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POTENTIAL GRADIENT STABILIZED CATHODE-RAY TUBE

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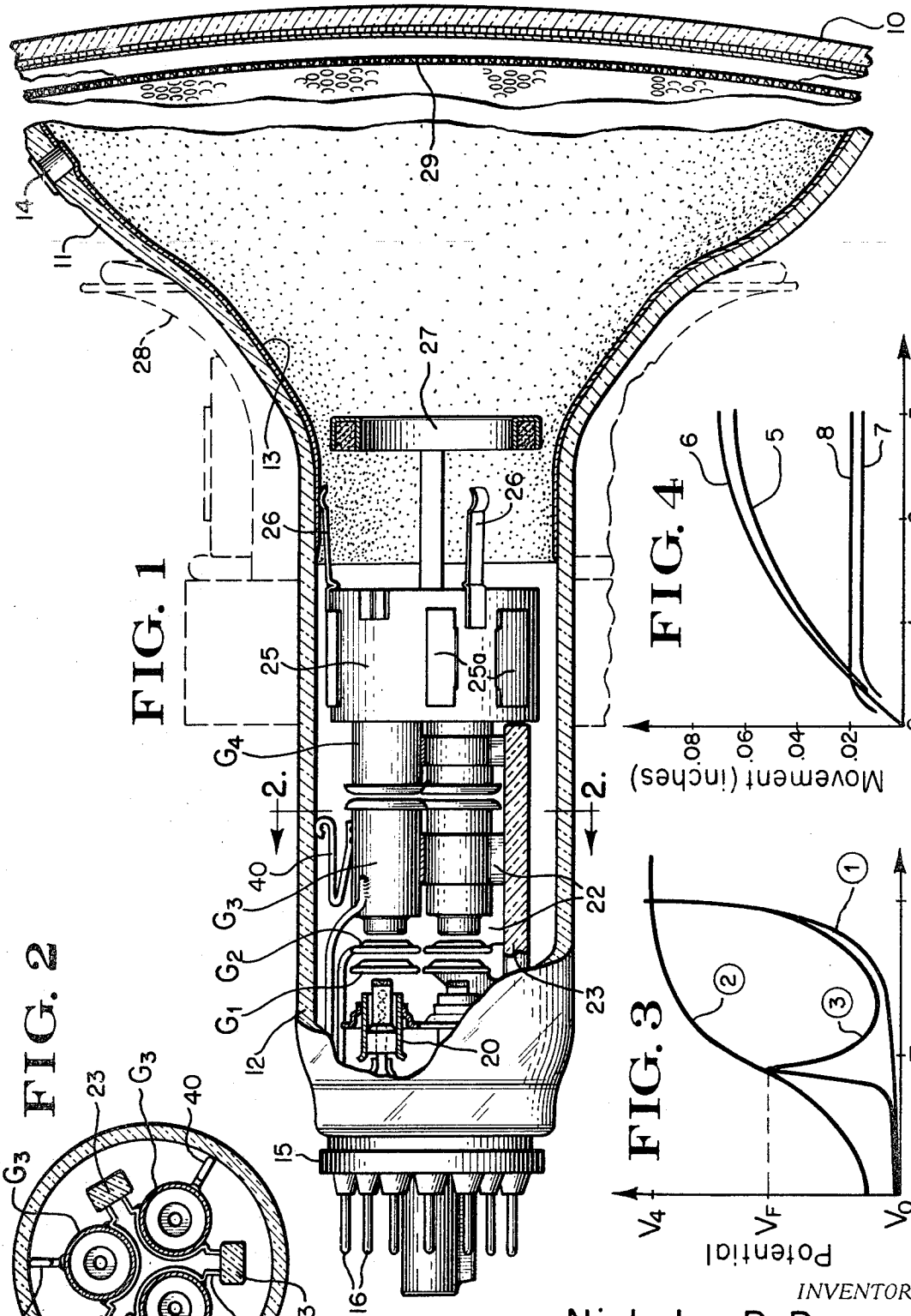


FIG. 1

FIG. 2

FIG. 4

FIG. 3

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POTENTIAL GRADIANT STABILIZED CATHODE-RAY TUBE

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ABSTRACT OF THE DISCLOSURE

A tri-color picture tube with a delta array of electron guns has a conductive coating of Aquadag extending into the end of the neck that is remote from the tube base and the coating, being established at final anode potential, gives rise, in stabilized operation of the tube, to a potential gradient extending from anode potential at one end of the neck to approximately zero or ground potential at the other end. The electrode next adjacent the anode, in the direction of the tube base, is used for focus control and is established at a positive potential although of much lower value than anode potential. A conductive contact is mechanically and electrically connected to the focus electrode of each of the three guns and contacts the glass of the tube neck in a plane where the potential, in stabilized operation, has a value approximately equal to the operating potential of the focus electrode. This accelerates achieving stabilized potential distribution within the neck of the tube and minimizes convergence drift, electron spot aberrations, stray electron emission and arcing.

BACKGROUND OF THE INVENTION

The present invention is addressed to cathode-ray tubes and, while useful in monochrome tubes, is especially advantageous for minimizing convergence drift in tri-color picture tubes and will, for convenience, be described in that environment.

The usual tri-color picture tube has a delta array of three electron guns each of which has four electrodes aligned with the cathode and utilized for developing and accelerating an electron beam subject to modulation by control signals applied to the first grid and/or cathode. The acceleration of the beam electrons is achieved by establishing a desired positive potential on the anode or, as designated in this text, the electrode referred to as G_4. The anode has conductive snubber springs which contact an Aquadag coating deposited on the funnel of the tube envelope and extending into the contiguout end portion of the glass neck and a high voltage terminal projecting into the funnel establishes the desired high voltage on the Aquadag coating and, through the snubber springs, on the G_4 electrode. Focusing of the electron beam results from a lens action produced by operating G_3 at a positive potential of much lower value than anode potential. Such a prior art structure is very well known and operates in a generally satisfactory manner synthesizing images in simulated natural color under the control of luminance and chrominance information.

Some difficulty has been experienced, however, in this type of tri-color tube which is attributable to the potential distribution along the tube neck. It is found, for example, that when the tube is first energized the end of the neck to which the dag coating extends is at a high anode potential whereas the other end is at essentially zero or ground potential giving rise to a potential distribution which changes sharply in the G_3–G_4 region and a charge accumulation takes place on the inner wall of the neck. As a consequence, a field is created which penetrates the interelectrode space of the G_3–G_4 electrodes. It may cause aberrations of the electron spots, spurious electron emission, arcing and convergence drift. The nature of that drift depends on the initial conditions of convergence adjustment.

If the receiver is adjusted with its electron beams fully converged before stabilized operation has been attained, and this is the usual case since stabilization customarily requires several hours of sustained operation, the ultimate effect of the field in the G_3–G_4 region is a condition of misconvergence. This follows from the fact that as the tube is operated over an extended period, typically a minimum of three hours, the potential distribution along the neck undergoes a change because the charge accumulation dissipates and a condition of stability ensues. When this occurs, the potential gradient along the tube neck becomes much less severe in the G_3–G_4 region and the field attributable thereto decreases, causing the beams to shift from their initial condition of adjustment and introducing convergence drift. The extent of the drift is a function of the field change. It is, of course, undesirable and as stated is experienced over an undesirably long operating interval of several hours duration.

Accordingly, it is an object of the invention to provide a cathode-ray tube which minimizes the aforedescribed difficulty of prior structures.

It is a particular object of the invention to provide a cathode-ray tube structure in which stable operating conditions, especially in regard to the potential gradient of the neck, are attained much more quickly.

It is still a further and particular object of the invention to provide a tri-color picture tube in which misconvergence attributable to the potential distribution on the neck of the tube is minimized.

SUMMARY OF THE INVENTION

In practicing the present invention a cathode-ray tube which is otherwise conventional in construction is provided with means for minimizing potential gradient variations along the neck during the initial operating time interval required for the attainment of stabilized operation. Structurally, this means comprises a conductive contact mechanically and electrically connected to an electrode which is intermediate the anode and cathode. The contact engages the glass neck of the tube in a plane where the potential realized under stable operating conditions has a value substantially equal to the operating potential of the electrode to which the contact is connected.

As applied to a tri-gun color tube, a similar connector extends from an electrode, such as the focusing electrode, of each of the three guns and engages the glass neck in a plane which, for stable conditions of operation, represents a potential corresponding to the operating potential of that particular electrode. This materially minimizes convergence drift.

BRIEF DESCRIPTION OF THE DRAWING

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The invention, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawing, in the several figures of which like reference numerals identify like elements, and in which:

FIG. 1 represents a tri-color cathode-ray tube partially in cross section, constructed in accordance with the invention;

FIG. 2 is a sectional view taken along lines 2—2 of FIG. 1; and

FIGS. 3 and 4 are curves used in explaining voltage

and convergence conditions of prior art color tubes contrasted with a tube embodying the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now more particularly to FIG. 1, the cathode-ray tube there represented is a multi-beam color picture tube which, more specifically, is a three-gun shadow mask device. Its envelope is of glass and terminates at one end in a screen area **10** upon the internal surface of which is deposited an ordered array of phosphor elements. In the most popular version of this type structure, the phosphor screen is a myriad of dot triad elements with each such triad containing a dot of red, a dot of blue and a dot of green phosphor. Usually the screen is provided with an aluminum backing layer that is pervious to the electrons of the beams used to excite the phosphor and serves as a specular reflector to increase screen brightness. Screen **10** terminates the funnel section **11** of the envelope.

Normally, the cap of the tube including screen **10** is separate from funnel **11** which facilitates depositing the phosphor elements and after the screen has been formed, the cap is frit sealed or otherwise integrated with the funnel. They, of course, must be configured and dimensioned to match and usually are either round or rectangular in profile. These details, however, form no part of the present invention and need not be considered in any greater depth.

It is customary to coat the internal surface of funnel **11** and the contiguous end of the glass neck **12** of the envelope with a conductive coating **13** of colloidal graphite such as that available commercially under the designation "Aquadag." A high voltage terminal **14** molded into a portion of funnel section **11** and arranged to receive a connector extending from a high voltage power supply (not shown) causes the Aquadag coating to be maintained at a high potential usually in the order of 25,000 volts. The opposite end of neck **12** terminates in the usual base **15** which has terminal prongs **16** serving to apply voltages to the electrode structures of the guns of the tube as well as energizing voltage for the heaters of the cathodes of those guns.

For the most part, the guns of the picture tube are of conventional construction and it will suffice to enumerate the elements of one since they are all alike. Each gun has a cathode **20** followed by four electrodes G_1–G_4, inclusive. Of these, the electrode G_1 is the signal modulating grid while G_2 is the first anode. G_3 is the focus electrode and G_4 is the final anode. Their facing end portions define an unshielded interelectrode space. Electrodes G_1–G_4 have support elements **22** which are embedded in beads or insulating pillars **23** to integrate the electrodes into a desired gun assembly. Each cathode with its associated heater is supported in known fashion from electrode G_1 and all of these elements, except for grid G_4, connect with assigned ones of terminal pins **16** so that suitable operating potentials may be readily applied to them.

At the end of the gun mount closer to screen **10** there is the usual convergence cylinder **25** which is secured to and supported by the several electrodes G_4. This cylinder is a convenient means for shielding and for supporting three pairs of convergence pole pieces **25***a*. One pair of convergence pole pieces is disposed on opposite sides of the path of the beam issuing from one of the three guns of the gun mount and the remaining two pairs are similarly associated with the remaining two electron beams. A convergence system (not shown) causes magnetic fields to be established between the assigned pairs of convergence pole pieces in order to accomplish dynamic convergence of the three beams in a fashion that is well understood in the art and constitutes no part of the subject invention. It will be observed that snubber springs **26** of conductive material extend from convergence cylinder **25** and contact Aquadag coating **13**. These springs mechanically position

the gun mount within neck **12** and at the same time extend the final anode potential from high voltage terminal **14** and conductive coating **13** through convergence cylinder **25** to the anode electrodes G_4. It is also conventional to have a getter **27** supported from convergence cylinder **25** for the purpose of clearing up residual gas that may be trapped within the tube envelope.

A deflection yoke **28** is positioned about the end of funnel **11** which is contiguous to neck **12** and establishes deflection fields for deflecting the three beams generated in the gun mount across a shadow mask electrode **29** which is positioned across the paths of the beams immediately before the screen deposited on the internal surface of faceplate **10**. Electrode **29** has a field of apertures corresponding in number to the triads of screen **10** and this mask in conjunction with the geometry of the guns constituting the gun mount as well as the convergence system permit each of the three electron beams to see only an assigned one of the three color phosphors arranged in the triads of the screen. In this way, color selection is achieved; again, in a manner well understood in the art. Since the invention is addressed most particularly to the nature and control of the voltage distribution along the inner wall of glass neck **12** and its effect on the electron beams of the tube, consideration will be confined to this subject matter as distinguished from the control of the beams by luminance and chrominance information as required to synthesize images in simulated natural color.

With particular reference to curve **1** of FIG. 3, which is a plot of potential along neck **12** from the base plane Z_0 to the plane Z_4 at the start of Aquadag **13**, at the instant the tube is energized the voltage at the plane Z_4 corresponds with the final anode potential while the voltage at the Z_0 plane, at the other end of neck **12**, is at approximately ground or zero potential. Curve **1** shows the resulting potential distribution along the glass neck between these planes. It is determined by the geometry of the gun mount, the operating potentials and the surface conditions of neck **12**. The abscissa Z_3 of FIG. 3 represents the plane or space between the adjacent ends of grids G_3–G_4 and it is apparent from FIG. 3 that there is a very large difference of potential between planes Z_3 and Z_4; for a representative 25 inch rectangular tube having a focus potential of about 4500 volts, this potential difference approaches 20,000 volts. Since the neck of the tube is not a perfect insulator, the potential difference existing along this section of internal surface of neck **12** may cause an undesirable arc discharge and also tends to establish a charge condition along the wall of the neck. As a consequence of this charge, a field is established which penetrates the space between electrodes G_3 and G_4 and spreads the electron beams relative to one another. As the tube operation is continued, the potential distribution along neck **12** changes at a rate determined by the effective time constant of the neck until finally the distribution in accordance with curve **2** is attained. This is the stabilized operating condition of the tube for which the potential distribution along neck **12** has changed sharply in relation to the initial condition of curve **1**.

In considering the effect on convergence, resulting from the change in conditions represented by curves **1** and **2**, it will be assumed that the beams are fully converged during set up, that is, at the time operating potentials are applied to the tube. Curves **5** and **6** of FIG. 4 represent the convergence drift experienced by the tube as the potential distribution along its neck changes from that indicated by curve **1** to the stabilized condition of curve **2**. Curves **5** and **6** show the separation of the green and blue beams, respectively, referenced to the red beam. It is clear that the green and blue beams require as much as three hours to stabilize and in the process they spread relative to the red beam, causing misconvergence. It is this long delay in achieving stabilized operation and the consequent convergence drift which the present invention improves substantially.

In accordance with the invention, a tube structure of the type under consideration is provided with means for minimizing potential gradient variations along the internal surface of neck **12** during the attainment of stabilized operation after the tube has been energized. More specifically, this means comprises a conductive contact **40** mechanically and electrically connected to an electrode of at least one of the guns which electrode has an operating potential that is high relative to the cathode but low relative to that of the anode. In the preferred arrangement for a three-gun mount, and as illustrated in FIG. 2, a conductive contact **40** is provided for each of the three guns being connected to and supported by focus electrode G_3. Of course, there may be one or more contacts provided for each gun or a ring type conductor, supported by conductive elements from the focus electrodes, may be used. However, it has been found sufficient to use a single member for each gun made of resilient conductive metal and contacting the glass of neck **12** in a plane where the potential, in the presence of stabilized operating conditions and attributable to the potential gradient which exists on the neck of the tube, represents a potential level substantially equal to the operating potential of the focus electrode. The plane of contact **40** is close to but on the cathode side of the G_3–G_4 interelectrode space.

With reference to FIG. 3, the voltage level V_F is the point on curve **2** corresponding to a value of potential which equals the operating potential of focus electrode G_3. This point is located physically on the cathode side of the G_3–G_4 interelectrode space.

With conductors **40** secured to focus electrodes G_3, the initial potential distribution along the internal surface of neck **12** when the tube is energized is modified to that represented by curve **3** of FIG. 3. There is a pronounced change of potential in the Z_3 plane since the G_3 electrode immediately assumes the potential V_F and as a consequence the potential drop between planes Z_3 and Z_4 is substantially reduced. Among other things, this definitely reduces the possibility of spot aberration, stray electron emission and arc discharges that are otherwise experienced because of the much larger potential difference presented without the stabilizing effect of contacts **40**. Additionally, contact **40** provide a low impedance path through which charge accumulations on neck **12** leak off rapidly, effectively decreasing the time constant of neck **12** as required to accelerate the attainment of the stabilized conduction of curve **1**.

Referring to FIG. 4, curves **7** and **8**, respectively, show the manner in which convergence drift is minimized through the utilization of the invention. It is apparent that not only is stabilization achieved in a much shorter period of time for both the green and blue guns as referenced to red but also the movement or spread of these beams in relation to the red beam is very markedly decreased. This, of course, means that adjustment of the convergence system for optimum operation is greatly facilitated.

Contacts **40** may additionally serve to position and mechanically support the gun mount within the tube neck in much the same manner as snubber springs **26**. Usually it is preferred to form each of contacts **40** into the configuration shown in FIG. 1, with its free end defining a curve or toe so that the contact may freely slide along neck **12** as the gun mount is inserted into the tube.

While particular embodiments of the invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention in its broader aspects, and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of the invention.

I claim:

1. In a multi-beam color cathode-ray tube having, in stabilized operation, a potential gradient extending from anode potential at one end of the glass neck of the tube to approximately zero potential at the opposite end of the neck, having a plurality of electron guns positioned within the neck for developing a plurality of electron beams convergence of which varies with changes in potential distribution along the neck, and having in each such gun an anode adjacent and conductively connected with one end of said neck, a cathode adjacent the other end of said neck and another electrode positioned between the anode and cathode and maintained at a predetermined operating potential that is high relative to that of said cathode but low relative to that of said anode, the improvement in beam convergence which comprises means, including a conductive contact mechanically and electrically connected to said other electrode of at least one of said guns and contacting the glass of said neck in a plane where the potential attributable to said potential gradient has a value substantially equal to said operating potential of said other electrode, for minimizing convergence drift as said tube attains stabilized operation after having been energized.

2. An arrangement in accordance with claim **1** in which said tube is a tri-color tube having three electron guns positioned within said neck in a delta array and in which said other electrode of each of said guns is a focus electrode positioned adjacent said anode on the side thereof closer to said cathode.

3. An arrangement in accordance with claim **2** in which the interelectrode space of said focus electrode and said anode of each gun is unshielded and in which each of said conductive connections contacts the glass of said neck in a plane that is adjacent said interelectrode space.

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