June 17, 1941. S. O. EKSTRAND 2,245,581

ELECTRON DISCHARGE DEVICE

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FIG. 1

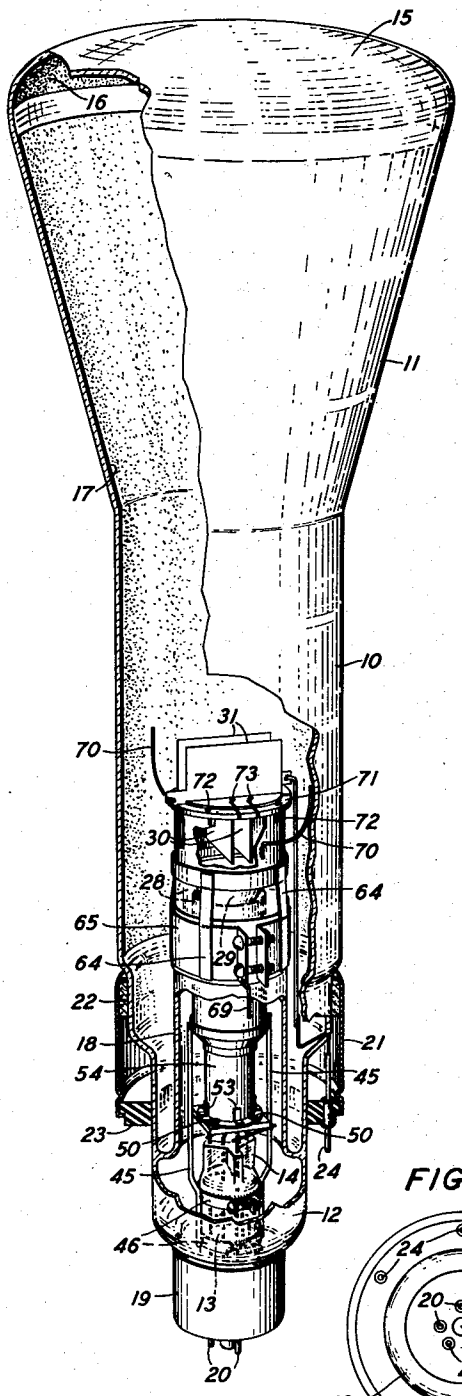


FIG. 3

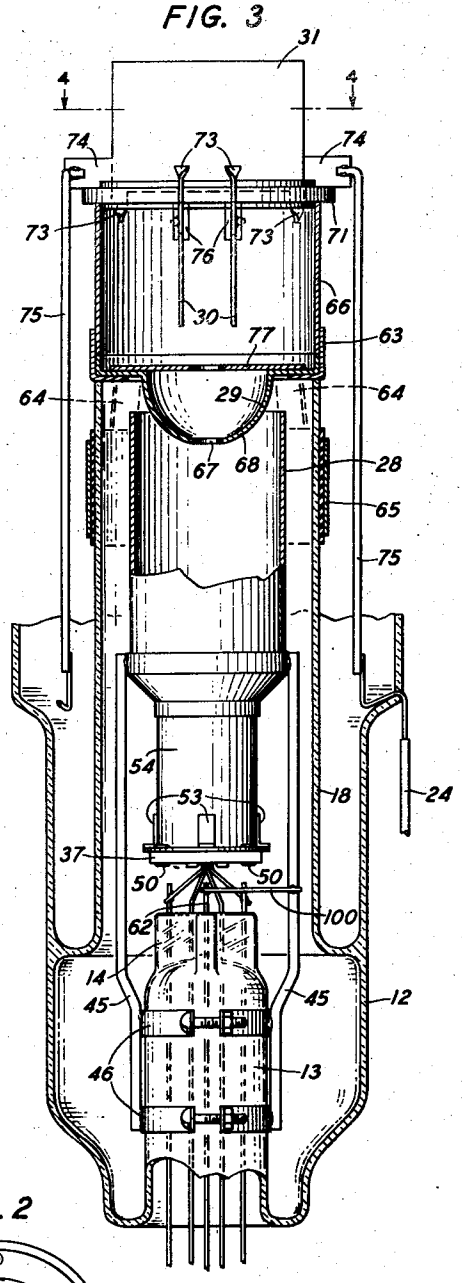
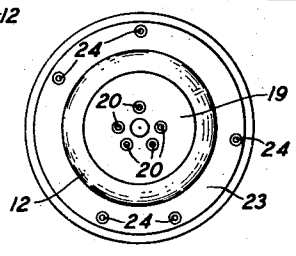


FIG. 2



INVENTOR
S. O. EKSTRAND
BY
Walter C. Kiesel
ATTORNEY

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FIG. 4

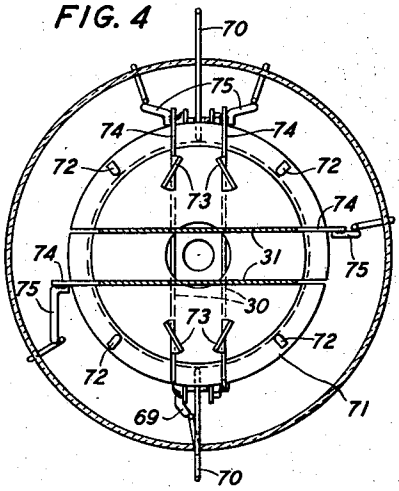


FIG. 5

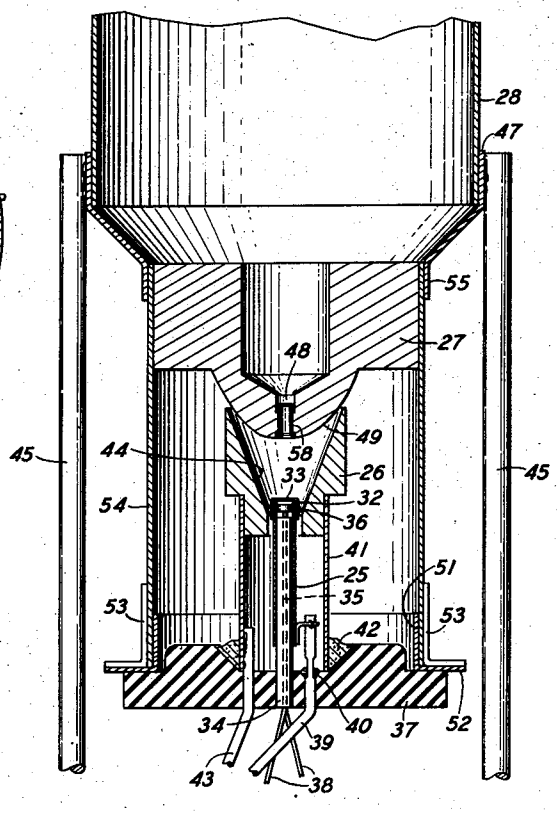


FIG. 7

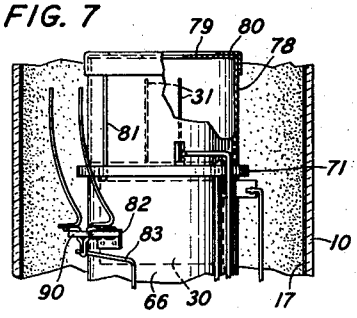


FIG. 8

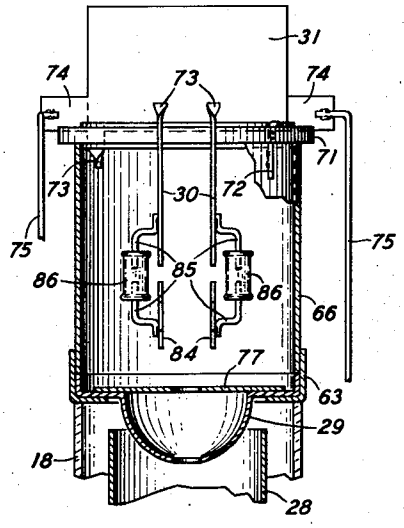
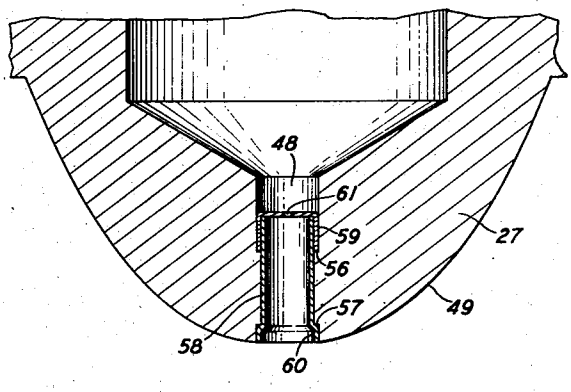


FIG. 6



INVENTOR
S. O. EKSTRAND
BY
Walter C. Kiesel
ATTORNEY

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UNITED STATES PATENT OFFICE

2,245,581

ELECTRON DISCHARGE DEVICE

Sture O. Ekstrand, Ridgefield Park, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application December 2, 1939, Serial No. 307,231

8 Claims. (Cl. 250—162)

This invention relates to electron discharge devices and more particularly to cathode ray devices of the type disclosed in the application Serial No. 387,232, filed December 2, 1939, of Myron S. Glass.

Cathode ray devices, such as shown in the above-identified application of Myron S. Glass, comprise in general an electron source, such as a cathode, an electron receiving element, such as a fluorescent screen, spaced from the electron source, and an electrode system for concentrating the electrons emanating from the source into a thin beam or pencil, for focussing the beam or pencil upon the screen and for deflecting the beam whereby it traces a pattern upon the electron receiving element.

As pointed out in the Glass application, the desired concentrating and focussing of the electron beam may be achieved by a multielectrode collimating system and a multielectrode focussing system, the various electrodes being of predetermined configuration and axially symmetrical whereby axially symmetrical fields of particular contour and strength are produced.

The number of electrodes involved entails mechanical difficulties from the standpoint of construction and, furthermore, the complexity of the electrode system renders difficult the attainment of accurate coaxiality of the electrodes which is requisite for the production of axially symmetrical fields.

One general object of this invention is to simplify the assembly of multielectrode systems for cathode ray devices.

Another object of this invention is to expedite the mounting of the electrodes of such systems in cathode ray devices.

A further object of this invention is to facilitate the accurate coaxial alignment of a plurality of electrodes in a collimating and focussing system for cathode ray devices.

Still another object of this invention is to shield effectively the deflector plates in cathode ray devices from extraneous fields.

In one illustrative embodiment of this invention, a cathode ray device comprises an enclosing vessel having a stem at one end and a fluorescent screen at the other end, and provided with a cylindrical column or standard extending from adjacent the stem and coaxial therewith. A cathode is mounted adjacent the stem and a collimating system and a focussing system are disposed between the cathode and the screen, each of these systems including a pair of axially symmetrical electrodes. A plurality of deflector plates are located between the focussing system and the screen.

In accordance with one feature of this invention, the entire electrode system is fabricated in two unitary assemblies one of which is supported from the stem and the other of which is supported by the column or standard.

In accordance with another feature of this invention, the assembly supported from the stem comprises collimating and modulating electrodes and one of the electrodes of the focussing system, and means are provided for automatically locating these electrodes in accurate coaxial relation during fabrication of the assembly.

In accordance with a further feature of this invention, the other unitary assembly comprises pairs of deflector plates and a plurality of shields each enclosing a pair of the deflector plates.

The invention and the foregoing and other features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawings in which:

Fig. 1 is an elevational view in perspective of a cathode ray discharge device illustrative of one embodiment of this invention, portions of the enclosing vessel and of one of the terminal carrying bases being broken away to show the internal structure more clearly;

Fig. 2 is an end view of the device shown in Fig. 1, illustrating the arrangement of the terminals for the electrodes;

Fig. 3 is an enlarged detail view, mainly in section, of the electron gun and deflector plate assembly included in the device shown in Fig. 1;

Fig. 4 is a plan view, partly in section along line 4—4 of Fig. 3, of the assembly illustrated in Fig. 3;

Fig. 5 is an enlarged detail elevational view, mainly in section, of the electron gun included in the assembly shown in Fig. 3;

Fig. 6 is another enlarged detail view, mainly in section, showing details of the collimating electron; and

Figs. 7 and 8 are detail views of modifications of the deflector plate and shield assembly in the structure shown in Fig. 3.

Referring now to the drawings, the cathode ray device shown in Fig. 1 comprises an evacuated enclosing vessel, for example of glass, having an elongated cylindrical intermediate portion 10, a flaring end portion 11 and a reduced cylindrical end portion 12 provided with an inwardly extending stem 13 which terminates in a tri-armed press 14. The flaring end portion 11 terminates

in a dome-shaped wall 15, the inner surface of which has thereon a fluorescent coating 16 defining a screen. Portions of the inner surfaces of the tubular portion 10 and flaring end portion 11 are coated with an opaque electrically conductive material 17, such as colloidal graphite known commercially as "Aquadag," as described in Patent 2,096,416, granted October 19, 1937, to Howard W. Weinhart. Sealed to an intermediate area of the reduced end portion 12 is an elongated cylindrical insulating column or standard 18 coaxial with the stem 13. The column or standard 18 may be, for example, of glass and fused at one end to the inner wall of the reduced end portion 12.

Suitably affixed to the end of the reduced cylindrical portion 12 is a base 19 carrying a plurality of terminal prongs 20 through which electrical connection may be established to certain of the electrodes of the device. A second base is affixed to an intermediate portion of the enclosing vessel and comprises a metallic shell 21, cemented to the vessel as indicated at 22, and an insulating disc 23, which carries a plurality of terminal prongs 24 to which the other electrodes of the device are connected.

Supported by the stem 13 and column or standard 18 and constituting a unitary assembly therewith is an axially symmetrical electrode system for producing a concentrated electron beam having a sharp clearly defined spot focus upon the fluorescent screen 16.

In general, this electrode system comprises an electron source, a collimating system for concentrating the electrons emanating from the source into an electron beam of small cross-section, a focussing system for bringing the electron beam to a sharp point focus upon the screen 16, and means for controling the direction or intensity or both of the electron beam. More specifically, as shown in detail in Figs. 3 and 5, the electrode system comprises a cathode 25, a control or modulating electrode 26, a collimating electrode 27, a cylindrical focussing electrode 28 and a dished focussing electrode 29. The direction of the electron beam may be controled by pairs of parallel deflector plates 30 and 31, one pair being mounted at right angles to the other and the plates of each pair being equally spaced on opposite sides of the longitudinal axis of the electrode system.

The cathode 25, as shown clearly in Fig. 5, may be of the indirectly heated equipotential type, and comprises an elongated metallic sleeve to one end of which a metallic cap 32 is secured, the cap having the base surface 33 thereof coated with a thermionic material. The cathode sleeve encompasses an insulating, preferably ceramic, core 34 in which a heater filament 35 is embedded, the inner end of the filament 35 being insulated from the cap 32 by an insulating plug or insert 36. The core 34 is fitted in a central aperture in an insulating, preferably ceramic, platform or spacer 37. Electrical connection to the filament 35 and to the cathode may be established through leading-in conductors 38 and 39, respectively, sealed in the press 14 and connected to appropriate ones of the terminals 20. The cathode may be anchored in position by the leading-in conductor 39, which is fitted in an aperture in the platform 37 and cemented to the platform as indicated at 40 in Fig. 5.

The cathode 25 is encompassed by a cylindrical metallic sleeve 41 positioned in exact coaxiality with the cap 32 and abutting the platform 37 at the base of a recess in one surface of the platform. As indicated at 42 in Fig. 5, the sleeve 41 may be cemented to the platform 37 and further locked in position by a bent leading in conductor 43, which is fitted in an aperture in the platform, embedded in the press 14 and connected to one of the terminal prongs 20.

The control or modulating electrode 26, which may be machined from a metallic block such as nickel, is fitted in the end of the metallic sleeve 41 and secured, as by welding, to the sleeve 41. As illustrated in Fig. 5, the electrode 26 has an inner frustoconical surface 44 coaxial with the cap 32.

The collimating electrode 27 and cylindrical focussing electrode 29 are mounted coaxially with the modulating electrode 26 and cap 32 and are supported as a unit by a pair of metallic standards or uprights 45 extending from split metallic bands or collars 46 clamped about the stem 13, the standards or uprights 45 being affixed, as by welding, to the cylindrical portion 47 of a metallic coupler in which the electrode 28 is fitted, as shown clearly in Fig. 5. The collimating electrode 27 may be machined from a metallic block, for example of cold rolled steel, and has a central aperture 48 and a convex surface 49 coaxial with and opposite the surface 44. The opposed surfaces 44 and 49 are of accurately predetermined configuration, as described in the application of Myron S. Glass identified hereinabove, whereby the field therebetween is such as to concentrate the electrons emanating from the cathode surface 33 into a thin beam entering the aperture 48.

As pointed out in the aforenoted application of Myron S. Glass, production of the fields requisite for the attainment of the desired electron concentration requires that the surfaces 44 and 49 be accurately coaxial and symmetrical with respect to the common axis. It will be apparent from Fig. 5 that such accurate coaxiality cannot be obtained by usual methods, such as sighting, because the collimating electrode blocks the view into the frustoconical aperture in the modulating electrode 26. The accurate coaxiality is obtained, however, in accordance with one feature of this invention as will be clear from the following description.

Secured to the insulating member 37, as by a plurality of rivets or eyelets 50, and in exact coaxiality with the cylindrical sleeve 41 is a flanged circular metallic guide having a cylindrical upstanding portion 51 and a laterally extending flange 52. A plurality of resilient fingers or clips 53 are affixed to the flange 52, as by welding. Fitted between the cylindrical portion 51 and the fingers or clips 53 is a cylindrical metallic member 54 in which the electrode 27 is fitted and to which it is secured, as by welding. The end of the member 54 may be fitted in and secured to a depending cylindrical portion 55 of the coupler member.

In the assembly of the device, the cylindrical sleeve 41 with the modulating electrode 26 thereon and the flanged guide 51, 52 are affixed to the insulating member 37 in accurate coaxial relation. The electrodes 27 and 28, cylinder 54, coupler member, supports 45 and bands or collars 46 are fabricated into a unitary assembly, the spring clips 53 are affixed as by welding to the cylinder 54, and the cylinder 54 is then slipped over the flange 51, the clips 53 are affixed as by welding to the flange 52 and the bands or

collars 46 are clamped about the stem 13. The electrodes 27 and 28, cylinder 54 and coupler member, of course, can be held in accurate coaxial relation while they are being assembled. Hence, when the cylinder 54 is inserted between the cylindrical guide 51 and spring clips 53, both the collimating electrode 27 and the focussing electrode 28 will be located accurately coaxial with the modulating electrode 26.

It is highly desirable, of course, that the aperture in the collimating electrode 27 through which the electron beam passes be accurately alined with the cathode surface 33 and be on the axis of symmetry of the surfaces 44 and 49. Furthermore, as pointed out in the aforenoted application of Myron S. Glass, preferably this aperture should be very small, for example of the order of 10 mils in diameter. From a mechanical standpoint it is not feasible, if not impossible, to drill a straight bore of such small diameter in the collimating electrode. However, in accordance with a feature of this invention, the desired aperture properly located is achieved readily. As shown in Fig. 6, the aperture 48 in the collimating electrode 27 is made of relatively great diameter and the walls thereof are provided with shoulders 56 and 57. A length of tubing 58 having a cap 59 affixed thereto is fitted in the aperture 48 with the edge of the cap 59 abutting the shoulder 56 and the tubing is spun over as indicated at 60 to lock the tubing in the aperture 48. The cap 59 is provided with a central aperture 61 of the desired shape and dimension, for example circular and of the order of 10 mils in diameter.

It will be noted that the cathode 25, modulating electrode 26, collimating electrode 27 and focussing electrode 28 together with the insulating spacer 37 and coupler 47, 55 constitute a unitary assembly which is supported by the bands or collars 46 clamped about the stem 13, so that but small stresses are produced in the leading-in conductors 38, 39 and 43, and, consequently, similarly small stresses obtain in the arms of the press 14 whereby cracking or breaking of the stem is prevented.

A suitable positive potential may be applied to the electrodes 27 and 28 through a leading-in conductor 62 embedded in the press and connected to one of the standards or uprights 45 by a tie wire 100.

A second unitary assembly comprising the focussing electrode 29 and the deflector plates 30 and 31 is supported upon the tubular column 18 as best shown in Fig. 3. This assembly includes a dished metallic base member 63 which is seated upon the inner end of the column 18 and held thereagainst by a plurality of arms 64 carried by and extending from a split metallic band 65 clamped about the column 18. The focussing electrode 29 is provided with an integral cylindrical portion 66 fitted in the dished member 63, is coaxially positioned with the cylindrical electrode 28 and is provided with a central aperture 67 through which the electron beam passes. The surface 68 of the focussing electrode 29 is of accurately determined configuration, as described in the application of Myron S. Glass identified hereinabove, whereby the electron beam is brought to a sharp point focus upon the fluorescent screen 16. Electrical connection to the electrode 29 may be established through a leading-in conductor 69, shown in Fig. 1, connected to the band or collar 65 and to one of the terminal prongs 24. The conductive coating 17 may be connected electrically to the focussing electrode 29 by a plurality of resilient metallic fingers 70 which are secured at one end, as by welding, to the cylindrical shield 66 and bear against the coating.

A centrally apertured insulating, preferably ceramic, platform or disc 71 supports the deflector plates 30 and 31, is seated upon the edge of the cylindrical shield 66 and is locked against this edge as by a plurality of wires 72 secured to the shield, extending through the platform or disc and bent over against the platform or disc. Each of the deflector plates 30 and 31 has an edge seated on a chordal groove or slot in the platform or disc 71 and is provided with extensions 73 which extend through slots in the platform and are twisted to hold the plates 30 and 31 securely in position. Each of the deflector plates 30 and 31 is provided also with an extension 74 to which a leading-in conductor 75, connected to a corresponding one of the terminals 24, is affixed. The extensions 74 on the deflector plates 30 extend through apertures 76 in the cylindrical member 66.

The cylindrical member 66, it will be noted, surrounds the deflector plates 30 and screens these plates and also the beam passing therebetween from extraneous fields.

Seated upon the focussing electrode 29 is a centrally apertured metallic barrier or baffle 77 which is coaxial with the focussing electrode 29 and screens the focussing field, between the focussing electrodes 28 and 29, from potentials upon the deflector plates.

As illustrated in Fig. 7, the deflector plates 31 also may be screened from extraneous fields by a metallic shield including a cylindrical portion 78 and a centrally apertured top plate 79 which is held in position by a centrally apertured cap 80, the apertures in the plate 79 and cap 80 being in axial alignment with the aperture in the insulating platform or disc 71. The shield may be secured to the platform or disc 71 by wires 81 which are affixed to the cylinder 78, extend through the platform 71 and are bent over against the platform. Also, as shown in Fig. 7, the resilient fingers 71 may be the arms of a hairpin shaped wire element carried by an insulating, preferably ceramic, member 90 mounted on a bracket 82 secured to the cylinder 66. The fingers 71 may be connected electrically to terminals 20 or 24 by conductors 83 whereby the coating 17 may be used as an accelerating electrode.

In the modification illustrated in Fig. 8, an auxiliary pair of deflector plates 84 are provided within the shield 66 to enable control of the deflection sensitivity of the device. Each of the deflector plates 84 is coplanar with a corresponding one of the deflector plates 30 and is supported therefrom through wire stubs 85 embedded in insulating beads 86. Suitable leading-in conductors, not shown, may be provided for the auxiliary plates 84 and connected to terminals 24.

Although specific embodiments of this invention have been shown and described, it will be understood, of course, that they are but illustrative and that various modifications may be made therein without departing from the scope and spirit of this invention as defined in the appended claims.

What is claimed is:

1. A unitary electrode assembly for electron discharge devices comprising a stem, a platform supported above said stem and having a central aperture and a recess coaxial with said aperture, guide means carried by said platform and

coaxial with said aperture, a cathode fitted in said aperture, an electrode coaxial with said cathode and having a tubular portion seated in said recess and secured to said platform, and a second electrode having a tubular portion positioned by said guide means in coaxial relation with said cathode and said first electrode.

2. A unitary electrode assembly for cathode ray discharge devices comprising a platform having a circular recess in one face thereof, a cylindrical guiding member mounted on said platform coaxial with said recess, a cathode carried by said platform and coaxial with said recess and guiding member, a modulating electrode coaxial with said cathode having a tubular portion seated in said recess and positioned thereby, an electrode structure having a collimating portion opposite said modulating electrode and a cylindrical portion fitted to said guiding member, and resilient means affixed to said platform and locking said cylindrical portion to said guiding member.

3. A unitary electrode assembly in accordance with claim 2 wherein said collimating portion is provided with a central aperture countersunk at opposite ends, said assembly comprising also an insert fitted in said aperture and having its ends locked to said countersunk ends, said insert having a laterally extending portion provided with a restricted aperture in alignment with said cathode.

4. An electron gun for cathode ray discharge devices comprising a stem, an insulating platform having a central aperture and a recess coaxial with said aperture, a guiding member secured to said platform and having a cylindrical portion coaxial with said aperture, a cathode fitted in said aperture, a control electrode having a tubular portion seated in said recess and affixed to said platform, a unitary assembly including a collimating electrode, a cylindrical focussing electrode and a cylindrical member, said cylindrical member being fitted on said cylindrical portion, means locking said cylindrical member to said cylindrical portion, and supporting means affixed to said stem and to said unitary assembly.

5. An electron discharge device comprising an enclosing vessel having an internal tubular column, and a unitary electrode assembly mounted on said column, said assembly including a base member, a cylindrical shield carried by said base member, an insulating platform supported by said shield and affixed thereto, a pair of deflector plates depending from said platform and within said shield, and a second pair of deflector plates extending from said platform and supported thereon.

6. An electron discharge device in accordance with claim 5 comprising a second cylindrical shield mounted on said platform and encompassing said second pair of deflector plates.

7. An electron discharge device in accordance with claim 5 wherein said platform is provided with chordal slots in which said deflector plates are seated, each of said deflector plates having extensions projecting through said slots and anchored to said platform.

8. A cathode ray discharge device comprising an enclosing vessel having a stem at one end and an interior tubular standard extending longitudinally of said vessel from adjacent said stem, a unitary electrode assembly within said standard including a cathode and control, collimating and focussing electrodes coaxial with one another, a platform having a central aperture in which said cathode is fitted, and having also a recess in one surface coaxial with said cathode, said control electrode including a tubular portion seated in said recess, guiding means affixed to said platform and having a tubular member coaxial with said aperture, said collimating electrode having a tubular portion fitted on said tubular member, means affixing said tubular portion to said tubular member, and means supporting said focussing electrode upon said tubular member and in coaxial relation therewith, means supporting said unitary assembly from said stem, a second unitary assembly including a base member, a second focussing electrode carried thereby, a second platform supported from said base member, and pairs of deflector plates mounted on said second platform, and means supporting said second assembly on said standard coaxial with said first assembly.

STURE O. EKSTRAND.