

Oct. 19, 1937.

H. W. WEINHART

2,096,415

ELECTRON DISCHARGE DEVICE

Filed Dec. 27, 1933

2 Sheets-Sheet 1

FIG. 1

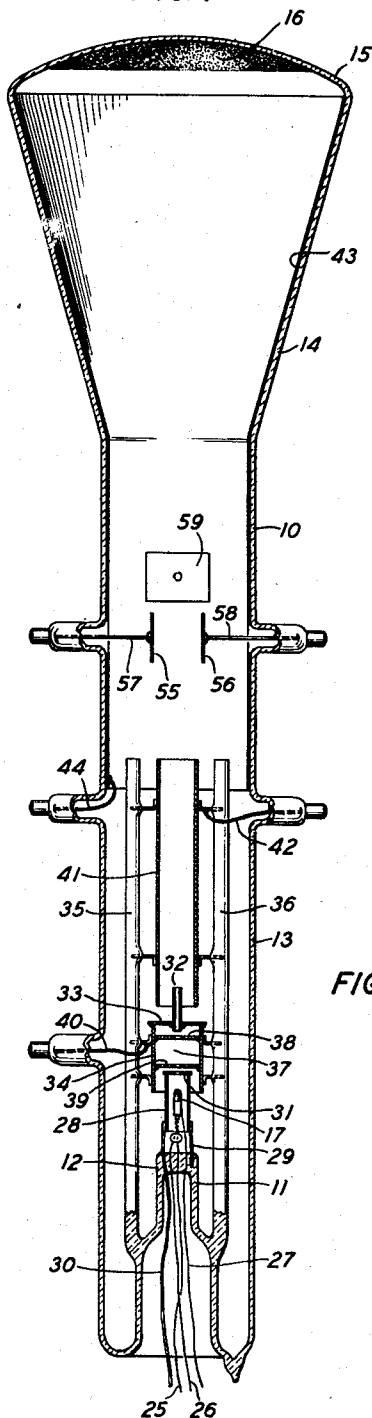


FIG. 4

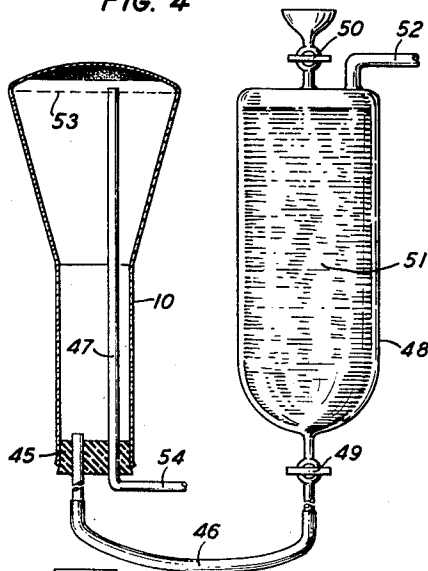


FIG. 3

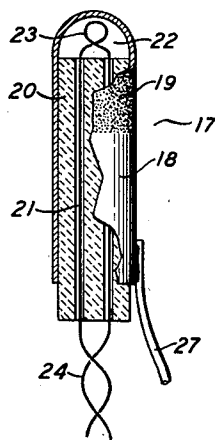
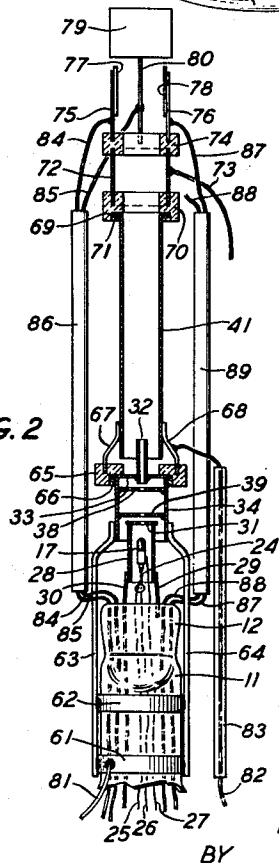


FIG. 2



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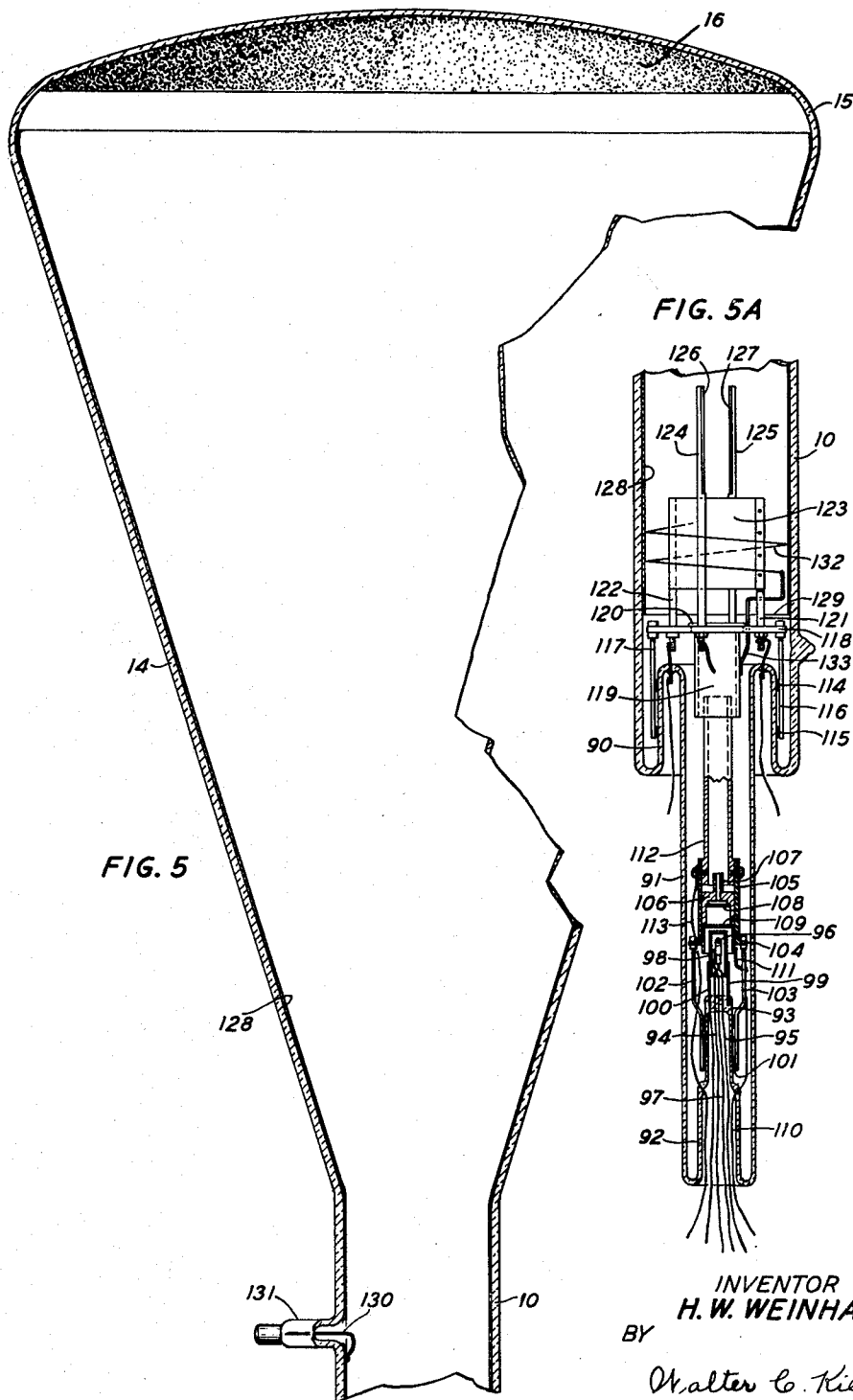
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2 Sheets-Sheet 2



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2,096,415

ELECTRON DISCHARGE DEVICE

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Application December 27, 1933, Serial No. 704,101

8 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to a device of the type in which a cathode ray beam is projected toward a fluorescent screen on one end of the device.

5 In an evacuated cathode ray device in which it is desired to focus electrons projected from an electron source toward a fluorescent screen by electrostatic means only, it is difficult to focus the electron beam into a small and well defined spot which may be deflected over a large screen area without distortion or spreading of the beam at the place of contact with the fluorescent screen.

10 An object of this invention is to produce a beam of electrons of maximum current density in a vessel evacuated to a high degree in which gas ionization is wholly eliminated so that all the electrons emitted by the emission source reach the fluorescent screen in a small and well defined spot.

15 Another object of the invention is to control the focusing of the beam by a system of electron optical lenses to insure concentration of the beam of electrons.

20 These and other objects may be attained in accordance with this invention in an enclosing vessel which is evacuated to a very high degree and in which no gas is present to form an ionized sheath to affect the focusing of the cathode ray beam. The vessel is provided with a stem at one end from which the main electrodes are supported and with a fluorescent screen at the other end which becomes luminous at the spot struck by the electrons so that deflections of the beam, due to impressed forces, can be seen or photographed. The electrode structure for producing the cathode ray beam comprises an electron source or emitting cathode supported by the stem in the axis of the vessel and surrounded by a tubular shield having a closure at one end provided with a central aperture. An enclosing chamber is superimposed on the tubular shield and overlaps it to avoid stray paths for the electrons to the wall of the vessel. This chamber supports a tubular anode in the axis of the vessel and two baffle plates spaced apart in the chamber between the anode and tubular shield form a trapping enclosure for any stray electrons which are not projected axially through the aperture in the baffle plate adjacent the anode. The anode is of sufficient length to compel the electrons to follow an axial path in the form of a pencil or beam. When the beam emerges from the end of the anode it is electrostatically controlled by a long tubular member which has one end overlapping the anode. When the beam emerges from

the end of the long tubular member it is further acted upon by a second electrostatic member that may be in the form of a conductive coating on the wall of the glass, or a second metallic cylinder overlapping the end of the first electrostatic member. After the beam passes through the electric fields created by the electrostatic members it may be deflected by pairs of oppositely disposed elements and projected on the fluorescent screen formed on the end of the vessel.

10 In order to maintain the intensity of the beam after deflection and to overcome charging of the vessel wall and also to eliminate reflection which might deleteriously affect the indication of the tracing on the screen, the remaining portion of the wall of the vessel is coated with a non-metallic coating, such as colloidal graphite.

15 A method of forming the coating on the vessel and the necessary apparatus therefor is disclosed and claimed in my copending application, Serial No. 740,877, filed August 22, 1934, and comprises a coating receptacle involving a reservoir containing "Aquadag" or colloidal graphite which is connected to an enclosing vessel by a suitable passageway and air under pressure forces the graphite material to rise into the vessel to a proper level. The air trapped above the incoming liquid is removed through an outlet pipe and when the desired amount of coating material is injected into the vessel the air supply is removed from the reservoir and applied to the outlet pipe. The pressure of air entering the vessel forces the coating liquid to flow back into the reservoir and when all the excess liquid is removed a uniform coating of colloidal graphite adheres to the wall of the vessel. The coating is dried and baked by heating to form a hard and adherent coating on the vessel. This method facilitates the application of the coating and insures a uniform layer of material on the glass wall. Furthermore, the boundary of the coating on the glass wall adjacent the screen is uniformly spaced from the screen so that the coating does not mask the fluorescent screen material.

20 Another feature of the invention is the elimination of stray discharges on the wall of the vessel. This is due to the overlapping arrangement of the electrodes so that no electrons can escape toward the wall, to build up electric fields which cause spreading of the beam of rays.

25 Another feature relates to the arrangement of the electrodes so that the beam emanating from the electron source is focussed by a system of ternary electron optical lenses which is produced in the vicinity of the shield and trapping cham-

ber and the ends of the anode and electrostatic member. The potentials applied to these elements set up electric fields which serve to focus the electron stream in the same manner as physical optical lenses focus a beam of light. Furthermore, the field present at the adjacent ends of the electrostatic members functions as a combination of two lenses to correct distortion in the same sense that two optical lenses are used to correct for spherical aberration.

A more detailed understanding of the invention may be obtained from the following description and drawings:

Fig. 1 shows in cross-section one embodiment of a device made in accordance with this invention and illustrates the detailed arrangement of the various elements;

Fig. 2 illustrates another embodiment of the invention in the form of unitary assemblies of the electrodes which may be inserted in a vessel similar to that shown in Fig. 1;

Fig. 3 shows in cross-section the detailed structure of the electron emitting cathode;

Fig. 4 illustrates one embodiment of the apparatus for performing the operations for applying a coating on the vessel in accordance with a method of this invention; and

Figs. 5 and 5—A show another embodiment of the invention in which the electrodes are arranged in two units which cooperate to project a cathode stream to a large screen on the end of the device.

Referring to Fig. 1, the discharge device in one aspect of this invention, is embodied in an elongated enclosing vessel 10 having an inwardly projecting stem 11 terminating in a press 12 in which the leading-in wires for some of the electrodes are embedded. This vessel has a long tubular portion 13, an outwardly tapered portion 14 forming an extension of the tubular portion and a dome-shaped window portion 15. A fluorescent coating or screen 16 is deposited on the inner surface of the window portion. A highly efficient fluorescent coating may be formed on the window portion of the vessel in accordance with the disclosure in U. S. Patent 1,603,284, granted October 19, 1926 to J. B. Johnson. The screen 16 becomes fluorescent upon impact by an electron beam and shows a figure on the screen when the beam is influenced or deflected by circuit under test which gives an indication of the type of curve or variation desired to be shown. The electron beam emanates from a primary source, such as an equipotential cathode or emitter 17, shown more clearly in Fig. 3. This cathode comprises a metallic thimble 18 having an emissive coating 19 on the closed end of thermionically active substances, such as barium and strontium oxides. Within the thimble is an insulating plug 20 having twin bores through which a heater element 21 extends. Between the end of the plug 20 and the dome of the thimble 18 is a cavity 22 in which the heater element is looped as shown at 23. The terminations of the heater element 21 are twisted together at 24, to prevent a ripple from being introduced into the cathode beam when alternating current is employed as the energizing source for the heater element. The heater element 21 is connected to two leading-in wires 25 and 26 extending from the press 12, and the thimble 18 is connected to and supported by a conductor 27. The cathode 17 is arranged in the axis of the vessel so that a beam of electrons emanating therefrom is projected to the axis of the fluorescent screen on the other end of the vessel 10.

The cathode 17 is surrounded by a tubular screen or shield 28, of non-magnetic material, such as aluminum, which is supported from the press 12 by a short wire 29 and a leading-in wire 30. The top of the shield 28 is closed by a disc 31 having a central aperture substantially in alignment with the end of the cathode 17. The disc 31 is attached to the shield 28 and together with the shield form an enclosure for the cathode 17. The enclosure around the cathode facilitates the concentration of the emission of electrons from the cathode since the tubular shield 28 prevents any electrons emitted from the cathode from leaving the confined space within the shield except through the aperture, and also controls the number of electrons permitted to pass through the aperture 31, by applying a suitable potential to the leading-in wire 30, and therefore may be used as a modulating electrode or trigger control electrode. It, furthermore, conserves the heat generated by the cathode.

An anode 32 is arranged in the axis of the vessel in alignment with the aperture in the modulating disc 31 and may be in the form of a tubular member. The tubular anode 32 is preferably of non-magnetic material, such as aluminum and is rigidly held in position by a chamber which extends beyond the modulating disc 31. This chamber has a cup-shaped form and consists of a disc 33 having a central aperture through which the anode 32 extends, so that the anode may be affixed to the disc by soldering or welding it to the inner surface of the disc, and a cylindrical metallic shield or member 34 of similar material which extends downwardly from the disc 33 to a point well beyond the inner end of the shield 28 so that the modulating disc 31 is wholly within the boundary of the metallic member 34 and the shield 28 is reentrant with respect to the member 34. The anode 32 and the cup-shaped enclosure comprising the disc 33 and the cylindrical shield 34 are supported from outwardly extending wires which are held in supporting members, such as glass rods 35 and 36, which extend from the stem 11 in parallel relation outside the range of the electrodes.

A trapping chamber 37 may be formed intermediate the modulating disc 31 and the anode 32 by two parallel spaced discs 38 and 39, in the form of baffle plates with central apertures which are arranged in the cylindrical member 34 and are secured to the walls thereof to form an enclosure to entrap any electrons that are not axially projected from the aperture in the primary modulating disc 31. In order to draw the electrons from the emission source or cathode 17 it is necessary to apply a positive potential to the anode structure. For this purpose a leading-in wire 40, projecting through the side of the cylindrical portion 13 of the vessel, is connected to the anode structure adjacent the supporting wire attached to the support 35 and the member 34. The positive potential applied to the trapping chamber and anode 32 causes an electric field to extend within the scope of the discs 38 and 39 and thereby produce, in effect, a primary electron lens for focusing the beam of electrons. In a similar manner an electric field extends into the end of the anode away from the disc 33 and therefore produces a second electron optical lens through which the beam of cathode rays is projected. In effect, the second lens is similar to the first lens, but due to its spacial relation with respect to the emission source, the beam of cathode rays is concentrated into a fine pencil of electrons.

An elongated electrostatic focussing member or electrode 41, in the form of a metallic cylinder of non-magnetic material, such as aluminum, is supported in axial alignment with the preceding electrodes by support wires extending toward the support rods 35 and 36. This member should be preferably several times the length of the anode and have a diameter substantially the same as the length of the anode. Furthermore, the end nearest the anode should overlap the anode so that the end of the anode is reentrant with respect to the electrostatic electrode 41. A higher positive potential is applied to this electrode through a leading-in wire 42 which extends from the cylindrical portion of the vessel and is connected to the electrostatic electrode 41 by a support wire extending to the support rod 36. The potential applied to this electrode produces the electric field which extends into the end of the anode 32 and forms the second electron optical lens for focussing the beam of cathode rays projected toward the screen at the other end of the vessel. An additional electric field is produced at the end of this electrode due to the potential applied to the conductive coating on the wall of the vessel which will be described hereinafter. This field forms a third electron optical lens to concentrate and focus the stream of electrons and also functions as a correctional lens similar to an optical lens for the correction of spherical aberration. The electrostatic focussing produced by the member 41 insures concentration of the beam of rays which is projected therethrough and the length thereof is closely related to the dimensions of the anode 32. As an example, the anode 32 may be a tube having an internal diameter of $\frac{1}{8}$ of an inch and a length of $\frac{1}{2}$ inch, while the inside diameter of the focussing tubular member 41 may be $\frac{1}{2}$ inch and the length thereof $3\frac{1}{4}$ inches.

The three-lens system in accordance with this invention insures an optimum concentration of the cathode beam of electrons which is projected along the axis of the vessel toward the screen. Furthermore, the overlapping assembly of the various electrodes insures that none of the electrons in the beam can be diverted to the glass wall of the vessel and there build up electric fields which might influence the beam of cathode rays being projected along the axis of the vessel. It is well known that if the glass assumes a negative electric charge electrons in the beam will be repelled, and consequently such charges on the glass wall will seriously affect the concentration of the electron beam emanating from the cathode. Since the cathode is completely shielded by the cylinder 28 and only the aperture in the modulating disc 31 permits a projection of cathode rays and the area in the vicinity of this disc is completely shielded by the depending edge of the shield 34, it is evident that no electrons can escape from the beam toward the wall of the vessel. In the same manner the travel of the beam through the trapping chamber is completely shielded by the cylindrical wall of the shield 34 and when the beam enters the anode 32 it is completely shielded by the tubular construction of this electrode. Similarly, the path of the beam is protected along the whole length of the electrostatic electrode 41, due to its cylindrical form, and the end of the anode is protected because of its reentrant arrangement with respect to electrostatic member 41. It will therefore be seen that along the whole path of the beam it is completely shielded from the wall of the vessel so

that no electric charges can build up on the wall to influence the cathode beam.

After the beam is projected from the end of the electrostatic focussing member 41 it must still travel a considerable distance to the screen 16 on the end of the vessel and in order to prevent electric charges from building up on the wall portion between the electrode 41 and the screen, this wall is provided with a non-metallic coating or layer 43, of colloidal graphite, commercially known as "Aquadag". It will be noted that the coating extends beyond the edge of the electrostatic member 41 so that the end of the member 41 is reentrant with respect to the coating 43. This prevents any charges spreading to the wall of the vessel in the horizontal plane of the end of the member 41. The graphite coating on the wall of the vessel prevents the building up of electric charges or fields on the glass wall which might influence the beam of rays projected to the screen 16. A leading-in wire 44 is sealed in the wall of the vessel adjacent the coating 43 and is connected thereto to apply a still higher potential to the coating so that the graphite material in the coating forms a conductor for establishing a focussing field at the end of the cylinder 41 for the beam of rays projected toward the screen.

In view of the fact that the conductive coating 43 should not ordinarily flow over the surface of the fluorescent screen 16 it is evident that considerable care must be employed in forming the coating on the inner surface of the vessel wall. An efficient apparatus for producing this coating in the vessel is shown in Fig. 4 in which the vessel 10 is provided with a removable plug 45 having an inlet tube or connection 46 which extends into the vessel 10 a slight distance beyond the inner surface of the plug 45. An elongated outlet tube 47 extends through the plug 45 and terminates within the vessel 10 at a point slightly beyond the line to which the coating is desired. The inlet connection 46 is an elongated U-shaped tube which is connected to a reservoir 48 provided with a valve 49 between the reservoir and the inlet tube 46. A similar valve 50 is inserted in the mouth of the reservoir and normally is in a closed condition except when it is desired to replenish the colloidal graphite material 51 within the reservoir. Adjacent the valve 50 and above the level of the colloidal graphite coating material 51 is a tubular projection 52 to which may be connected any source of pressure, such as air.

The method of coating the inner wall of the vessel 10 consists in opening the valve 49 and applying air pressure to the tube 52 to inject air into the reservoir 48 whereby the coating material is forced into the vessel 10 through the inlet connection 46. The pressure of air is maintained constant until the level of the coating liquid reaches the level of the dotted line 53 in the vessel 10. During the filling of the vessel 10 with the colloidal material all of the imprisoned air in the vessel displaced by the liquid is ejected through the outlet pipe 47 and when the level of the coating material reaches the line 53 the air pressure is removed from the connection 52 and applied to the open end 54 of the outlet pipe. The pressure of air emerging from the inner end of the pipe 47 forces the liquid in the vessel 10 back through the U-shaped connection 46 into the reservoir 48 and when all the liquid is removed the plug 45 and pipe connections attached thereto may be taken

out of the end of the vessel 10. It is to be understood that in practice the U-shaped tube is mounted in such a position that the end projecting into the vessel 10 is approximately at the same height as the level of liquid in the reservoir 48 and that the vessel 10 is above the elevation of the reservoir 48. After the coating operation is completed the vessel 10 is dried in an oven and baked to form a hard and adherent coating on the inner wall of the vessel. This method which forms the subject-matter of the above-mentioned application produces a uniform coating on the wall of the vessel and realizes a uniform boundary between the graphite coating on the vessel and the fluorescent screen. Furthermore, due to the black opaque coating on the wall of the vessel no reflection can alter the indication of the electrical phenomena exhibited on the fluorescent screen. Another advantage is the avoidance of difference of expansion between the glass and the coating such as might be present if a metallic coating is applied to the vessel.

While the beam of cathode rays emanating from the cathode is completely controlled electrostatically to insure a concentrated beam of electrons and the production of a bright and intense spot on the fluorescent screen, this spot being of very small diameter, for instance, one millimeter, it is evident that this beam may be deflected, in any well known manner, to cause the indication of the deflection to be reproduced on the fluorescent screen. For instance, the beam may be deflected electrostatically by two pairs of oppositely disposed plates such as plates 55 and 56 supported by leading-in wires 57 and 58, respectively, which are sealed through the side wall of the vessel 10. A similar plate 59 is shown above the plates 55 and 56 and this plate together with a similar parallel plate, not shown, is arranged at right angles to the plates 55 and 56 and provided with suitable terminals and supports through the side wall of the vessel. The vessel 10 is highly evacuated by well known pumping equipment to such a degree that no gas ionization occurs in the vessel to influence the focussing of the beam of electrons or enter into the discharge from the emission source. The vessel is hermetically sealed at 60 after the evacuation is completed.

In the device shown in Fig. 1 the anode structure and the electrostatic element are shown supported from glass standards and the deflecting plates are supported from wires extending through the wall of the vessel. It is evident that this invention may also be embodied in a structure in which the leading-in wires are contained in the stem of the vessel so that all the electrodes may be mounted as a unit on the stem and the unit inserted in the vessel without the need of any other connections through the wall of the vessel. Such a structure is shown in Fig. 2 in which a stem 11 having a press 12 surrounding leading-in wires 25 and 26 for the heater element 24 and a leading-in wire 27 for the emission source or cathode 17. The cathode is surrounded by a cylindrical shield 28 attached to the press by wire 29 and leading-in wire 30. The shield 28 is provided with a modulating disc 31 similar to the disc shown in Fig. 1. A pair of collars 61 and 62 embrace the stem 11 and carry support rods 63 and 64 which are attached to the shield member 34 in which the trapping plates 38 and 39 are situated. The top of the shield 34 is closed by the disc 33 which has a central aperture for the reception of the tubu-

lar anode 32. Surrounding the periphery of the disc 33 is an insulating ring or collar 65 having an overhanging edge extending beyond the edge of the disc 33 to readily position the insulator with respect to the rest of the electrode structure. The insulating collar may be secured in position by cement 66 which fills the space between the wall of the shield 34 and the edge of the insulating collar 65. The insulating collar supports two standards or rods 67 and 68 which are connected to the elongated focussing member 41. The member 41 is provided at its upper edge with an outwardly projecting flange 69 which forms a base for an insulating ring 70 secured to the flange 69 by cement 71. The ring 70 carries a short cylindrical metallic member 72 which is provided with a conductor 73 extending to the stem. This member and the potential applied to it forms the field for focussing the electron stream at the end of the electrostatic focussing member 41. The short cylinder 72 carries an insulating collar 74 in which are positioned supports 75 and 76 for the parallel deflecting plates 77 and 78 and also other supports for the second pair of deflecting plates, only one of which is shown at 79 and connected to a support 80 extending into the insulating ring 74. A leading-in wire 81 is connected to the collar 61 on the stem to serve as a conductor for the anode assembly and this leading-in wire is embedded in a seal between the stem flare and the vessel wall in a manner well known in the art. A leading-in wire 82 embedded in a seal oppositely disposed with respect to the leading-in wire 81 extends through an insulating glass tubing 83 and is connected to the support 68 so that a suitable potential may be impressed on the electrostatic focussing member 41. Suitable leading-in wires 84 and 85 extend through the press 12 and are located in an insulating tubing 86 and separately connected to the supports 75 and 80 of the deflecting plates 77 and 79, respectively. On the opposite end of the press leading-in wires 87 and 88 extend through an insulating tube 89 and the conductor 87 is connected to the support wire 76 of the plate 78. It is understood that the conductor 88 is connected to the other deflecting plate which is arranged parallel to the plate 78 shown in Fig. 2. This arrangement forms a compact and unitary assembly in which all the electrodes are rigidly held in axial relation so that the beam of rays emanating from the cathode is maintained in the axis of the various electrodes.

The device shown in Figs. 5 and 5-A is a large embodiment of the invention in which the stream of electrons is projected for a distance of about 3 feet and the diameter of the fluorescent screen is approximately 15 inches. It is evident that in order for the beam to travel this distance it must be focussed accurately to maintain the intensity of the beam when it reaches the screen. The device consists of a vessel having a cylindrical portion 10 connected to an outwardly tapered portion 14 which continues up to the dome-shaped window portion 15 on which the screen 16 is deposited. The cylindrical portion of the vessel 10 is provided with a reentrant tubular portion 90 which is open at its inner end and provided with an outwardly extending long tubular portion 91. The outer end of the long tubular portion 91 is provided with a reentrant stem 92 which terminates in a press portion 93. The press supports leading-in wires 94 and 95 for the internal heater of an equipotential cathode 96 75

and a conductor attached to the cathode is sealed in the press at 97. A hollow cup-shaped shield 98 surrounds the cathode and is supported from the stem 93 by a short wire 99 and a leading-in wire 100. The screen electrode 98 is provided with a central aperture through which a stream of electrons is projected from the cathode 96. The remaining electrodes supported by the stem 92 are carried by a collar assembly 101 which surrounds the upper part of the stem 92 and carries two rods 102 and 103 which are fastened to a flange 104 on an insulating cylinder 105 of highly purified material, such as magnesium silicate or "isolantite". The insulating cylinder forms a support for the anode assembly and the elongated focussing electrode and rigidly maintains the space relation of these elements. The anode structure consists of a single piece of metal having a cup portion 106 and a short tubular portion 107 at the top of the cup portion. The interior surface of the cup portion is stepped to insure accurate spacing between perforated discs or baffle plates 108 and 109 and to provide chambers of definite areas on opposite sides of these plates. The anode structure is held within the insulating cylinder by a locking screw, not shown. A voltage is supplied to the anode structure by a leading-in wire 110 which is sealed in the side of the stem 92 and connected to the up-right support 103, the support carrying a short stub wire 111 which is attached to the edge of the anode structure. An elongated focussing electrode 112 is provided at its lower end with a reinforcing collar which is threaded to receive screws which pass through the cylindrical insulator 105 to hold it rigidly in position. It will be noted from this assembly that the cathode is completely enclosed by the shield electrode 98 and this electrode is reentrant with respect to the cup portion of the anode structure and the anode 107 is reentrant with respect to the focussing electrode 112.

A second electrode unit is supported from the stem 90 by a structure including clamping bands 114, 115 which embrace the stem and carry support rods 116 and 117. These rods are attached to an insulating disc 118 having a central hole in which is situated a metallic cylinder 119. The metallic cylinder 119 is held on the disc 118 by a flanged rim 120 and is concentric with and partially surrounds the end of the elongated focussing member 112. A pair of rods 121 and 122 project upwardly from the disc 118 and carry a pair of parallel plates, only one of which is shown at 123. A similar pair of rods, 124 and 125, of longer length, extend from the disc 118 and carry a pair of parallel plates 126 and 127 which are arranged at right angles to the plane of the plate 123. A graphite coating 128 is formed on the wall of the tube from a point 129 up to the screen 16 and an electrical connection is made with this coating by a leading-in wire 130 sealed in an arm 131. The voltage applied to the metallic coating on the wall of the vessel is also applied to the cylindrical metallic electrode 119 by a helical expansion spring 132 which presses against the metallic coating on the wall of the vessel and is attached to a conductor 133 which passes through the insulating disc and is attached to the side wall of the cylindrical electrode 119. The four deflecting plates are provided with suitable terminal wires which are sealed in the top of the stem 90 and pass out of the vessel between the cylindrical portion 10 and the long tubular portion 91. In this arrangement the

electric field produced in the vicinity of the cylindrical electrode 119 and the top of the focussing electrode 112 forms a focussing lens for concentrating the beam of rays passing through the tube and this field is isolated from the deflecting area just beyond the disc 118.

While this invention has been disclosed in several embodiments, it is to be understood that various modifications may be made in the detail structure of the elements and such modifications are intended to be within the scope of the invention as defined in the appended claims.

What is claimed is:

1. A cathode ray discharge device comprising a highly evacuated vessel having a fluorescent screen at one end thereof, an electron emitter at the other end thereof, a ternary electron optical lens system between said emitter and said screen, and a non-metallic conductive coating on said vessel between said lens system and said screen.
2. A cathode ray discharge device comprising a highly evacuated vessel having a fluorescent screen at one end thereof, an electron emitter at the other end thereof, a ternary electron optical lens system between said emitter and said screen, and a colloidal graphite layer on the wall of said vessel, said layer being uniform and continuous from said screen to said lens system.
3. A cathode ray discharge device comprising a highly evacuated vessel having a stem at one end, a fluorescent screen at the other end, an electron emitter supported on said stem, a shield surrounding said emitter and having an apertured closure at one end, an inverted cup-shaped member superimposed on said shield, a tubular anode projecting from the axis of said member, spaced parallel baffle members situated in said member and having apertures in alignment with said anode, and an elongated electrostatic tubular member adjacent said anode.
4. A cathode ray discharge device comprising a highly evacuated vessel having a stem at one end and a screen at the other end, a conductive coating on the wall of said vessel, an electron emitter supported by said stem, a primary focussing member, a secondary focussing member, and an elongated focussing member, each of said members and said coating successively surrounding a beam of rays to be projected from said emitter to said screen.
5. A cathode ray discharge device comprising a highly evacuated vessel having a stem, an electron emitter supported by said stem, a primary focussing member, a secondary focussing member, an elongated focussing member, said members successively overlapping the adjacent boundary of the preceding member, and a graphite film on the wall of said vessel having a portion overlapping said elongated focussing member.
6. A cathode ray device comprising a highly evacuated vessel having a fluorescent screen at one end, a cathode at the other end for projecting a beam of rays toward said screen, and a series of electrostatic focussing members intermediate said screen and cathode and arranged to eliminate dispersion of said rays to the wall of said vessel throughout the length of said vessel, said members including a primary focussing member, an electron trapping member, an anode, a distortion correcting member, and a terminating member, said primary member, anode and correcting member each having a portion extending within the boundary of the succeeding member.
7. A cathode ray device comprising a highly

5 evacuated vessel having a stem, a cylindrical
portion, an outwardly tapered portion and a ter-
minating wall portion, a fluorescent screen on
said terminating wall portion, a non-metallic
10 coating on said tapered portion, and a unitary
electrode assembly on said stem supported within
said cylindrical portion, said electrode assembly
including a cathode, a cup-shaped shield mem-
ber surrounding said cathode, a cup-shaped elec-
tron trapping member superimposed on said
15 shield member, a tubular anode supported by
said trapping member in alignment with said
cathode, and an elongated focussing member
surrounding a portion of said anode and coax-
ially related therewith.

8. A cathode ray discharge device comprising
a highly evacuated vessel having a fluorescent

screen at one end and a stem at the other end,
and a unitary electrode structure supported by
said stem, said structure comprising an electron
emitter, a shield having an aperture surrounding
5 said emitter, a cup-shaped member partially sur-
rounding said shield and supported from said
stem, a tubular anode supported by said mem-
ber, an elongated tubular focussing member in-
sulatingly supported by said cup-shaped mem-
ber and partially surrounding said anode, a cylin-
10 drical metallic member insulatingly supported by
said tubular focussing member, an insulator at-
tached to said cylindrical member, and a plu-
rality of deflecting plates carried by said insu-
lator.

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