitable for most applications. The ghost images are caused by the emission of secondary electrons from the mask electrode **50** as the beam passes through the apertures in this electrode. In accordance with the invention there is provided a special construction of the grid **48** and electrode **50** so as to overcome this deficiency and obtain a display on the screen **53** which is not accompanied by ghost images.

FIGS. 2, 5 and 6 illustrate the apertured electrode **50**, with FIGS. 5 and 6 showing sections greatly enlarged for the purposes of explanation. The apertures **60**, through which the beam passes, are arranged so that adjacent ones are equidistant from one another. Merely by way of example, it may be stated that the apertures **60** in electrode **50** shown in FIGS. 5 and 6 are of 20 mil diameter and spaced 30 mils on center to provide an optical transparency of the order of 50%. The electrode portion 61 may be composed of a metal suitable for photo-engraving, such as an alloy of 95% copper and 5% nickel, having a thickness of the order of 8 mils. It is electrode portion 61 which is coupled to the junction of resistors 29 and 30 (FIG. 1) and in the example of the invention under consideration a potential of 100 volts below that of the coating 36, or 2,900 volts, is impressed on portion 61.

A coating or film 65 composed of insulating material which has high secondary electron emissive properties is provided on the side of electrode 50 which is facing the conducting grid 48 so that as the beam scans this electrode and electrons pass therethrough, secondary electrons are emitted from coating 65 and a positive surface charge is developed thereon which will approach the potential of grid 48. If the charge of the coating 65 of the barrier mask rises above the potential of the grid 48, the electrons of the scanning beam will neutralize this charge and thereby reduce the charge on coating 65.

Coating 65 may be comprised of a vitreous enamel with a further layer of magnesium oxide on the outer surface thereof. This coating may be secured to portion 61 by sintering granular glass on portion 61 in an oven at 800° F. with magnesium oxide dusted on the outer surface. The thickness of the coating film is neglible being a fraction of a mil.

The potential developed on the magnesium oxide layer being higher than the potential on the base metal 61 provides a steep negative going potential gradient across electrode 50, since it is of small thickness. This gradient forms a barrier to secondary electrons, and exists in the axial direction of the tube across the electrode 50. A potential difference of the order of 100 volts is adequate for most applications. With portion 61 of the electrode 50 being 100 volts below the potential of portion 65 the barrier for secondary electrons so formed eliminates the gost images referred to above.

FIGS. 3 and 4 illustrate the construction of the collector grid 48. A mounting rim 70 is supported through insulators 71 from the rim 51 of the barrier mask 50. The rim 51 is in turn secured to the glass enevelope of the cathode ray tube. Extending from the rim 70 are contact springs 72 which engage the Aquadag coating 36 on the inside of the tube envelope. To provide a sure contact, a second leaf spring 73 may be provided against which engages the first spring 72 as it flexes when it is positioned in the tube. Fine wire grids 74 are supported on the rim 70 and may be secured to punched out portions 75 best shown in FIG. 4. The entire structure including the rim and grids is maintained at the potential of the Aquadag coating and the second anode through the connection made by the contact springs 72. The collector grid may be quite open with the structure being composed of 49 wires in either direction, for a 19" tube with the wires being .004" or less stainless steel. Such an open grid provides substantially no shadowing effect. Further by maintaining the potential difference between the barrier mask and the collector at the proper value, the emission from the collector may be made to be substantially the same as the absorption thereby so that the collector will be electronically invisible.

As previously stated it is important that the potential gradient between the barrier mask and the screen of the tube be held below a predetermined critical value so that the effect of the potential barrier at the mask is not overcome by the high field intensity between the barrier mask and the screen. It has been found when using a construction as has been described, the potential gradient in the space between the barrier mask and the screen should not exceed 12 kilovolts per inch. With a potential gradient of 22 kilovolts the spacing must be at least 1.8 inches. The spacing may be made greater so that the field behind the mask falls below the maximum critical value without causing objectionable effects.

The permissible accelerating field depends upon the physical dimensions of the tube and particularly of the mask 50. The following table shows the variation for different tube sizes.

Screen Size, inches	Hole Diam., mil.	Mask Thick., mil.	E_{48}	E_{53}	E_{61}	Volts Per In.	Mask-Screen Spacing, inches
19	20	8	3,000	25,000	2,900	12,000	1.8
10	10	8	{3,000	25,000	2,900	40,000	0.6
			{1,000	8,000	900	40,000	0.2
5	5	8	3,000	25,000	2,900	80,000	0.3

The various dimensions and potential values for a tube having a 19 inch screen have been set forth in the specification and the values in the table above agree with the values previously stated. For a tube having a 10 inch screen, in order to have the same resolution as in the 19 inch tube described, the holes 60 in the mask 50 must be reduced by the same ratio as the screen size. Accordingly holes of 10 mil diameter may be used. In order to retain the same electrical effect by the mask, the mask thickness should be reduced by the same ratio as the hole diameter, but it is not practical to reduce the mask thickness below 8 mils. The potential gradient permissible between the mask and the screen will be greatly increased by reducing the diameter of the holes. Therefore, the potential gradient may be increased from 12,000 volts per inch to 40,000 volts per inch. This permits a reduction in the spacing between the mask and the screen from 1.8 to 0.6 inch.

A tube having a screen of 10 inches in diameter may be satisfactorily operated at a lower voltage than the 25,000 volts specified and which is required for a 19 inch tube. Actually, 8,000 volts may be adequate and with a voltage of 1,000 volts on the second anode the potential difference between the mask and the screen is only 7,000 volts. This requires a spacing of only 0.2 inch between the mask and the screen. Accordingly, the spacing for a 10 inch tube may be greatly reduced so that the over-all size of the tube is not substantially increased by a structure in accordance with the invention.

The above table also shows the dimensions required for a 5 inch tube. In such case the diameter of the holes is reduced to 5 mils. As such a tube may be used in a projection system, the light intensity must be high and the screen voltage of 25,000 volts may be necessary. However, the potential gradient is again doubled due to the reduction in diameter of the opening so that a potential gradient as large as 80,000 volts may be used. This permits a spacing of 0.3 inch between the mask and the screen so that the resulting tube can be very small.

FIG. 7 illustrates an embodiment of the invention which may be used with a color television receiver. Signals from the antenna 80 are applied to the color television receiver 82 which, in accordance with principles understood in the art demodulates the received signal into 3 primary color signals and applies these to the electron guns 84—86 in cathode ray tube 83. The signals applied to these guns serve to vary the intensity of the three electron beams emitted thereby in accordance with color content of the scene at any instant. Additional electrodes may be included in the cathode ray tube 83 in order to focus the electron beams produced by source 84—86 but such other electrodes are not illustrated herein since the invention is not concerned with the portion of the tube in which the guns would be contained.

The guns 84—86 produce electron beams which travel along paths 88, 89 and 90. A magnetic deflection yoke 92 is shown supported on the neck and flair of tube 83 and this yoke is connected to the receiver 82 which supplies necessary signals thereto so that the electron beams are scanned across screen 94. Guns 84—86 are spaced equidistant from one another and aimed so that their respective electron beams will converge at the apertured focus mask 96. The beams pass through an aperture in mask 96 depending upon their deflected position, after which they impinge upon respective phosphor dots on the screen. The dots indicated as 97, 98 and 99 are arranged in triad groups with each dot in a group being adapted to emit light of a primary color when impinged by an electron beam. Each triad group then assumes a color according to the energization of the separate dots thereof and becomes an element of a completed color picture which is produced on the screen 94 as the beams scan the triad groups. Mask 96 is constructed so that each aperture thereof is placed in line with the center of a particular triad of phosphor dots in order that the beams will not strike phosphor dots as they are scanned from triad to triad. The receiver as described thus far is known in the art and further details of its operation are familiar to those skilled in television practice.

Coating 100 on the interior of the flared portion of tube 83 and collector grid 101 are connected to terminal 102 to which a potential is applied for causing the beam to be energized to a first velocity. The voltage divider network consisting of resistors 105 and 106 is connected between terminal 102 and ground. The junction of resistors 105, 106 is coupled to mask 96 which may be constructed in accordance with the description given for FIGS. 2, 5 and 6. Screen 94 is made electrically conductive and is connected to terminal 110 to which is applied a high voltage potential.

In the system as illustrated in FIG. 7, mask 96 performs a number of functions, one being a focus mask in the trigun cathode ray tube 83 to cause the electron beams to strike the proper phosphor dots as the beams are scanned across the screen. Another function is to separate the drift space from the high potential field adjacent screen 94, and to perform this latter function, mask 96 must be constructed to prevent the passage of secondary electrons therefrom to the screen 94 as has been described. To effect this result mask 96 may have an insulating coating such as coating 65, described above (FIG. 6), on a conducting portion such as portion 61. The insulating coating has high secondary emission properties so that it establishes itself at the potential of collector grid 101.

Mask 96 is shown concentric with screen 94 in the spherical form illustrated in FIG. 7. The spacing between mask 96 and screen 94 may be determined by the geometry of the tube and more particularly by the spacing of the sources 84—86, the distance from the sources to the mask, and the spacing between the phosphor dots 97—99. The minimum spacing determined by the potential gradient between the mask and the screen as discussed above, must also be met. In a practical case the spacing of the mask and screen may be of the order of 1½ to 2 inches.

It should also be mentioned that in addition to providing post acceleration of the electron beams without the introduction of spurious images on the screen, the system also provides a very bright image on screen 94 since large openings may be provided in mask 96 due to the focussing action between the mask 96 and screen 94. The function of mask 96 as a focus mask makes it possible to form the apertures in this mask of a much larger diameter than the diameter of dots 97—99, and to permit the beam to fill the full diameter of the aperture without danger of it covering a larger area than its intended phosphor dot. This is illustrated in FIG. 7 in which the beam 90*a* is shown out of proportion for description purposes. It has a diameter which just fills aperture 120 in mask 96. However, as the beam proceeds from mask 96 to phosphor dot 122, it is converged to a smaller diameter so that it will not exceed the diameter of dot 122. Therefore mask 96 may have a high transparency (as much as 50%) while at the same time a very bright image may be produced on screen 94 without loss of detail or the introduction of color impurities. With known formulas it is possible to calculate the voltage in the drift space, for which focussing occurs on the screen. Accordingly the voltage values for the mask and screen must meet the requirements for focus and the post acceleration ratio may be limited thereby.

In accordance with the mask construction shown in FIG. 5 in which the apertures may be 20 mils in diameter and spaced 30 mils on centers, it is possible to pass the three electron beams therethrough each having diameters of substantially 20 mils, so that the focusing effect of the potential gradient between mask 96 and screen 94 causes each beam to concentrate onto phosphor dots of 8 mils diameter without falling beyond the edge of the dots. This means a gain in light output of 3 to 1 over standard shadow masks having openings the same size as the phosphor dots.

The invention provides therefore a cathode ray tube in which post acceleration of the electron beam, or increase of beam velocity after deflection, may be effected without ghost images. Deflection of the beam may be obtained when it is at a comparatively low velocity so that circuitry for producing deflection signals is simplified but yet brightness of the image on the viewing screen need not be sacrificed. Construction of the cathode ray tube as described above will permit the use of substantial post acceleration ratios with but a minimum of pattern distortion and without the production of spurious images on the screen. Furthermore, due to the focusing effect of the entire system as described, the apertured mask provided in the cathode ray tube for post acceleration purposes may have wide openings and high transparency so as to have high electron beam transparency. The high potential on the screen has only a minor effect on sweep size, when the mask and screen are both concentric at the deflection center, so it is not essential that the high voltage be accurately regulated.

The essential feature of all embodiments of the invention is that a double layer barrier mask is formed with the first surface about 100 volts more positive than the second. This 100 volts between the surfaces of the double layer forms a barrier which prevents secondary emission to the screen and the ghosts resulting therefrom. The barrier mask may be constructed as a metal mask with an insulating emissive coating on one side. The collector grid may be quite inexpensively constructed as the parts are critical. The potential gradient from the mask to the screen must be held at a value which will not override the negative gradient across the mask.

The invention has been described by reference to two embodiments thereof. It will be apparent that other embodiments may be constructed for various other cathode ray tube constructions. The values specified are merely representative, and are not limiting as other values may be desired in other applications. It will be obvious that the type of deflection used is not material and electromagnetic deflection may also be used in the construction of FIG. 1 with a great reduction of deflection power.

What is claimed is:

1. A cathode ray tube including in combination a viewing screen adapted to be maintained at a relatively high potential, an anode adapted to be maintained at a relatively low fixed potential, an electron beam source constructed to direct a beam through said anode so that the beam impinges upon said viewing screen, deflecting means for scanning said beam across said viewing screen, a composite apertured electrode separating the high and low potential spaces through which the beam passes, said electrode comprising a conductive portion facing said viewing screen and an insulating coating on said conductor portion facing the low potential space and having

a layer with high secondary electron emissive properties, a conducting grid maintained at said fixed low potential of said anode in said low potential space adjacent said insulating coating, said emissive layer of said electrode being adapted to emit electrons to said conducting grid as the beam passes through said apertured electrode so that said layer assumes said fixed low potential, means for maintaining said conductive portion of said electrode at a potential slightly below that of said conducting grid, so that the potential on said conductive portion of said apertured electrode is below that assumed by said emissive layer to provide a negative potential gradient from said layer to said conductive portion which forms a barrier to the flow of secondarily emitted electrons from said apertured electrode to said viewing screen.

2. A cathode ray tube including in combination, an evacuated envelope including a neck portion, a flared portion and a front face portion, an electron gun in said neck portion including an anode adapted to be maintained at a first relatively low fixed potential, a viewing screen on said face portion adapted to be maintained at a second potential substantially higher than said first potential, said electron gun being constructed to direct a beam through said anode so that the beam impinges upon said viewing screen, deflecting means for scanning the beam across said viewing screen, a conducting coating on said flared portion of said envelope electrically connected to said anode, a composite apertured electrode separating the high and low potential spaces through which the beam passes, said electrode comprising a conductive portion facing said viewing screen and an insulating coating on said conductor portion facing the low potential space, said coating having a layer spaced from said conductor portion with high secondary electron emissive properties, a conducting grid electrically connected to said conducting coating and positioned in said low potential space adjacent said insulating coating, said emissive layer of said electrode being adapted to emit electrons to said conducting grid and said conducting coating as the beam passes through said apertured electrode so that said insulating coating assumes said first fixed potential of said anode, means for maintaining said conductive portion of said electrode at a potential slightly below said first potential so that it is below the potential assumed by said emissive layer to provide a negative potential gradient from said layer to said conductive portion which forms a barrier to the flow of secondarily emitted electrons from said apertured electrode to said viewing screen.

3. A cathode ray tube including in combination a viewing screen adapted to be maintained at a relatively high potential, an anode adapted to be maintained at a relatively low fixed potential, an electron beam source constructed to direct a beam through said anode so that the beam impinges upon said viewing screen, deflecting means for scanning the beam across said viewing screen, a composite apertured electrode separating the high and low potential spaces through which the beam passes, said electrode comprising a conductive layer facing said viewing screen and an insulating layer facing the low potential space and having high secondary electron emissive properties, a conducting grid maintained at said fixed low potential of said anode in said low potential space adjacent said insulating layer, said insulating layer being adapted to emit electrons to said conducting grid as the beam passes through said apertured electrode so that said insulating layer assumes a potential substantially the same as said fixed low potential of said anode, means for maintaining said conductive layer at a potential slightly below said low potential so that said conducting layer is at a potential below that assumed by said insulating layer to provide a negative potential gradient from said insulating layer to said conductive layer, the distance between said electrode and said screen and the potential difference therebetween being so related that the positive potential gradient therebetween is less than the negative potential gradient between said insulating layer and said conducting layer, so that said electrode forms a barrier to the flow of secondarily emitted electrons from said apertured electrode to said viewing screen.

4. A cathode ray tube including in combination a viewing screen adapted to be maintained at a potential of the order of 25,000 volts, an anode adapted to be maintained at a fixed potential of the order of 3,000 volts, an electron beam source constructed to direct a beam through said anode so that the beam impinges upon said viewing screen, deflecting means for scanning the electron beam across said viewing screen, an apertured electrode separating the high and low potential spaces through which the beam passes, said electrode comprising a conductive layer facing said viewing screen and an insulating layer facing the low potential space and having high secondary electron emissive properties, the thickness of said apertured electrode being of the order of 8 mils, means for maintaining said conductive layer at a potential approximately 100 volts below said low potential, a conducting grid maintained at said fixed potential of said anode in said low potential space adjacent said insulating layer, said insulating layer being adapted to emit electrons to said conducting grid as the beam passes through said apertured electrode so that said insulating layer assumes said fixed potential, the positive potential gradient between said apertured electrode and said screen tending to cause a flow of secondarily emitted electrons from said apertured electrode to said screen, said apertured electrode being spaced from said screen by a distance of the order of 2 inches, so that said positive potential gradient is less than 12,000 volts per inch, with the negative potential gradient from said insulating layer to said conductive layer being greater than said positive potential gradient, whereby said apertured electrode forms a barrier to the flow of secondarily emitted electrons from said apertured electrode to said viewing screen.

5. A tri-beam cathode ray tube for a color television receiver including in combination, a viewing screen adapted to be maintained at a relatively high potential and having a plurality of phosphor dots energizable to phosphoresce in different colors by impingement of electron beams thereon, an anode adapted to be maintained at a relatively low fixed potential, an apertured shadow mask disposed in uniformly spaced relation with said viewing screen and between said anode and said viewing screen, said shadow mask including a conducting electrode portion facing said viewing screen and adapted to be maintained at a potential below that of said anode, deflecting means for scanning the electron beams across said shadow mask and said viewing screen, an insulating coating on said conducting electrode portion having a layer made of material having high secondary electron emissive properties facing said low potential anode, a conducting grid spaced from said emissive layer and electrically connected to said anode and maintained at said fixed potential thereof, means for directing a plurality of electron beams through said anode so that the same are converged in an aperture of said shadow mask and impinge individual ones of said phosphor dots, said layer emitting electrons as the beams pass through said mask so that said layer assumes the fixed potential of said conducting grid, the positive potential gradient from said mask to said screen tending to cause a flow of secondary emission from said mask to said screen, the negative potential gradient from said emissive layer of said mask to said conducting electrode portion thereof having a greater effect than the positive potential gradient from said mask to said screen with respect to the flow of secondary emission from said shadow mask to said viewing screen and thereby retarding the flow of such secondary emission.

6. A tri-beam cathode ray tube for a color television receiver including in combination, a viewing screen adapted to be maintained at a relatively high potential and having phosphor dots of a first diameter energizable

by impingement of an electron beam thereon, an anode adapted to be maintained at a relatively low fixed potential, a composite apertured shadow mask disposed between said anode and said viewing screen for confining the fields of said high and low potentials and having apertures of a second diameter greater than said first diameter, means for providing a plurality of electron beams of substantially said second diameter and directing the same through said anode so the same are converged in an aperture of said shadow mask and impinge individual ones of said phosphor dots, deflecting means for scanning said beam across said shadow mask and said viewing screen, said shadow mask including a first conducting portion facing said viewing screen and adapted to be maintained at a potential below that of said anode and a second insulating electrode portion secured to said first portion on the side toward said anode, said second electrode portion having a layer of high secondary emissive properties facing said anode, a conductive grid electrically connected to said anode and maintained at said fixed potential thereof, said conductive grid being positioned adjacent said second electrode portion, said emissive layer of said second electrode portion emitting electrons as the beam passes through said mask so that said layer assumes the fixed potential of said conductive grid, the negative potential gradient from said layer of said second electrode portion to said first electrode portion retarding the flow of secondary emission from said shadow mask to said viewing screen, the positive potential gradient from said shadow mask to said viewing screen focusing the beam to reduce the diameter thereof to substantially said first diameter for impinging a phosphor dot, said positive potential gradient being held at a value below that of said negative potential gradient.

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