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PLURAL BEAM CATHODE RAY TUBES

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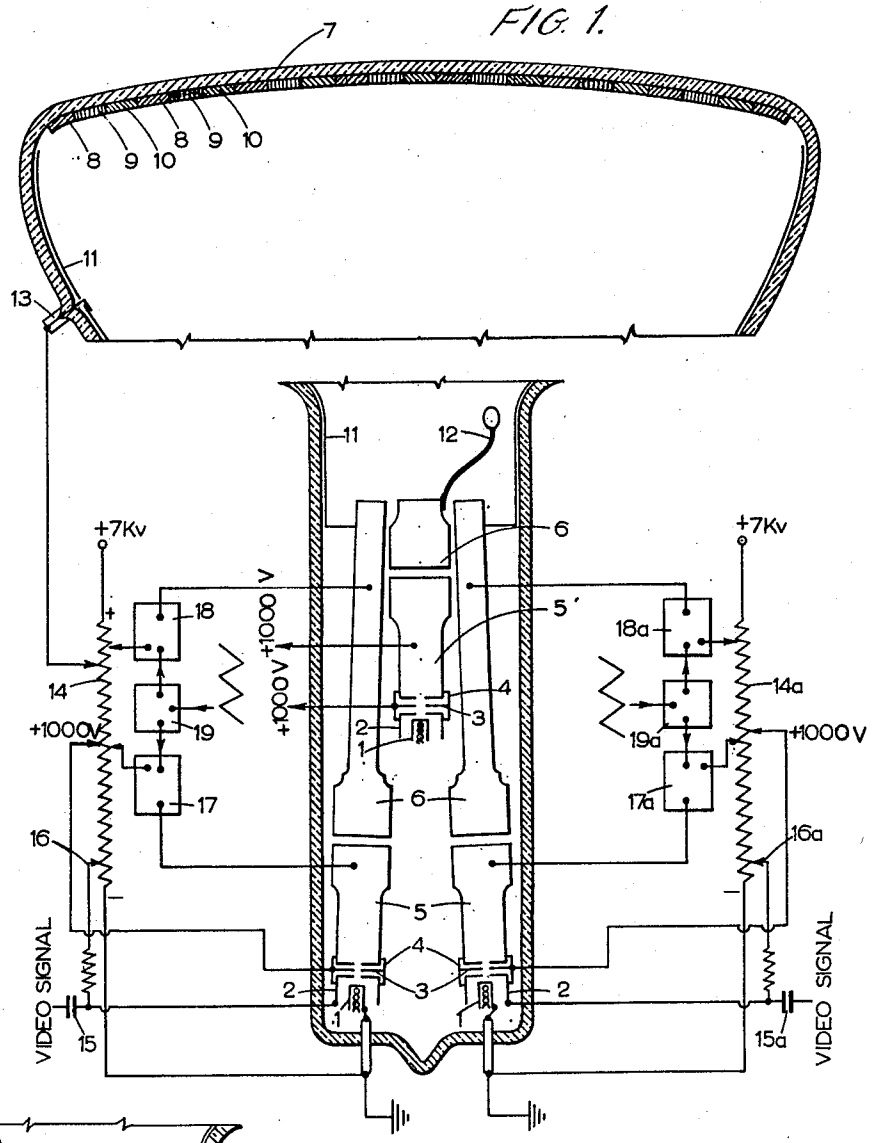
FIG. 1.



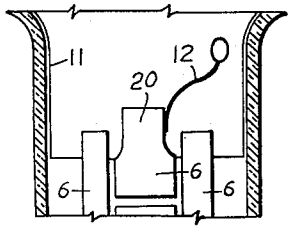


FIG. 2.

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PLURAL BEAM CATHODE RAY TUBES

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11 Claims. (Cl. 315—13)

The present invention relates to cathode ray tubes having a plurality of electron gun structures for providing a plurality of electron beams and is more particularly concerned with electric circuit arrangements for operating such tubes.

Plural beam cathode ray tubes have been proposed for various purposes, one very important application for such tubes being for the reception of television pictures in colour. Tubes employed for the latter purpose may be provided with two or more guns. With the two gun arrangement one beam may be used for indexing purposes and the other beam for reconstituting a coloured image by sequentially scanning a luminescent screen composed of a series of different colour emitting phosphor stripes. In a three gun arrangement a separate beam is employed for each of three colours and these beams are simultaneously scanned over a suitable luminescent screen such as one composed of a series of different colour emitting phosphor stripes, the stripes being arranged normal to the line scanning direction.

In both of the above arrangements the electron guns are arranged side by side so that their axes lie in a common plane with the axis of one of the guns coinciding with the axis of the tube, the other gun or guns being inclined to the tube axis in the common plane. The angles of arrival of the beams at the phosphor screen have to be controlled with great precision at all points of scanning over the screen to avoid colour mixing, so that some form of magnetic or electric correction of the beam angles for different regions on the phosphor is necessary, i.e. dynamic correction derived from the scanning waveform. The mechanical inclination of the two outer guns in a three gun arrangement is set for the desired angles of arrival at the centre (undeflected) spot on the screen, but in practice it is difficult to do this with sufficient precision and so non-mechanical correction becomes necessary.

Numerous schemes have been proposed for effecting electric, magnetic or combined correction of the beam angles. Magnetic methods of correction consist generally of solenoids placed around the neck of the cathode ray tube just beyond the beam exit openings of the off axis guns with or without co-operating internal pole pieces. Because of the spread of magnetic fields it is necessary to shield the gun arranged on the tube axis from the effects of these fields by means of high permeability metal shields. Furthermore, deflection in two planes at right angles is necessary on both of the outer beams so that extra shielding is required to prevent interaction between these fields.

Electrical deflection can be accomplished by the provision within the tube of sets of deflection plates arranged adjacent the beam exit openings of the guns with separate high voltage leads for these plates sealed through the envelope.

It is an object of the present invention to provide an improved manner of operating a plural beam tube whereby the directional angle of one or more of said beams towards a target can be controlled in a simple manner.

A further object of the invention is to provide a plural beam cathode ray tube in which electrostatic and magnetic screening between the various gun structures is obtained in a simple manner.

According to the invention there is provided an electric circuit arrangement comprising a cathode ray tube having a plurality of adjacent electron gun structures, each gun structure comprising an electron emitting cathode, a modulating electrode and an apertured anode, said guns being mounted in said tube facing a target so as to produce a plurality of individual electron beams focused at said target, means for applying different voltages to a pair of adjacent gun anodes thereby to set up an asymmetric field therebetween thereby to cause the beam issuing from one of said guns on entering said field to be deflected whereby a control of the angle at which said beam arrives at said target is effected by controlling said asymmetric field in dependence on the voltages applied to said gun anodes.

Preferably the voltage applied to one of said adjacent anodes is derived so as to vary as a function of the variable energisation of deflecting means provided for scanning the beams over said target and the voltage of said other adjacent anode is maintained at a fixed level.

The electron gun structures may be arranged in a common plane, the varying voltage applied between the final anodes of a pair of adjacent structures causing the beam to be deflected in the plane containing the guns. To provide electrostatic and magnetic screening with constructions employing guns on opposite sides of a central gun, the final anode of the central gun may be arranged so that it extends beyond the ends of the final anodes of the other guns thereby shielding the beams issuing from guns arranged on opposite sides of the central gun.

In order that the invention may be clearly understood and readily carried into effect, an embodiment of same applied to a three gun cathode ray tube for the reception of television images in colour will now be described with reference to the accompanying drawings in which:

Figure 1 shows a cathode ray tube circuit according to the invention showing a three gun cathode ray tube, and

Figure 2 illustrates a detail of a modified construction of the cathode ray tube suitable for use in the circuit of Figure 1.

Referring to the drawing there is shown three independent electron gun structures mounted in the neck portion of a cathode ray tube envelope, said guns being mounted side-by-side so that their axes lie in a common plane. Each electron gun comprises an indirectly heated cathode **1**, a modulating electrode **2**, a first anode **3**, an annular shield member **4**, a second anode **5** of tubular form and a tubular third anode **6**.

The two outer gun structures are assembled so that their axes are inclined towards the axis of the centre gun and the guns are mounted in the envelope with the axis of the centre gun coincident with the axis of the tube and with the beam exit aperture of each of the anodes **6** arranged so as to face a luminescent screen arranged on the inner surface of the end wall **7** of the tube envelope. A suitable luminescent screen may be composed of different phosphor particles which will produce different coloured light when struck by electrons, the different phosphors being deposited on a support as repeating groups of stripes **8**, **9**, **10** arranged to occupy positions which are normal to the line scanning direction of the electron beams when the tube is operated.

The three guns are carefully positioned within the tube envelope so that the anode **6** of each of the structures is situated just inside the field free space created by an electrode **11** provided by means of a conducting coating of graphite or aluminium deposited on the inner wall of the envelope of the tube. This wall coating **11** is elec-

trically connected to the anode 6 of the centre gun structure by means of a spring member 12 and to a high positive potential via a terminal 13. The tube so far described is basically similar to that described in the specification of co-pending United States application Serial Number 561,827 to which reference may be made for further information regarding the manner of arranging the group of guns within the envelope. A notable difference between the present tube and that shown in the aforementioned specification is that only the anode 6 of the centre gun is internally connected to the wall anode 11 and the anodes 6 of the two outer guns have separate external connections. Suitable electro-magnetic coils are provided for simultaneously deflecting all of the electron beams in line and frame sequence over the phosphor screen but these coils which are well known in the art are not illustrated in order to simplify the drawing.

The angle of arrival at the screen of the beams from the outer guns will be determined in the tube so far described by the angle of inclination of these guns to the axis of the tube but as previously explained some correction of this angle is required and is usually obtained either by magnetic means or by providing auxiliary deflecting plates following the last anode of the gun structure.

The gun structures of the tube described above are provided with three anodes but gun structures having one, two or more than three anodes are also known and for this reason in the following description reference will be made to the final anode of the structure and by this it is intended to mean the last anode electrode of the electron gun structure itself even though this anode may be followed by one or more further anodes i.e. wall anodes and in this case the anode 6 of the tube above described, would be termed the final anode of the structure.

In accordance with the invention correction of the beam angle of an outer gun is obtained by applying a voltage difference to a pair of adjacent final anodes i.e. of the centre gun and the outer gun or guns, whereby an asymmetric electrostatic field is set up between these anodes at the ends thereof which face the screen. This asymmetric field will cause the electron beam of the outer gun to be deflected in the common plane containing said guns. The voltage difference between the final anodes of the guns only needs to be small e.g. differing by only a few percent to obtain the necessary deflection. It will be understood that the actual voltage applied will depend to a large extent on the parameters of the electrode structure, and the distance at which the guns are arranged from the target surface and therefore in the following description the voltages given are merely by way of example.

In Figure 1 of the drawings suitable circuit connections are shown whereby adjustment of the beam angle of the outer guns may be obtained by applying different voltages to the final anodes.

Referring again to Figure 1 the voltages are applied to one of the outer guns via a resistance 14 connected between the positive end of a source of high voltage and earth. Video signals are applied to the modulating electrode 2 via a condenser 15 and a standing bias for this electrode is obtained by tapping the resistance 14 at 16, the cathode 1 of the tube being connected to earth. The first anode 3 is connected to the +1000 volt tapping on resistance 14 and the terminal 13 of the wall anode 11 connected to the resistance 14 at a point whereby it will have a high voltage e.g. 6.8 kv. An electrostatic lens is set up between anodes 5 and 6 by applying thereto suitable voltages such as +1000 volts to anode 5 and 6.8 kv. to anode 6, the voltages being applied to these electrodes via suitable combining circuits illustrated in block form at 17 and 18 the purpose of which will be explained later. It will be seen that if it is assumed that the combining circuits 17 and 18 merely act as a terminal block connecting the anodes 5 and 6 to their source of voltage supply it will be possible to adjust the voltage which is applied to the anode 6 of the outer gun such that it is slightly greater or less than the voltage of the final anode of the centre gun. By this means an asymmetric field is set up between these two anodes which can be adjusted by the voltage difference so as to cause the electron beam issuing from the outer gun to be deflected in either direction in the common plane containing these guns and thereby control the positioning of the spot formed on the screen by this gun in relation to the spot produced thereon by the centre gun.

By this means correction of the beam angle can be obtained in the plane containing the three guns, but as the correction required will vary with the position of the spots as they are scanned over the fluorescent screen, the voltage applied to the final anode of the outer gun should also have applied thereto a dynamic correction signal voltage generated from the scanning circuits, i.e. the voltages applied to the final anodes of the outer guns may be derived so as to vary as a function of the variable energisation of the deflecting means employed for scanning the beams over the screen. Similarly, the focussing voltage, in the case of electrostatically focussed guns, should have a similar dynamic correction voltage applied thereto so that the beam spot formed by this gun remains in focus at all points of the screen.

Circuits for generating dynamic correction voltage signals for this purpose are well known and an example of such a circuit can be found on pages 634–639 of RCA Review No. 3, part 2, September 1951 and a dynamic signal generator of this form is illustrated in block form in the drawing of the present application at 19, the signals generated thereby being applied to each of the combining circuits 17 and 18. Combining circuits suitable for this purpose are given on page 637 of the afore-mentioned RCA Review.

The three guns are independent of each other in that they have applied thereto different modulating signals and it will be understood that the cathode of the centre gun will be connected to earth potential and that video signals and a suitable bias voltage will be applied to the modulating electrode 2 the first anode 3 being maintained at +1000 volts and the second anode 5 at +1000 volts.

The second of the two outer guns has applied thereto voltages derived from circuit connections which are substantially the same as those already described in respect of the first outer gun and for this reason the various components thereof have been given the same reference numerals but with the suffix *a*.

It will thus be seen that by adjusting the voltages applied to the final anodes of the outer guns with respect to the voltage of the centre gun with dynamic control voltage added to the voltages applied to the anodes of the outer guns control of the angle at which the respective beams of these guns arrive at the fluorescent screen can be manitained throughout the deflection of the beams over the fluorescent screen.

In the arrangement just described the beam exit openings of the three electron guns are arranged at substantially the same axial position in the tube neck. However, in order to ensure that the asymmetric fields set up will only affect a particular beam it is preferable to extend the tube of the final anode of the centre gun a small distance further into the field free space of the wall anode so that the anode tube itself acts as a shield. Such an extension of the anode 6 is indicated in the detail shown in Figure 2 at 20. It will be understood that in all other respects the construction of the remainder of the cathode ray tube of Figure 2 and the manner in which it is connected in circuit will be the same as previously described with reference to Figure 1.

Correction of the beam angles in the plane at right angles to the common plane of the guns can be obtained by employing either of the well known schemes for magnetic or electrostatic deflection.

With the plural beam tube illustrated in Figure 2 in which the centre gun is mounted nearer the luminescent screen that the two outer guns magnetic beam angle correction in a plane at right angles to the common plane of the guns may be applied, without the need for providing any extra means for magnetically shielding the respective beams for each other.

Although the invention has been described with reference to a television receiver tube for reconstituting a picture in colour it is in no way limited to such and can be applied to other forms of tubes having a plurality of electron beams which need to be accurately positioned when caused to impinge on a target electrode.

What we claim is:

1. An electric circuit arrangement comprising a cathode ray tube having a plurality of adjacent electron gun structures, each gun structure comprising an electron emitting cathode, a modulating electrode and an apertured anode, said guns being mounted in said tube facing a target so as to produce a plurality of individual electron beams focused at said target, means for applying a fixed voltage to one of said gun anodes and means for applying a different voltage to a gun anode next adjacent thereto said different voltage being derived so as to vary as a function of the variable energisation of deflecting means provided for scanning the beams over said target, thereby to set up an asymmetric field between said anodes thereby to cause the beam issuing from said different voltage anode on entering said field to be deflected so as to provide a variable control of the angle at which said beam arrives at target.

2. An electric circuit arrangement according to claim 1 wherein said gun anodes are of tubular form with the beam exit portions of two of said anodes axially displaced so that the beam issuing from said anode which is nearer said target is screened by virtue of its displacement from said asymmetric field.

3. An electric circuit arrangement comprising a cathode ray tube having three electron gun structures mounted side by side with their axes in a common plane and with the axes of said outer guns tilted towards the axis of said centre gun, said electron gun structures each comprising an electron emitting cathode, a modulating electrode and an anode, said guns being disposed in said tube so as to produce a plurality of individual electron beams focused at a target, means for applying a fixed voltage to the anode of said centre gun and means for applying a voltage different from said first mentioned voltage to the anode of each of said outer guns so as to set up asymmetric fields between the anode of said centre gun and each of the anodes of said outer guns such as to cause the electron beams issuing from said outer guns in entering said asymmetric fields to be deflected whereby the angle at which the beams from said two outer guns arrives at said target is effected by controlling said asymmetric fields in dependence on the voltages applied to said two outer gun anodes.

4. An electric circuit arrangement according to claim 3 wherein said gun anodes are of tubular form with the beam exit portions of said centre gun axially displaced towards said target from the beam exit portions of said anodes of said two outer guns whereby the beam issuing from said centre gun is screened from said asymmetric fields.

5. An electric circuit arrangement according to claim 3 wherein a further anode is provided between said guns and said target and common to all said guns and said centre gun anode is connected so as to be electrically at the same potential as said further anode.

6. An electric circuit arrangement according to claim 3 wherein said different voltage applied to said two outer gun anodes is derived so as to vary as a function of the variable energisation of the deflecting means provided for scanning the beams from said guns over said target.

7. An electric circuit arrangement comprising a cathode ray tube having a wall anode extending towards a target and first and second electron gun structures for producing individual beams of electrons focused at said target each of said guns having a final apertured anode, means mounting said guns in said tube with the final anodes thereof adjacent each other and surrounded by said wall anode, the final anode of said first gun being electrically connected to said wall anode, means for applying an accelerating voltage to the final anode of said first gun and said wall anode and means for applying a different accelerating voltage to the final anode of said second gun structure thereby to set up an asymmetric electrostatic field between the final anodes of said first and second guns and between the final anode of said second gun and said wall anode to cause the beam issuing from said second gun to be deflected in dependence on the difference of potential between said final anodes.

8. An electric circuit arrangement according to claim 7 wherein the final anodes of said first and second gun structures are of tubular form.

9. An electric circuit arrangement according to claim 7 wherein the cathodes of said first and second guns are connected so as to be held at substantially the same D.C. potential to cause the individual beams to reach said target with substantially the same velocity.

10. An electric circuit arrangement comprising a cathode ray tube having a wall anode extending towards a target and first and second electron gun structures for producing individual beams of electrons focused at said target, each of said guns having a final anode of tubular form at the beam exit portion thereof, means mounting said guns in said tube with the beam exit portions of said final anodes surrounded by said wall anode and axially displaced so that the beam exit portion of the final anode of said first gun lies nearest to said target, said first gun final anode being electrically connected to said wall anode, means for applying an accelerating voltage to the final anode of said first gun and said wall anode and means for applying a different accelerating voltage to the final anode of said second gun structure thereby to set up an asymmetric electrostatic field between the final anode of said first and second guns and between the final anode of said second gun and said wall anode to cause the beam issuing from said second gun to be deflected in dependence on the difference of potential between said final anodes, the beam issuing from said first gun being substantially unaffected by said field by virtue of the position of its beam exit portion with respect to said field.

11. An electric circuit arrangement according to claim 10 wherein the cathodes of said first and second guns are connected so as to be held at substantially the same D.C. potential to cause the individual beams to reach said target with substantially the same velocity.

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