Aug. 12, 1947. G. LIEBMANN 2,425,682

CATHODE RAY TUBE WITH SHIELDED DEFLECTING PLATES

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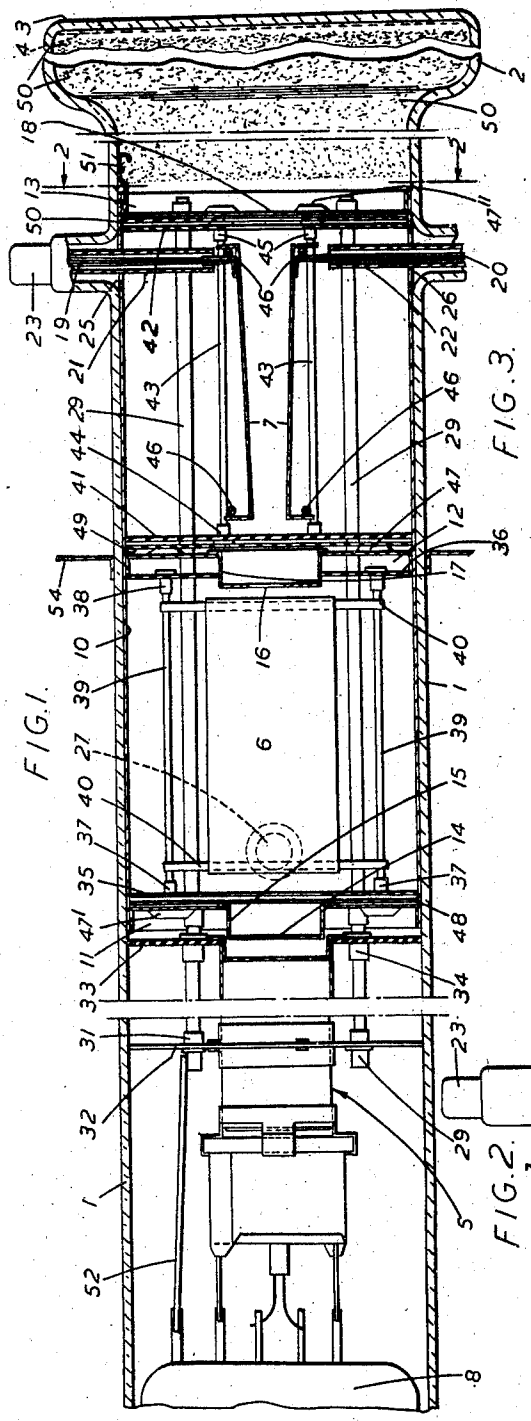

FIG. 1.

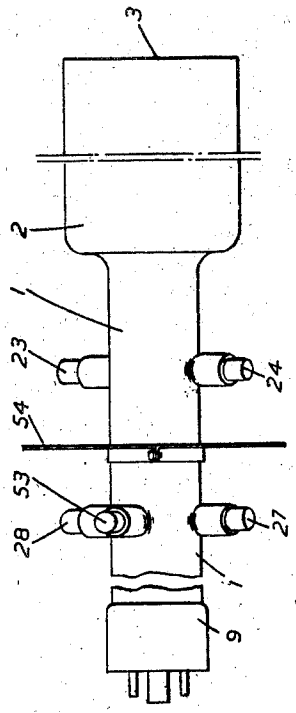

FIG. 3.

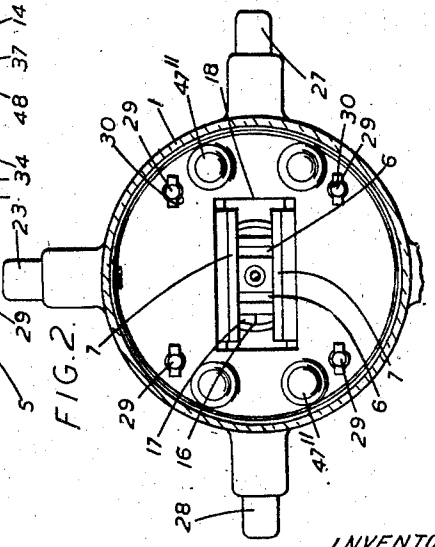

FIG. 2.

INVENTOR.
G. LIEBMANN.
BY
Emery, Booth, Holcombe & Thain
ATTORNEYS

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CATHODE-RAY TUBE WITH SHIELDED DEFLECTING PLATES

Gerhard Liebmann, Cambridge, England, assignor to Cathodeon Limited, Cambridge, England, a British company

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17 Claims. (Cl. 250—158)

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The invention relates to cathode ray tubes, and more particularly to cathode ray oscillograph tubes. In this kind of cathode ray tube an electron beam is formed which throws a small spot on to a suitable screen, which may be a fluorescent screen or a photographic plate or any other means to register or record the position, or the position and intensity, of the electron spot. The beam forming this spot is deflected by deflecting plates on which suitable potentials are impressed. Usually two sets of deflecting plates are employed, and in many applications of this kind of tube the potential to be investigated is brought to one set of plates and an alternating potential of a suitable and known wave form is applied to the other set of deflecting plates.

If the alternating potentials applied to one or both sets of deflecting plates are of a fairly high frequency, of the order of a megacycle/sec. or more, a serious interaction of the two deflecting potentials becomes apparent owing to the capacitative coupling between the two sets of deflecting plates. An object of the present invention is to eliminate this fault.

In a cathode ray tube, and particularly a cathode ray oscillograph tube, according to the present invention two or more sets of deflecting plates are entirely enclosed in a shielding metal cylinder of circular or other suitable cross-section which is adapted to be grounded when the tube is in use, this cylinder being partitioned by metal screening into compartments entirely shielded from each other, each compartment containing one set of deflecting plates. Openings of suitable shape and size have, of course, to be provided in the partitioning screens to let the electron beam pass through, taking into account the diameter of the beam and any deflection it may have suffered before passing through the opening. Further openings are provided in the mantle of the shielding cylinder to allow lead-in wires to the deflecting plates to pass through. These lead-in wires are sealed through the wall of the glass envelope near the position of the respective deflecting plates.

Preferably, the diameter of the shielding cylinder is only slightly smaller than the internal diameter of the glass envelope. The envelope is surrounded near the sealing through position of the deflecting plate leads by a metallic screen adapted to be grounded, which, preferably, has a screening flange extending perpendicularly to the axis of the tube and interposed between the leads from each set of deflecting plates. The bottom end of the internal shielding cylinder, facing the cathode end of the cathode ray tube, is constituted by a metal disc or metal cup, or a combination of both, and may be shaped and arranged in such a way that it forms the final accelerating anode of the cathode ray tube "gun" structure, and thus co-operates with the other electrodes in the formation of the electron beam. The internal shielding of the cathode ray tube is completed in a known way by a metal or graphite or other conductive coating on the inner wall of the tube envelope connected to the final anode. This conductive coating may extend from the bottom end of the internal shielding cylinder to the registering or recording screen.

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The described internal shielding cylinder may be used at the same time as a means for lining up correctly the various sets of deflecting plates, by assembling the sets of deflecting plates, conveniently with the help of jigs, on suitable insulating annular discs, for instance mica discs, which are such as to engage the internal wall of the shielding cylinder when the assembly is placed therein, thereby correctly locating the sets of deflecting plates.

In order that the invention may be more clearly understood, reference will now be made, by way way of example, to the accompanying drawings, in which

Fig. 1 shows a section through a cathode ray oscillograph tube embodying one form of the invention.

Fig. 2 shows a view looking along the line 2—2 in Fig. 1.

Fig. 3 is an external view of slightly modified tube.

Referring to the drawings, 1 represents the neck portion of the envelope of the cathode ray tube which encloses the cathode ray gun and deflecting plates and 2 the bulb portion of the tube, the front wall 3 of which is coated with fluorescent material 4 to form the viewing screen. The neck portion 1 accommodates the cathode ray gun structure 5 and two pairs of deflecting plates 6 and 7 for deflecting the beam in the X and Y directions. The construction of the cathode ray gun structure forms no part of the present invention and may be constructed in any suitable manner, for example as described in the specifications of British Patents Nos. 503,074, 503,125, 503,126, 519,111 and 528,979, the leads to the gun structure passing out through the stem 8 at the end of the neck portion of the tube which is fitted with the cap 9 carrying contact pins in known manner.

According to the present invention, the two

sets of deflecting plates 6 and 7 are shielded from one another by being enclosed in the shielding metal cylinder 10 which is provided with transverse metal screening partitions 11, 12 and 13 thereby producing two screened compartments within which two pairs of deflecting plates 6 and 7 are respectively located. Openings of suitable shape and size are provided in the partitioning screens 11, 12 and 13 to allow the electron beam from the cathode gun to pass through. The apertures in the partitioning screens increase progressively in size from the screen 11 to the screen 13 to allow for the increased transverse deflection of the beam as it approaches the fluorescent screen. Thus, the aperture at the centre of the screen 11 may comprise a small circular hole 14 since there is no deflection of the beam at this point, and conveniently this hole may be formed in the cup-shaped metallic member 15 which is welded to a larger aperture in the centre of the screen 11 as shown in Fig. 1, which member 15 constitutes the final accelerating anode.

The aperture 16 in the screen 12 may likewise be formed in a cup-shaped member 17 welded in a larger aperture in the centre of the screen 12, the aperture 16 having a width in the direction perpendicular to the plane of the drawing which is slightly greater than the distance between the ends of the pair of deflecting plates 6 which lie adjacent to the aperture 16 so as to allow for the maximum deflection of the beam effected by this pair of plates. The width of the aperture in the direction of the plane of the drawing may be smaller since the deflecting plates 6 do not deflect the beam in this plane, this dimension being preferably slightly smaller than the distance between the ends of the pair of deflecting plates 7 which are adjacent to this aperture. The aperture 18 in the screen 13 is made larger still, being of a size in the direction of the plane of the drawing slightly larger than the distance between the ends of the pair of deflecting plates 7 which are adjacent the screen 13 and in the direction perpendicular to the plane of the drawing of still larger size to allow for the deflection which the beam may have suffered by the action of the plates 6. Fig. 2 shows the arrangement of the apertures in the screens.

The outer peripheries of the screens 11, 12 and 13 are provided with flanges so that they may be welded to the cylindrical shielding metal cylinder 10 within which they are arranged in closely fitting contact. The leads from the pairs of deflecting plates, shown at 19 and 20 in the case of the plates 7, pass through insulating sleeves 21 and 22 to the external contacts 23, 24, apertures 25, 26 being provided in the metal shielding cylinder 10 to allow the leads and insulating sleeves to pass therethrough. The leads (not shown) from the deflecting plates 6 are similarly connected through insulating sleeves and appropriately positioned apertures in the shielding cylinder 10 to their corresponding external contacts 27, 28.

Also passing through the screening assembly are four main stay-wires 29 which are welded to portions of the screens 11, 12 and 13 struck up from apertures 30 therein through which the wires pass. These wires terminate at the screen 13 but extend beyond the screen 11, their ends being welded to eyelets 31 secured in apertures in a mica disc 32 which supports one end of the cathode ray gun structure. The other end

of the cathode gun structure is similarly supported by a mica disc 33 having apertures therein corresponding to the positions of the main stay wires 29, which apertures are fitted with eyelets 34 which are also welded to the stay wires. In this way, the cathode gun structure may be easily assembled in correct alignment with the apertures in the screens 11, 12 and 13.

The deflecting plates 6 and 7 are also supported by and located relative to the main stay wires 29 by being insulatingly supported therefrom by means of mica discs at opposite ends of each compartment, the mica discs having apertures which fit closely to the main stay wires and between which are supported further wires which carry the deflecting plates. In the case of the deflecting plates 6, mica discs 35, 36 are arranged at opposite ends of the compartment enclosing these deflecting plates which discs have apertures through which the stay wires 29 pass and prevent rotation of the discs relative to the stay wires. Mounted between and welded to the eyelets 37, 38 secured in the discs 35 and 36 respectively are two pairs of stout wires 39, each pair of which are bridged by a further pair of stout wires 40 to each of which are attached opposite ends of one of the deflecting plates 6.

Similarly, in the case of the deflecting plates 7, these are supported by two mica discs 41, 42 arranged at opposite ends of the compartment enclosing the plates 7 and apertured to fit the stay wires 29, the plates 7 being supported by two pairs of longitudinal stout wires 43 welded to eyelets 44, 45 secured respectively to the mica discs 41 and 42, each pair of longitudinal wires 43 being bridged by a pair of transverse wires 46 to which opposite ends of the deflecting plates 7 are welded.

It will be appreciated that, with the method of construction described, the cathode gun, the apertures in the partitioning screens and the deflecting plates are all located relative to the main stay wires 29 and can be easily assembled outside the tube envelope in correct alignment and spacial relationship.

In order to ensure insulation between the ends of the eyelets 37, 38, 44 and 45 and the adjacent portions of the partitioning screens 11, 12 and 13, the screens may be formed with recesses 47 opposite the ends of the eyelets so as to provide additional clearance between the eyelets and the screens. Such a recess is shown at 47 in screen 12. Similar recesses may be provided as shown at 47' and 47'' in the case of screens 11 and 13 but as an alternative or additional measure, the drawing shows a further mica disc 48 disposed between the screen 11 and the ends of the eyelets 37 to ensure this insulation. This mica disc has no apertures which will allow the eyelets 37 to contact the screen 11. The drawing shows similar insulating mica discs at 49 and 50 for respectively insulating the ends of the eyelets 44 and 45 from the screens 12 and 13. All these additional insulating mica discs are perforated to register with the main stay wires 29.

The metal shielding cylinder 10 preferably closely fits the internal surface of the neck portion 1 of the tube envelope so that it serves accurately to locate the entire assembly within the neck portion of the tube. The remaining part of the tube between the neck and extending almost up to the fluorescent screen may be screened in known manner by coating the internal surface thereof with graphite 50 which may be electrically connected to the screening assembly 10,

11, 12 and 13 by means of the contact spring 51.

The lead 52 to the final anode and the screening assembly may be taken out through the stem of the tube.

Figs. 1 and 2 show an arrangement in which the two pairs of deflecting plates are respectively connected to external contacts arranged at right angles to each other. Fig. 3 shows a slightly modified arrangement in which the external contacts to both sets of plates are brought out in the same plane. This facilitates mounting the tube on the chassis on which the circuit components are assembled and permits shorter leads from the output valves connected to the deflecting plate leads. Fig. 3 also shows an additional external contact 53 which provides an additional short connection to the shielding cylinder 10 to provide an effective earth connection to the internal shielding arrangement. A lead to the shielding arrangement, which also constitutes the final anode, is also brought out through the tube stem as shown in Fig. 1 in order to facilitate wiring connection of the static tube circuits.

Owing to its high deflection sensitivity the tube should be carefully shielded by earthed mu-metal shields. The screening between the two deflecting plate systems can be further increased by providing a well fitting earthed external screen 54 between the leads to the two sets of deflecting plates.

An alternative method of assembly which has been found useful in many cases is to form the sets of deflecting plates into "packets," each "packet" being constituted by a pair of deflecting plates with flexible lead wires attached to them, and mounted on a pair of suitably shaped mica discs, the planes of which extend perpendicularly to the axis of the tube. One of the shielding partitions may be fixed to one of the mica discs. The "packets" may then be combined into a single "long packet" by joining the individual packets together, for instance by eyeleting the top mica disc of one packet to the shielding partition fixed to the bottom mica disc of the succeeding "packet." The complete "long packet," having the deflecting plates and shielding partitions in their proper relative positions, is then inserted into the shielding cylinder, care being taken to thread the flexible plate leads through the appropriate holes in the mantle of the shielding cylinder, and is finally secured by welding the bottom shield, forming the final anode, to the shielding cylinder, the internal partitions making contact with the shielding cylinder. The complete assembly is then fixed to the other parts of the electron gun structure by means of insulated wires, clamps or beads in a known way.

The described methods of assembly, which form part of the invention, combine the advantages of the low capacity of deflecting plates having leads sealed through the sides of the glass envelope with a precise jig assembly, which was hitherto only possible if the entire electrode structure were mounted on a common stem.

I claim:

1. In a cathode ray tube, an electrostatically shielded beam deflecting structure comprising a plurality of deflecting plate units assembled in end to end relation, each unit including spaced insulating supports disposed transversely of the unit at opposite ends thereof, a pair of deflecting plates extending longitudinally of the unit between said supports, and means for supporting said plates from said supports, a metallic shielding tube embracing said assembly to enclose said units therewithin, and transverse metallic shielding means partitioning said tube into compartments each containing one of said units, whereby the pairs of deflecting plates of said units are electrostatically shielded from each other, said partitioning screening means and said supports having aligned apertures therein to permit an electron beam to pass therethrough.

2. In a cathode ray tube, an electrostatically shielded beam deflecting structure comprising a plurality of deflecting plate units assembled in end to end relation, each unit including spaced insulating supports disposed transversely of the unit at opposite ends thereof, a pair of deflecting plates extending longitudinally of the unit between said supports, and means for supporting said plates from said supports, a metallic shielding tube embracing said assembly to enclose said units therewithin, and a plurality of transverse metallic screens including a screen between each of said units and a screen at each end of said assembly to partition said tube into metallic walled compartments each containing one of said units, whereby the pairs of deflecting plates comprised in said units are electrostatically shielded from one another, said partitioning screens and said supports having aligned apertures therein to allow an electron beam to pass therethrough.

3. A cathode ray tube comprising a vessel having an electron responsive surface at one end thereof, an electron gun structure at the other end thereof for projecting a beam of electrons towards said surface, and a beam deflecting structure between said gun structure and said surface, said beam deflecting structure comprising a plurality of deflecting plate units assembled in end to end relation, each unit including spaced insulating supports disposed transversely of the unit at opposite ends thereof, a pair of deflecting plates extending longitudinally of the unit between said supports, and means for supporting said plates from said supports, a metallic shielding tube embracing said assembly to enclose said units therewithin, and a plurality of transverse metallic screens including a screen between each of said units and a screen at the end of said assembly which faces said gun structure to partition said tube into metallic walled compartments each containing one of said units, whereby the pairs of deflecting plates comprised in said units are electrostatically shielded from one another, said partitioning screens and said supports having aligned apertures therein to allow an electron beam produced by said gun structure to pass therethrough, and said partitioning screen at the end of said assembly which faces said gun structure constituting a final accelerating anode of said gun structure.

4. A cathode ray tube comprising a vessel having a neck portion connected to a bulb portion, an electron responsive surface in said bulb portion, an electron gun structure in said neck portion for projecting a beam of electrons towards said surface, and a beam deflecting structure disposed longitudinally in said neck portion between said gun structure and said surface, said beam deflecting structure comprising a plurality of deflecting plate units assembled in end to end relation longitudinally in said neck portions, each unit including spaced insulating supports disposed transversely of the unit at opposite ends thereof, a pair of deflecting plates extending longitudinally of the unit between said supports, and means for supporting said plates from said supports, a metallic shielding tube embracing said

assembly to enclose said units therewithin, and transverse metallic shielding means partitioning said tube into compartments each containing one of said units, whereby the pairs of deflecting plates comprised in said units are electrostatically shielded from one another, said partitioning screening means and said supports having aligned apertures therein to permit an electron beam produced by said gun structure to pass therethrough, and said shielding tube engaging the wall of said neck portion to thereby locate said beam deflecting structure in said neck portion.

5. A unitary beam-deflecting electrode structure for a cathode ray tube, comprising a plurality of structurally independent deflecting plate units each of which includes a pair of deflecting plates mounted between and supported from a pair of insulating plates disposed transversely at opposite ends of the unit, said units being assembled end to end alternately with transversely disposed metallic screening plates, means fixing said units and screening plates in assembled relation, and a tubular metallic shield fitted on said assembly and affixed thereto, said shield enclosing said units therewithin and said screening plates peripherally engaging said shield to partition said shield into compartments each containing one of said units, whereby to shield the pairs of deflecting plates comprised in said units from one another, said screening plates and said insulating plates having aligned apertures therein to permit an electron beam to pass therethrough.

6. A unitary beam-deflecting electrode structure for a cathode ray tube, comprising a plurality of structurally independent deflecting plate units each of which includes a pair of deflecting plates mounted between and supported from a pair of insulating plates disposed transversely at opposite ends of the unit, said units being assembled end to end alternately with transversely disposed metallic screening plates, a plurality of stay wires extending through said insulating plates and said screening plates to support said units and screening plates in aligned assembly, means fixing said assembly to said stay wires, and a tubular metallic shield fitted on said assembly and affixed thereto, said shield enclosing said units therewithin and said screening plates peripherally engaging said shield to partition said shield into compartments each containing one of said units, whereby to shield the pairs of deflecting plates comprised in said units from one another, said screening plates and said insulating plates having aligned apertures therein to permit an electron beam to pass therethrough.

7. A unitary electrode structure as defined in claim 6, wherein said screening plates are conductively fixed to said stay wires and said tubular shield is conductively fixed to said screening plates.

8. A unitary beam-deflecting electrode structure for a cathode ray tube, comprising a plurality of structurally independent deflecting plate units each of which includes a pair of deflecting plates mounted between and supported from a pair of insulating plates disposed transversely at opposite ends of the unit, said units being assembled end to end alternately with transversely disposed metallic screening plates including a plate at each end of the assembly, a plurality of parallel spaced stay wires extending through said insulating plates and said screening plates to support said units and screening plates in aligned assembly, said screening plates being conductively fixed to said stay wires, and a tubular metallic shield extending the full length of said assembly being fitted therearound in engagement with the peripheries of said screening plates and conductively fixed thereto, whereby said screening plates partition said shield into shielded compartments containing said units individually, said screening plates and said insulating plates having aligned apertures therein to allow an electron beam to pass therethrough.

9. A unitary electrode assembly for a cathode ray tube, comprising an electron gun structure for producing a beam of electrons, and a unitary beam-deflecting structure comprising a plurality of structurally independent deflecting plate units each of which includes a pair of deflecting plates mounted between and supported from a pair of insulating plates disposed transversely at opposite ends of the unit, said units being assembled end to end alternately with transversely disposed metallic screening plates, a plurality of stay wires extending through said insulating plates and said screening plates to support said units and screening plates in aligned assembly, means fixing said assembly to said stay wires, and a tubular metallic shield fitted on said assembly and affixed thereto, said shield enclosing said units therewithin and said screening plates peripherally engaging said shield to partition said shield into compartments each containing one of said units, whereby to shield the pairs of deflecting plates comprised in said units from one another, said screening plates and said insulating plates having aligned apertures therein to permit an electron beam to pass therethrough, said stay wires having extensions projecting from the end of the beam deflecting structure which faces said gun structure, and means supporting said gun structure from said extensions in alignment with said apertures in said screening plates and insulating plates.

10. A unitary electrode assembly as defined in claim 9, wherein said electron gun structure includes a pair of axially spaced insulating support plates through which said stay wire extensions pass to support said gun structure therefrom, said support plates being fixed to said extensions.

11. A unitary electrode assembly for a cathode ray tube, comprising an electron gun structure including a pair of axially spaced insulating support discs disposed perpendicular to the axis of said structure; a plurality of beam deflecting units each comprising a pair of axially spaced insulating support discs at opposite ends of the unit, support members extending between and fixed to said discs to hold said discs in spaced relation, and a pair of deflecting plates disposed between said discs and supported by said support members in insulated relation to each other; a plurality of peripherally flanged metallic shielding discs; said gun structure, units, and shielding discs being assembled in axially aligned relation with said gun structure and said units disposed end to end in succession and said shielding discs disposed one at each end of the succession of units and between the end insulating support discs of adjacent units, said shielding discs and said support discs of both said gun structure and said units all having locating holes similarly positioned therein, a plurality of stay wires extending parallel through said locating holes in said shielding and support discs to thereby support the assembly in axially aligned relation, means fixing said support discs of said gun structure to said stay wires, means conductively fixing said shielding discs to said stay wires, and a metallic shield-

ing cylinder fitted on said assembly and extending the full length of said succession of units, said cylinder engaging the peripheral flanges of said shielding discs and being conductively fixed thereto, whereby said shielding discs partition said cylinder into shielded compartments containing said units individually, said shielding discs and said support discs of said units having apertures therein in alignment with said gun structure to permit an electron beam produced by said gun to pass therethrough, said cylinder having apertures therein opposite the respective compartments thereof, and lead-in conductors extending through said apertures and connected to the pairs of deflecting plates in the respective compartments.

12. A cathode ray tube comprising an envelope enclosing an electrode assembly mounted therein, said assembly including a beam deflecting structure comprising a plurality of deflecting plate units assembled in end to end relation, each unit including spaced insulating supports disposed transversely of the unit at opposite ends thereof, a pair of deflecting plates extending longitudinally of the unit between said supports, and means for supporting said plates from said supports, a metallic shielding tube embracing said assembly to enclose said units therewithin, and transverse metallic shielding means partitioning said tube into compartments each containing one of said units, whereby the pairs of deflecting plates of said units are electrostatically shielded from each other, said partitioning screening means and said supports having aligned apertures therein to permit an electron beam to pass therethrough, said shielding tube having apertures in the wall thereof opposite the respective compartments thereof, and lead-in conductors connected to the pairs of deflecting plates in the respective compartments extending respectively through said apertures in said tube and being sealed through said envelope at points adjacent the respective positions of said apertures.

13. A cathode ray tube as defined in claim 12, and further comprising external metallic shielding means around said envelope and extending between the lead-in conductors of the respective pairs of deflecting plates.

14. A cathode ray tube as defined in claim 12, wherein said units include at least two pairs of deflecting plates adapted for beam deflection in different planes, and the lead-in conductors connected to the plates of said repairs are sealed through said envelope at points in substantially the same plane.

15. A cathode ray tube comprising a vessel containing an electrode assembly including an electron gun for producing a beam of electrons, and a beam deflecting structure mounted in alignment with said gun, said deflecting structure comprising a plurality of structurally independent deflecting plate units each of which includes a pair of deflecting plates mounted between and supported from a pair of insulating plates disposed transversely at opposite ends of the unit, said units being assembled end to end alternately with transversely disposed metallic screening plates including a plate at each end of the assembly, a plurality of parallel spaced stay wires extending through said insulating plates and said screening plates to support said units and screening plates in aligned assembly, said screening plates being conductively fixed to said stay wires, and a tubular metallic shield extending the full length of said assembly being fitted therearound in engagement with the peripheries of said screening plates and conductively fixed thereto, whereby said screening plates partition said shield into shielded compartments containing said units individually, said screening plates and said insulating plates having apertures therein in alignment with said gun to allow an electron beam produced by said gun to pass therethrough, and the said one of said screening plates at the end of said unit assembly which faces said gun constituting a fixed anode of said gun.

16. A cathode ray tube comprising a vessel having an electron responsive surface at one end thereof, an electron gun at the other end thereof for projecting a beam of electrons towards said surface, and a beam deflecting structure between said gun and said surface mounted in alignment with said gun, said deflecting structure comprising a plurality of structurally independent deflecting plate units each of which includes a pair of deflecting plates mounted between and supported from a pair of insulating plates disposed transversely at opposite ends of the unit, said units being assembled end to end alternately with transversely disposed metallic screening plates including a plate at each end of the assembly, a plurality of parallel spaced stay wires extending through said insulating plates and said screening plates to support said units and screening plates in aligned assembly, said screening plates being conductively fixed to said stay wires, and a tubular metallic shield extending the full length of said assembly being fitted therearound in engagement with the peripheries of said screening plates and conductively fixed thereto, whereby said screening plates partition said shield into shielded compartments containing said units individually, said screening plates and said insulating plates having apertures therein in alignment with said gun to allow an electron beam produced by said gun to pass therethrough, the said one of said screening plates at the end of said unit assembly which faces said gun constituting a final anode of said gun, an internal conductive coating on said vessel extending from a point adjacent said tubular shield to a point adjacent said electron responsive surface, and means carried by said deflecting structure electrically connecting said coating to said shield.

17. A cathode ray tube comprising an enclosing vessel containing an electrode assembly including an electron gun for producing a beam of electrons, and a beam deflecting structure mounted in alignment with said gun, said vessel terminating at one end in a base carrying terminal contacts for establishing electrical connection to electrodes of said assembly, said deflecting structure comprising a plurality of structurally independent deflecting plate units each of which includes a pair of deflecting plates mounted between and supported from a pair of insulating plates disposed transversely at opposite ends of the unit, said units being assembled end to end alternately with transversely disposed metallic screening plates including a plate at each end of the assembly, a plurality of parallel spaced stay wires extending through said insulating plates and said screening plates to support said units and screening plates in aligned assembly, said screening plates being conductively fixed to said stay wires, and a tubular metallic shield extending the full length of said assembly being fitted therearound in engagement with the pe-

ripheries of said screening plates and conductively fixed thereto, whereby said screening plates partition said shield into shielded compartments containing said units individually, said screening plates and said insulating plates having apertures therein in alignment with said gun to allow an electron beam produced by said gun to pass therethrough, means electrically connecting said shield to a contact at said base, and a conductor fixed to said shield and sealed through said vessel at a point adjacent said shield to provide a short-path electrical connection to said shield.

GERHARD LIEBMANN.

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