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J. B. JOHNSON ET AL

2,063,314

ELECTRON DISCHARGE DEVICE

Filed Dec. 27, 1933

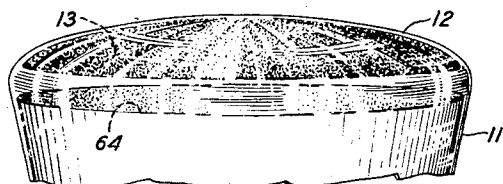


FIG. 1

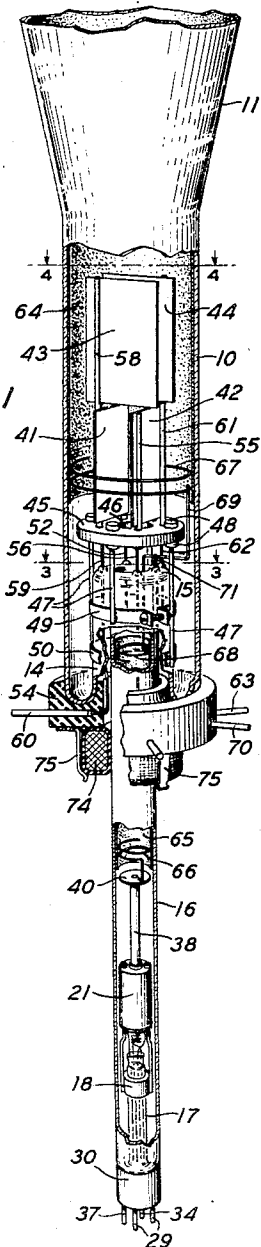


FIG. 2

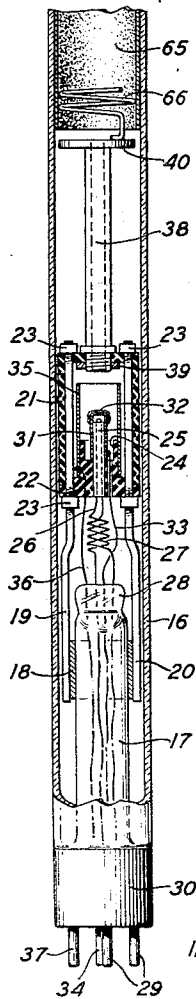


FIG. 5

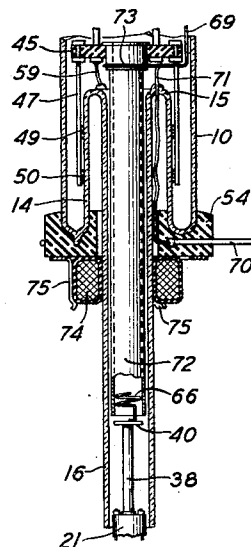


FIG. 3

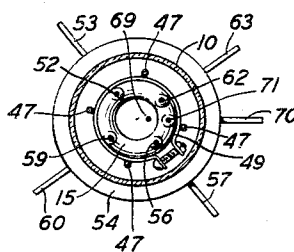
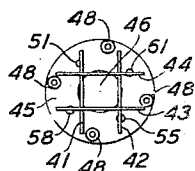


FIG. 4



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2,063,314

ELECTRON DISCHARGE DEVICE

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18 Claims. (Cl. 250—27.5)

This invention relates to electronic discharge devices of the Braun type in which an electronic stream is projected toward one end of the device.

Recently in these devices the focusing gas has been eliminated, and other media, such as an electrostatic or an electromagnetic element has been utilized to concentrate or focus the stream of electrons into a fine point or spot on the fluorescent screen. However, difficulties arose heretofore in the application of these principles so that an intense electronic stream focussed to a high degree of efficiency was not attained.

An object of this invention is to secure a highly efficient and intensely concentrated electronic stream in a cathode ray device.

Another object of the invention is to eliminate disturbances which deleteriously affect the electronic stream in such a device.

In accordance with one aspect of the invention the cathode ray device comprises a vessel having a fluorescent screen at one end, an electron gun or source of electrons at the other end, and sets of deflector plates intermediate the gun and screen to cause the electron stream to sweep over the complete area of the screen. The electron stream is focussed or concentrated by an electromagnetic field to insure efficient operation at high frequencies, greater brightness of the spot of incandescence on the screen, less distortion because of space charge, higher impedance between the deflector plates and longer life of the emission source and the device.

A feature of the invention relates to the lining up of the electron gun to insure that the electron stream or beam emerging from the source is axially aligned with respect to the deflector plates. This arrangement consists of a unitary structure in which an equipotential emitter or cathode is located in an insulating housing which supports an elongated collimating anode and the housing is rigidly supported in a long tubular member extending from one end of the vessel.

Another feature of the invention is concerned with focussing the stream of electrons at a position intermediate the ends of the anode and the deflector plates. This is accomplished by sliding a magnetic coil along the long tubular member in which the electron gun is situated so that the magnetic field of the coil is concentrated in a region some distance from the collimating anode and also some distance from the deflector plates. The essential point in the positioning of the magnetic coil is to avoid the setting up of a magnetic field between the deflector plates, since any appreciable field present here will produce

harmful effects of insensitivity and twisting of the electronic stream.

A further feature of the invention relates to the coating of the wall of the vessel and a portion of the long tubular member with an opaque conductive film of carbonaceous material which forms a continuation of the anode and permits the electronic stream to travel the entire length of the device in a nearly field-free space. A non-magnetic metal tube also may be employed in the long tubular member instead of the carbonaceous film with satisfactory results.

The invention also contemplates an efficient connection between the conductive film on the vessel, the conductive film or the metal tube in the long tubular member and the anode, in order to apply the accelerating voltage to these elements. In a preferred form the connections consist of frictional springs which expand into contact with the conductive films on the glass wall of the device and form a series connection to the anode.

Another feature of the invention relates to the mounting and the proportioning of the deflector plates to insure accurate alignment, low electrostatic capacity and increased sensitivity to impressed voltages. These results are obtained by supporting the deflector plates upon a rigid platform which is affixed to the stem of the vessel, and distributing the terminal conductors of the plates around the edge of the stem to increase the capacity therebetween. The sensitivity of the deflector plates may be attained by proportioning the pair of plates furthest from the electron source so that they have a greater area than the corresponding lower plates or the upper plates may have the same area but are spaced closer to the axis of the vessel and are therefore relatively more sensitive to impressed voltages for applying their deflecting action to the beam of electrons which passes the plates.

These and other features of the invention will be more clearly understood from the following detailed description taken in connection with the accompanying drawing:

Fig. 1 is a perspective view of an electronic device made in accordance with this invention showing portions of the enclosing vessel broken away to show the disposition of the internal electrodes and other portions of the device shown in cross-section to illustrate the detail structure of these portions. This figure also shows an intermediate portion of the vessel omitted in order to present a straight line picture of the device;

Fig. 2 is an enlarged cross-sectional view of the

electron gun assembly which is illustrated in the lower end of Fig. 1;

Fig. 3 is a plan view partly in cross-section illustrating a view of the stem of the vessel shown in Fig. 1 looking down on the line 3—3;

Fig. 4 is a plan view of the supporting structure for the deflector plates from a position looking down on the line 4—4 of Fig. 1 showing the arrangement of the deflector plates in boxed formation; and

Fig. 5 is an enlarged cross-sectional view of a portion of the vessel shown in Fig. 1 to illustrate a modification of the invention as applied to the structure shown in Fig. 1.

Referring to the drawing, the invention is disclosed as applied to a highly evacuated cathode ray discharge device which includes an enclosing vessel having a long tubular portion 10 which merges into a tapered portion 11 and terminates in a beveled or domed portion 12 which forms a window for visual observance of the electrical phenomena produced by the stream of electrons projected through the device. The window may be provided with a screen 13 which may be applied as a coating of a mixture of materials which become fluorescent, as disclosed in J. B. Johnson, U. S. Patent 1,603,284, issued October 19, 1926. The other end of the vessel is provided with a stem 14 which is reentrant for a short distance with respect to the vessel 10 and is provided with an annular rim 15 to which is fused a long tubular glass member 16 extending outwardly from the stem 14 and projecting a considerable distance beyond the end of the portion 10 of the vessel. This arrangement insures the accurate alignment of the electron gun and the deflector plates.

The tubular glass member 16 is provided with a reentrant stem 17 which serves as a support for the electron gun assembly which forms one of the features of this invention. The details of the electron gun are shown clearly in Fig. 2 and consist of a collar 18 embracing the stem 17, the collar carrying a pair of rods 19 and 20 which serve as rigid supports and clamps for an insulating housing completely enclosing the emission source. The insulating housing consists of an inverted cup-shaped cylindrical member 21, preferably of "Isolantite", which is seated on a flanged insulating disc 22 of similar material and the member and disc are held together by the rods 19 and 20 and nuts 23 which are threaded on the rods. The disc 22 has a central extending cup portion 24 and a central aperture leading into the cup portion. A central rod 25 of insulating material, such as quartz or magnesia, is firmly fitted into the aperture in the disc 22 and is provided with parallel bores to receive a heating element 26, preferably of tungsten. The heating element is threaded through the bores of the rod 25 so that only a short loop is exposed at the inner end of the insulating rod 25. The terminations of the heater element are wound inductively as shown at 27 and attached to wires sealed in the press 28 of the stem 17, to provide connections which are attached to the terminal prongs 29 on an insulating base 30 secured to the end of the long tubular member 16.

The exposed surface of the insulating rod 25 above the base of the cup portion 24 of the disc forms a support for a metallic thimble 31 which functions as the cathode of the device. As shown in Fig. 2, the closed end of the thimble 31 is coated with highly emissive material, such as barium and strontium oxides to serve as an elec-

tron source when heated by conduction and radiation produced by the heater element within the cathode. The purpose in constructing the cathode as above described is to concentrate the emission of electrons from the end only of the cathode thimble so that the electrons are projected as a stream along the axial line of the device and toward the screen 13 on the end of the vessel in a manner to be hereinafter described. A conductor 33 is connected to the thimble 31 and 10 extends through a longitudinal opening in the disc 22 and is attached to a leading-in wire in the press 28 which is finally secured to a terminal 34 on the base 30. The electron emission of the cathode may be controlled by an electrode 35 15 which is shown in the form of a metallic cylinder surrounding the cathode and lined up with the cathode by being in contact with the outer surface of the cup-shaped portion 24 of the disc. A leading-in wire 36 is connected to the electrode 35 and extends through the disc and press 28 and is connected to terminal 37 on the base 30.

The electrode 35 may be employed as a primary focussing electrode by applying a negative potential thereto to cause the electron emission 25 to follow a path along the axial line of the vessel. When a varying potential is applied to the electrode 35, this electrode functions as a modulating electrode to discontinue the flow of electrons or modify the amount of electrons flowing in the stream. A long tubular metallic electrode 38, which forms the anode or collimating electrode of the electron gun, extends from the top of the insulating housing and is secured thereto by inserting the threaded end through an opening in the top of the insulator cap 21 and securing the anode by a lock nut 39 which engages the inner surface of the cap 21. The anode 38 is provided with a circular flange 40 at the other end which extends radially almost to the wall of the long tubular glass member 16. It will be apparent that the unitary assembly of the electron gun secures accurate lining up of the respective electrodes and this assembly is rigidly supported from the stem 17 so that the flow of electrons is along the axial line of the tubular member 16. Furthermore, the insulating housing insures extremely high insulating paths between the respective electrodes and completely shields the electron source from bombardment by electrons. The flanged portion of the anode also aids in maintaining a high insulating path for the anode since it prevents the deposition of conductive material on the surface of the insulating housing.

One of the uses of a cathode ray discharge device is to reproduce the wave shape or hysteresis curve of electrical phenomena which are to be studied and this is accomplished by applying the electrical phenomena under investigation to deflecting elements which will influence the cathode ray beam projected toward the screen in the vessel to follow or trace the path which is desired to be shown on the screen. Deflection or shifting of the beam or electronic stream may be produced electromagnetically or electrostatically and, in accordance with this invention, electrostatic deflection is employed by arranging two pairs of rectangular plates 41, 42, 43 and 44 in superimposed transverse relation to form a box-like enclosure through which the electronic stream must pass to the screen. These plates are preferably formed of non-magnetic material, such as copper or aluminum. Consequently, the potentials to be studied are impressed on the deflector plates in order to shift the electronic

stream and thereby trace a pattern on the fluorescent screen 13 on the end of the vessel. The deflector plates are rigidly supported on an insulating disc 45 having a central aperture 46 substantially the diameter of the space between the four deflector plates.

In order to obtain the highest efficiency for the operation of the device it is essential that the deflector plates should be accurately spaced with respect to the axial line of the vessel. The accurate alignment of the deflector plates is secured in accordance with this invention by a supporting structure rigidly attached to the stem 14 which is coaxial with the tubular member 16. The insulating disc 45 is secured to a plurality of upright rods 47 by clamping nuts 48 and the rods are attached to equally spaced metallic bands 49 and 50 which are clamped around the stem 14. The deflector plate 41 is supported in a vertical plane by upright rod 51 extending from the disc 45 and directly below the disc 45, the rod 51 is attached to a leading-in wire 52 which is sealed in the annular rim 15 of the stem 14 and extends between the stem 14 and the tubular member 16 to a terminal 53 extending radially from an annular insulating base 54 which is secured to the end of the tubular portion 10 of the vessel. The plate 42 is arranged parallel to the plate 41 and is supported by an upright rod 55 which is connected to a leading-in wire 56 extending from the rim 15 of the stem, the wire 56 being attached to a terminal 57 on the base 54. The plate 43 is supported above the lower plates 41 and 42 in a vertical plane at right angles to the planes of the lower plates by a supporting rod 58 which is attached to the disc 45 and is also connected to a leading-in wire 59 extending through the rim 15 of the stem and finally connected to a terminal 60 on the base 54. The plate 44 is arranged parallel to the plate 43 and supported by upright rod 61 extending from the disc 45 and this rod is attached to a leading-in wire 62 which is finally connected to a terminal 63 extending from the base 54.

It will be noted from Fig. 4 that the parallel arrangement of the two pairs of plates in superimposed relation forms a box-like space through which the stream of electrons pass to the screen. Another important feature of this assembly is the distribution of the leading-in wires for the deflector plates in uniform spaced relation in the rim 15 of the stem so that the electrostatic capacity between the deflector plates is extremely low and the insulation resistance of the stem between the various leading-in wires offers increased protection against shorting.

In order to increase the sensitivity of the deflector plates in accordance with a feature of this invention, the upper pair of plates 43 and 44 are made longer in the direction of the axis of the tube than the lower plates, provided the upper plates have the same special relation as the lower plates, otherwise the upper plates may have the same length as the lower plates, but in this instance these plates should be arranged closer to the axis of the device and thereby compensate for the difference in the longitudinal spacial relation of the plates with respect to the source of emission. As a specific example, the dimensions of the lower plates may be one and one-quarter inches by one and eleven-sixteenths inches while the dimensions of the upper plates may be one and one-quarter inches by two inches, so that the relative areas of the plates are approximately in the ratio of 2.50 to 2.11. If all

the plates have the same area, the upper plates may be spaced one-half inch apart while the lower plates are spaced five-eighths of an inch lower.

The device of this invention is highly evacuated in order to eliminate conduction between the deflector plates due to ions and also to eliminate space charge due to positive ions. The highly evacuated condition of the device overcomes change in focus and sensitivity of the beam when modulation takes place and the beam is more sensitive to high frequencies because of the absence of the ion sheath around the beam. Furthermore, the absence of a gas in the device increases the life of the cathode and the device since there is no bombardment due to ions. However, in highly evacuated devices it is essential to screen the beam completely from the glass walls of the device since it is possible that an electric charge may build up on the glass walls of the vessel, thereby forming an electric field which may deleteriously affect the electronic stream projected toward the end of the vessel.

In accordance with this invention, the inner wall of the vessel is provided with an electrostatic screening in the form of a conductive film coated or deposited thereon. A highly desirable conductive film may consist of a carbonaceous coating 64 which may be applied to the inner wall of the enclosing vessel by a method such as disclosed in a copending application of H. W. Weinhart, Serial No. 740,877 filed August 22, 1934. This coating may be applied in the form of "Aquadag", which is colloidal graphite in solution, and when dry forms an opaque non-reflecting film that will prevent the accumulation of charges on the glass wall of the vessel and at the same time produce the necessary electrostatic screening in order to project the beam toward the fluorescent screen on the end of the vessel. The tubular glass member 16 is also provided with a carbonaceous film 65 and this film extends from the anode 38 to a point well within the boundary of the stem 14, in order to prevent the charging of the wall of the tube 16 and to provide electrostatic screening of the electronic beam.

An important object in the use of carbonaceous coating is that it is non-reflecting, thereby preventing the light of the spot from being reflected back on the screen to produce a diffused background illumination. A further feature of the invention is to connect these electrostatic screens or coatings to the anode so that the electronic beam travels the full length of the device in substantially a field-free space. The connection of the film to the anode is accomplished by the use of a frictional expansion spring, for instance, as shown more clearly in Fig. 2, in which a helical metallic spring 66 is expanded within the tubular member 16 and contacts with the carbon coating 65. The end of this spring is attached to the flange 40 of the anode 38. The carbon coating 64 on the wall of the vessel is connected to the carbon coating in the tubular member 16 by a double helical spring having a friction portion 67 expanded into contact with the coating 64 and a friction portion 68 in contact with the upper end of the coating 65 in the tubular member 15. Both of these friction portions are joined to a bent wire connection 69 which extends around the insulating plate 45 and enters the tubular member 16 adjacent the top of the stem 14. A suitable accelerating voltage or potential is applied to the anode and the carbonaceous films

by means of a terminal 70 on the base 54 and this terminal is connected to a leading-in wire 71 which extends through the top of the stem and is joined to the connecting portion 68 of the double expansion spring.

Instead of coating the interior of the tubular member 16 with a carbonaceous material, the results of the invention may also be attained by an arrangement as shown in Fig. 5 in which a non-magnetic metallic tube 72, preferably of aluminum, is centrally supported by the apertured insulating disc 45 and extends through the tubular member 16 substantially to the end of the anode 38. In this case the friction spring 66 attached to the anode 38 is in contact with the internal surface of the non-magnetic tube 72 and the lower portion 68 of the double expansion spring is omitted and the connecting wire 69 terminated by wrapping around the metallic tube 72 as shown at 73 in Fig. 5.

The advantages of the carbonaceous coating or film are: It is easier to apply than a metallic coating, it also preserves the vacuum by absorbing gas after the tube is sealed-off, and it has a very low reflecting power for light so that the light from the fluorescent spot is not reflected back diffusely over the whole screen. Furthermore, by connecting the carbonaceous coating to the anode, the return of electrons from the screen to the deflector plates is largely prevented thereby insuring still higher impedance between the deflector plates.

The purpose in arranging the electron gun in a long tubular member projecting from the main enclosing vessel is to project the electronic stream from a source to a point where the magnetic focussing arrangement of this invention is applied. As shown in Figs. 1 and 5, a magnetic coil 74, of small diameter, slides over the tubular member 16 and is positioned close to the base 54 on the end of the vessel. A magnetic field is set up by a steady electric current flowing through the coil. This magnetic field acts in a well-known manner to focus the electrons in a sense analogous to the focussing of a light beam by a lens. In order to focus the electrons in a small spot on the screen the field must be of a certain strength as determined by the number of turns of wire in the coil and the strength of the current flowing in it, for any given position of the coil. The magnetic field established within the tubular member 16 by the coil 74 causes the lines of force to converge the electronic stream into a pencil of light which appears on the screen as a spot of intense luminosity and small diameter. The magnetic focussing coil is made small in order that the magnetic field does not extend into the space occupied by the deflector plates since any appreciable field between the deflector plates will cause a decrease in sensitivity and a twisting of the axis of the beam and therefore cause inequality of the beam between the two pairs of plates. As a practical illustration of the position of the magnetic focussing coil, it is desirable that the distance of the plates from the coil should be at least three times the diameter of the coil. Of course, the size of the coil is dependent on the number of turns in the winding and this is determined by the voltage applied to the anode. For any given anode voltage, a certain number of ampere turns in the coil will focus the electrons in a small spot on the screen. The support of the magnetic coil 74 may be accomplished in several ways. For instance, if the cathode ray device

is arranged in a horizontal position, the coil may be slidably supported merely by frictional contact with the tubular portion 16 of the vessel since the coil closely embraces the glass tubular portion. However, if the device is arranged for vertical projection the coil may be held in position by spring clips 75 which are attached to and extend from the lower surface of the base 54.

While various features of this invention are shown and described as embodied in several forms, it should be understood that the combination of these features is not limited to the specific disclosures set forth, since it is apparent that one or more features may be incorporated in other structures for performing their respective functions, and, therefore the invention is only to be limited within the scope of the appended claims.

What is claimed is:

1. A cathode ray discharge device comprising a vessel having tubular portions of different diameters, an electron source located in the smaller diameter portion thereof at one end, a fluorescent screen at the other end, a collimating anode adjacent said electron source for projecting a narrow beam of electrons to said screen, a set of deflector plates located in the larger diameter portion of said vessel intermediate said anode and screen, and a magnetizing coil embracing said smaller diameter portion for focusing said beam, said coil being so proportioned and so spaced with respect to said deflector plates and anode that the magnetic field is concentrated in a region which excludes the field from said deflector plates.

2. A cathode ray discharge device comprising a vessel having a stem, a central elongated tube extending outwardly from said stem, an electron emitting element supported in said tube, a tubular anode extending beyond said element within said tube, a plurality of deflecting plates supported by said stem, and a magnetic focussing coil surrounding said tube intermediate said anode and said deflecting plates.

3. A cathode ray discharge device comprising a vessel having a stem, a central elongated tube extending outwardly from said stem, said tube having an inwardly projecting stem, an electron emitting element supported by said tube stem, a tubular anode extending beyond said element within said tube, a plurality of deflecting plates supported on said first stem, and a magnetic coil frictionally supported on said elongated tube closely adjacent said first stem.

4. A cathode ray discharge device comprising a vessel having a stem, a central elongated tube extending outwardly from said stem, an electron emitting element supported in said tube, a tubular anode extending beyond said element within said tube, a plurality of deflecting plates supported by said stem, a magnetic focussing coil surrounding said tube intermediate said anode and deflecting plates, a base on the end of said tube, said base having terminals for said element, and a base on said vessel having terminals for said deflecting plates and said anode.

5. A cathode ray discharge device comprising a vessel having a stem, a central elongated tube extending outwardly from said stem, an electron emitting element supported in said tube, a tubular anode extending beyond said element within said tube, a plurality of deflecting plates supported on said stem, a magnetic focussing coil surrounding said tube intermediate said anode and deflecting plates, a base on the end of said

tube having terminals for said element, and an annular base carried by said vessel having radially extending terminals for said deflecting plates and said anode.

5 6. A cathode ray discharge device comprising a vessel having a stem, a central elongated tube extending outwardly from said stem, an electron emitting element supported in said tube, a tubular anode extending beyond said element within
10 said tube, a plurality of deflecting plates supported on said stem, a magnetic focussing coil surrounding said tube, a base on the end of said tube having terminals for said element, a base carried by said vessel having terminals for said
15 deflecting plates and said anode, and means on said second base supporting said coil.

7. A cathode ray discharge device comprising a vessel having an electron source at one end, a fluorescent screen at the other end, a collimating anode adjacent said electron source, a mag-
20 netic coil surrounding said vessel adjacent said anode, a plurality of conductive surfaces adjacent the walls of said vessel, and helical contact springs connecting said surfaces in series with
25 said anode.

8. A cathode ray discharge device comprising a vessel having an electron source at one end, a fluorescent screen at the other end, a collimat-
30 ing anode adjacent said electron source, a magnetic coil surrounding said vessel adjacent said anode, a plurality of separate carbonaceous films on the walls of said vessel, and internal
spring contact means connecting said films in series with said anode.

9. A cathode ray discharge device comprising a vessel having a stem, a central tube extending
35 outwardly from said stem, an electron emitting element supported within said tube, a tubular anode extending beyond said element within said tube, a non-metallic film on the wall of said ves-
40 sel, a tubular member of non-magnetic material extending between said stem and said anode within said tube, connections between said film and member and said member and anode, and a
45 magnetic focussing coil surrounding said tube and tubular member.

10. A cathode ray discharge device comprising a vessel having a stem, a central tube extending
50 outwardly from said stem, an electron emitting element supported within said tube, a tubular anode extending beyond said element within said tube, a conductive coating on the wall of said
vessel, conductive means extending substantially from said stem to said anode within said tube,
55 a magnetic coil surrounding said conductive means and tube, and a plurality of expansible conductive members connecting said anode to said conductive coating and conductive means.

11. A cathode ray discharge device comprising
60 a vessel having a stem, a central tube extending outwardly from said stem, an electron emitting element supported within said tube, a tubular anode extending beyond said element within said
tube, a conductive coating on the wall of said
65 vessel, conductive means extending substantially from said stem to said anode within said tube, an expansion spring connecting said anode to said conductive means, an expansion spring connect-
ing said coating to said conductive means, and
70 a leading-in conductor in said stem connected to said second expansion spring.

12. A cathode ray discharge device comprising a vessel having a stem, a central elongated tube
75 emitting element supported within said tube, a

tubular anode extending beyond said element within said tube, a plurality of uprights extend-
ing beyond the stem of said vessel, a deflecting plate attached to each of said uprights, the plates
being arranged in superimposed pairs at right
5 angles to each other, and an insulating plate at-
tached to said uprights intermediate said plates and stem, said insulating plate being carried by
said stem and having an aperture in alignment
10 with said elongated tube.

13. A cathode ray discharge device comprising a screen, an electron gun for projecting a stream
of electrons to said screen, and a plurality of de-
flector plates between said gun and screen, said
electron gun including an electronic emitter, a
15 housing surrounding said emitter, said housing
having a central aperture in alignment with the
end of said emitter, and a tubular anode having
a cross-sectional area less than the cross-sectional
area of said housing projecting through the aper-
20 ture and supported by said housing.

14. A cathode ray discharge device comprising a screen, a plurality of deflector plates, an elec-
tron gun for projecting a stream of electrons be-
tween said plates toward said screen, said gun
25 comprising an elongated tube projecting from
one end of said device, a unitary housing sup-
ported in said tube including a disc having a cen-
tral elevated portion, a heater element extending
beyond said portion, a metallic thimble enclosing
30 said heater element and fitted over said elevated
portion, an insulating cap enclosing said thimble,
fastening means securing said cap to said disc, a
metallic tubular anode extending from the end
of said cap, and means securing said anode to
35 said cap.

15. A cathode ray discharge device comprising an enclosing vessel having a tapered portion, a
dome portion and a reentrant stem, a fluorescent
material deposited on the interior of said dome
40 portion, a carbonaceous material deposited on
said tapered portion a plurality of deflecting
plates supported from said stem and arranged in
vertical planes equidistant from the axis of said
vessel, leading-in conductors sealed in said stem
45 and connected to said plates, an elongated sealed
glass tube extending centrally from said stem,
said tube also having a reentrant stem, a collar
on said tube stem upright rods carried by said
collar, an insulating housing secured to said rods,
50 an equipotential cathode axially supported with-
in said housing, a tubular metallic anode extend-
ing from said housing and axially supported with
respect to said cathode, an elongated conductive
member between said anode and said deflector
55 plates, means connecting said conductive mem-
ber to said anode and connecting said carbona-
ceous material to said conductive member, and
a leading-in conductor in said first stem connect-
ed to said means.

16. A cathode ray discharge device comprising
60 an enclosing vessel having a tapered portion, a
dome portion and a reentrant stem, a fluorescent
material on the interior of said dome portion, a
carbonaceous material on said tapered portion,
65 an insulating plate having a central aperture sup-
ported beyond said stem, a plurality of deflecting
plates supported by said insulating plate and ar-
ranged in vertical planes equidistant from the
axis of said vessel, leading-in conductors sealed
70 in said stem and connected to said plates, an
elongated sealed glass tube extending centrally
from said stem, said tube also having a reen-
trant stem, a collar on said tube stem, upright
rods carried by said collar, an insulating housing
75

secured to said rods, an equipotential cathode enclosed in said housing, a tubular metallic anode extending from said housing and axially supported with respect to said cathode, tubular conductive member between said anode and said deflecting plates, means frictionally connecting said conductive member to said anode and connecting said carbonaceous material to said conductive member, and a leading-in conductor in said first stem connected to said means.

17. A cathode ray discharge device comprising an enclosing vessel having a tapered portion, a dome portion and a reentrant stem, a fluorescent screen on said dome portion, a carbonaceous film on said tapered portion, an insulating plate having a central aperture supported from said stem, a plurality of deflecting plates extending from said insulating plate and arranged in vertical planes which encompass the boundary of the aperture in said insulating plate, leading-in conductors sealed in said stem and connected to said plates, said stem having an elongated tubular member extending outwardly therefrom, said tubular member having a reentrant stem, a collar on said stem, upright rods carried by said collar, an insulating housing secured to said rods, an equipotential cathode axially supported within said housing, a tubular metallic anode extending from said housing and supported axially with re-

spect to said cathode, a metallic tubular member supported from said insulating plate and extending toward said anode within said stem tubular member, a friction spring engaging the interior surface of said metallic tubular member and connected to said anode, a second friction spring connected to said carbonaceous film and to said metallic tubular member, and a leading-in conductor in said stem connected to said second friction spring.

18. A cathode ray device comprising an elongated vessel having a fluorescent screen at one end and a stem at the other end terminating in a long tubular projecting extension, an electron gun including an anode supported within said extension for projecting a cathode ray beam toward said screen, a plurality of deflector plates supported from said stem and arranged in parallel pairs about the axial line of the beam, an electrostatic focusing shield surrounding the cathode beam and deflector plates within said vessel and said extension and extending from said anode to said screen, said shield being connected to said anode, and a magnetic focussing coil contiguously surrounding said extension and located intermediate said anode and said deflector plates.

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