July 16, 1940. H. W. WEINHART 2,207,841

ELECTRIC DISCHARGE DEVICE

Filed Nov. 25, 1932

FIG. 1

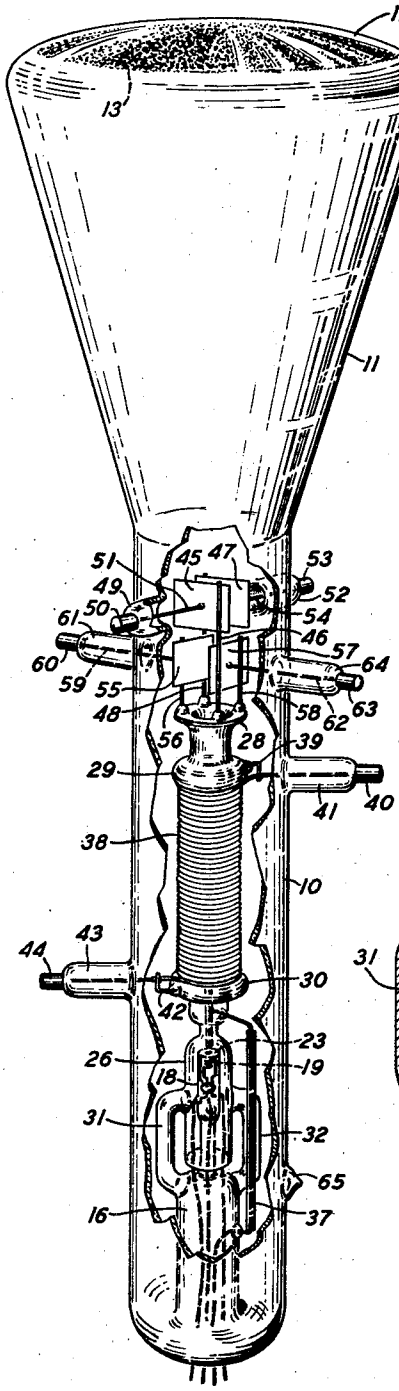


FIG. 2

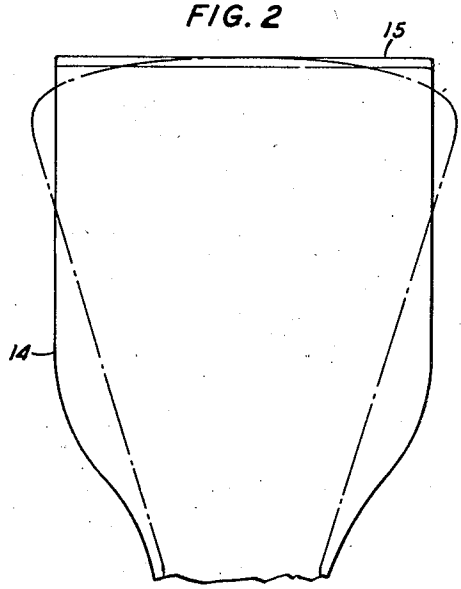


FIG. 3

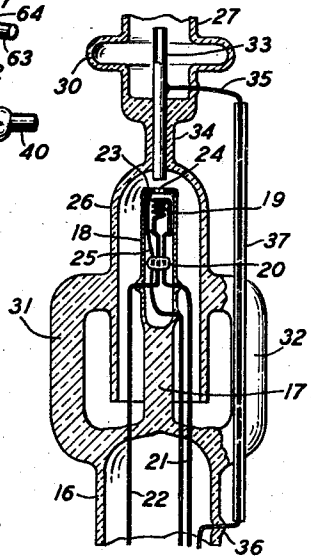


FIG. 4

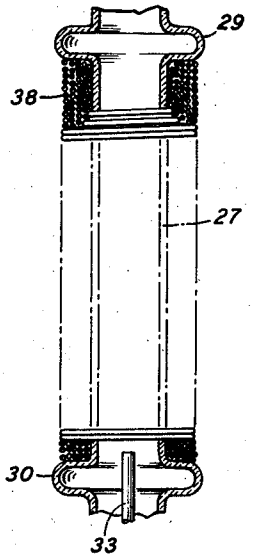
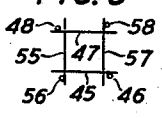


FIG. 5



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ELECTRIC DISCHARGE DEVICE

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20 Claims. (Cl. 250—161)

This invention relates to electric discharge devices and more particularly to a device in which a beam of cathode rays is projected toward a screen adjacent the end of the device.

This invention will be hereinafter described in connection with the type of electric discharge device known in the art as the Braun tube which is used primarily for the measurement or the indication of electric power, the wave form of alternating current or potential, or similar conditions in electrical circuits.

One of the difficulties of this type of device is its relatively short life due to the filamentary cathode burning out after a relatively short period. When a gas is used in the device for the purpose of focussing or providing a conducting medium for the cathode beam, positive ions are produced in the space discharge between the cathode and anode causing deterioration of the cathode coating and tending to reduce the operating life of the device. Furthermore, the use of a gas as a focussing aid limits the potentials which may be applied to the electrodes.

Another difficulty generally experienced with this type of device is the low actinic value of the pencil or beam of cathode rays projected toward the screen of the device. The low actinic value of the pencil of rays is due to a normal diffusion of the pencil of rays in the device. In order to take advantage of the low intensity of light produced in the device it has been necessary to enclose the device in a dark chamber or perform the measuring operations in a dark room.

An object of this invention is to concentrate the beam of cathode rays in an electric discharge device so that the pattern of the wave projected on the screen of the device may be readily observed in daylight. This can only be accomplished when the beam of cathode rays is concentrated to a high degree.

In accordance with this invention, the beam of cathode rays emanating from the cathode is focussed on the screen by an internal magnetic winding which prevents dispersion of the pencil of cathode rays passing through the vessel to the screen. In a preferred embodiment of the invention the electric discharge device comprises an enclosing vessel having a coating deposited on one end which is capable of becoming fluorescent when a cathode ray beam is directed toward it, and arranging the electrodes at the other end of the vessel in a vertical line along the axis of the vessel. The electrodes are supported on a glass superstructure extending from the stem which includes a hollow glass vessel enclosing the cathode, focussing disc and anode and a glass column adjacent the anode and surrounded by an electromagnetic winding having the ends thereof sealed in the side wall of the vessel. A plurality of deflecting plates are supported on one end of the glass column to alter the path of the cathode beam as it leaves the glass column. The device is highly evacuated in order to operate at high voltages. The internal magnetic winding tends to concentrate the beam of cathode rays and prevents the accumulation of electric charges on the glass wall of the device.

A feature of the invention relates to the concentration of the beam of rays as close as possible to the axis of the vessel. In order to accomplish this result the magnetic focussing coil is supported in immediate proximity to the axis of the vessel and the cathode ray beam passing through the coil is continually within the focussing field of the coil in its passage from the anode to the deflecting plates.

Another feature of the invention relates to a unitary support which maintains the elements of the cathode ray tube in alignment in the device. This support consists of a cylindrical mount or column having a chamber enclosing the cathode, a bobbin portion supporting the magnetizing coil and a flared portion supporting the deflecting plates. This mount is supported solely from the stem of the vessel and provides an assembly which may be constructed as a unit before incorporating it in the device.

A further feature of this invention is that the mount is constructed to form retaining and anchoring means for the magnetizing coil so that the leading-in wires sealed in the vessel are relieved from strains.

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 an enlarged perspective view of a cathode ray tube made in accordance with this invention with a portion of the enclosing vessel broken away to show the internal assembly of the electrodes;

Fig. 2 is a diagrammatic showing of a portion of the enclosing vessel illustrating a modification of the vessel to provide a flat end portion. In this figure the modified glass portion is superposed on a configuration of the vessel as disclosed in Fig. 1 to indicate the proportions of the different forms;

Fig. 3 is an enlarged detail view in cross-section of the electrode assembly shown in the lower

portion of Fig. 1 illustrating the support of the cathode and anode in relation to the glass column and the support of the column from the glass stem;

Fig. 4 is an enlarged view, partly in cross-section of the portion of the glass column supporting the magnetizing coil; and

Fig. 5 is a diagrammatic view showing the relationship of the deflecting plates and the position of the supports of the plates extending from the glass column in Fig. 1.

Referring to the drawing, the electric discharge device of this invention comprises an enclosing vessel having an elongated cylindrical portion 10, an extending conical portion 11 and a concave end portion 12, the end portion 12 serving as a depository surface for an internal coating of material 13, such as zinc silicate and calcium tungstate. This material, which forms a screen in the device, becomes fluorescent when a cathode ray beam is directed toward the material and is capable of showing the trace or form of an electric wave so that the wave may be viewed visually or photographic reproduction made of the wave form traced on the screen. The fluorescent screen may also be deposited on a flat surface as shown in the modification of Fig. 2 in which the conical portion 11 of the vessel is changed to a cylindrical portion 14 and a glass disc 15 having a diameter the same as the internal diameter of the cylindrical portion 14 is fused to the cylindrical portion to provide a tight sealed joint.

The enclosing vessel is provided with an inwardly projecting stem 16 which is fused to the elongated cylindrical portion 10 and forms a seal for the leading-in wires of the electrodes and a support for the electrodes. The stem 16 is provided with a central integral projection 17 which terminates in a tubular hollow portion 18 open at its free end. The tubular portion 18 forms a chamber for a helical ribbon cathode 19 of the oxide coated type which is maintained in position by a glass bead 20 and the cathode and bead are supported in the tubular chamber 18 by the leading-in wires 21 and 22 which project from opposite sides of the chamber 18 and are sealed in the glass portion of the stem 16. Although a filamentary form of cathode is shown in the device of this invention, it is, of course, understood that any indirectly heated cathode may be substituted for the filamentary cathode. The chamber formed by the tubular glass portion 18 is substantially closed at one end by an apertured metallic focussing disc 23 which is sealed into the edge of the glass tubular portion 18 and permits emanation of electrons from the cathode through the aperture 24 of the disc. A leading-in wire 25 attached to the disc 23 extends through the bead 20 and is sealed in the stem 16 to apply a suitable potential to the focussing disc.

A unitary mount or column is supported from the glass stem and consists of a bell-shaped portion 26, which forms a chamber around the cathode assembly and segregates the leading-in wires for the cathode and disc, an elongated tubular bobbin portion 27, shown more clearly in Fig. 4, and an outwardly flared termination 28. The mount is provided with spaced annular blown portions 29 and 30 intermediate the bell-shaped portion 26 and the flared termination 28. It will be evident from the disclosure that the bobbin portion 27 and the flared termination 28 provide a central tubular chamber for the passage of the cathode ray beam. The unitary mount may be supported solely from the stem 16, for instance, by glass arms 31 and 32 which are fused to the bell-shaped portion 26 and the stem 16. A tubular metallic anode 33 is supported in a solid glass portion 34 intermediate the bell-shaped portion 26 and the bobbin portion 27 of the mount and forms a communicating passageway for the cathode beam between the tubular chamber of the mount and the aperture 24 in the focussing disc 23. A leading-in wire 35 is attached to the tubular anode 33 and extends exterior to the bell-shaped portion 26 and is sealed in the glass stem 16 at 36. The portion of the leading-in wire extending between the anode and the seal is surrounded by a glass tubular member 37.

The emanation of electrons from the heated cathode and the projection of the electrons through the primary focussing disc 24 serve to produce an electron stream or cathode ray beam which is projected through the tubular anode 33. After leaving the anode the beam normally has a tendency to spread out or disperse and consequently reduces the intensity of the beam which is desired to be projected to the screen on the end of the vessel. In accordance with this invention the cathode beam after leaving the anode is focussed magnetically and concentrated in immediate proximity to the axis of the vessel to insure a pencil of light of high intensity and high actinic value so that the trace of the beam on the screen may be observed in daylight without the aid of a dark chamber surrounding the device. This is accomplished by placing an electromagnet winding 38 around the glass column or mount and entirely within the enclosing vessel of the device.

The electromagnet winding consists of a number of layers of preglowed copper wire and the turns thereof are coated with vacuum-treated insulation, such as lacquer or fused aluminum oxide, commercially known as "Alundum" cement. The winding is placed on the bobbin portion of the mount and the spaced blown portions 29 and 30 maintain the winding in position. An anchor wire 39 is fused into the blown portion 29 and attached to one end of the winding adjacent the coil, to relieve strain on the termination of the winding which projects out to a terminal 40 fastened to a projection 41 on the vessel 10, the termination of the winding being attached to a suitable leading-in wire sealed in the end of the projection 41. A similar anchor wire 42 is fused in the blown portion 30 of the mount in a position 180° from the position of the anchor wire 39 in the portion 29. The anchor wire 42 is attached to the other termination of the winding 38 to relieve strains on the leading-in wire extending to extension 43 and the extension is provided with a terminal cap 44 to which the end of the winding is soldered. This arrangement places the external connections of the electromagnet coil at diametrically opposite points on the exterior of the vessel and they are arranged in alignment with the terminations of the winding as they leave the bobbin portion of the mount.

When current flows through the magnetizing winding 38 an intensive magnetic field surrounds the axis of the vessel within the tubular chamber formed by the mount. The cathode beam projected from the tubular anode 33 is focussed by this magnetic field to insure a beam of high intensity and high actinic efficiency.

The control of the cathode ray beam after leaving the magnetic focussing field is accomplished by a plurality of deflector plates which are arranged adjacent the exit of the tubular mount in the device. These plates are arranged in pairs as shown in the drawing and one pair is at right angles to the other pair to form a rectangular space, as shown in Fig. 5, for the passage of the cathode beam. As shown in Fig. 1, a deflector plate 45 is arranged parallel to the axis of the vessel and supported by a wire 46 which is fused into the rim of the flared portion 28 of the mount. A companion plate 47 is arranged parallel to plate 45 and supported from the flared portion 28 by an upright wire 48. A tubular projection 49 extends from the portion 10 of the enclosing vessel and is provided with a terminal cap 50 which is in alignment with the center of the deflector plate 45. The terminal cap 50 and the plate 45 are connected together by a straight leading-in wire 51. Diametrically opposite the projection 49 is a similar projection 52 which carries a terminal cap 53 attached to a leading-in wire 54 connected to the center point of the deflector plate 47. A similar pair of deflector plates 55 and 57 are arranged below the deflector plates 45 and 47, but are positioned at right angles to the planes of the deflector plates 45 and 47. The plates 55 and 57 are supported from the flared portion 28 of the mount by supporting wires 56 and 58, respectively.

It will be noted from Fig. 5 that the plates 55 and 57 extend in parallel planes within the supports 46 and 48 of deflector plates 45 and 47 so that the lower plates are not in contact or electrically connected to the other pair of plates. The deflector plate 55 is provided with an external connection by a straight leading-in wire 59 which extends from the center of the plate 55 to a terminal 60 on the end of an extension 61 formed on the wall of the tubular portion 10 of the vessel. A similar connection is made for the deflector plate 57 by the straight wire 62 extending from the center point of the plate 57 to a terminal 63 on the integral extension 64 of the vessel. These individual terminal connections for the deflector plates may be utilized to apply different methods of control to the cathode ray beam in its passage to the fluorescent screen on the end of the device. The device is highly evacuated and after obtaining the desired degree of evacuation the enclosing vessel is sealed off at 65.

While the features of this invention have been described and illustrated in a particular embodiment, it is, of course, understood that the invention is not limited to the specific assembly shown but that the various elements may be combined in other forms and the invention is only to be limited within the scope of the appended claims.

What is claimed is:

1. An electric discharge device comprising a vessel having a fluorescent screen at one end, a cathode and an anode for projecting a cathode ray beam toward said screen along the axis of said vessel, deflecting plates for acting on said beam, electromagnetic focussing means within said vessel, and a unitary mount supporting said anode, electromagnetic means and plates with respect to said cathode and screen.

2. An electric discharge device comprising a vessel having a fluorescent screen at one end, a cathode and an anode for projecting a cathode ray beam toward said screen, a plurality of deflecting plates for acting on said beam, an elongated tubular member surrounding said cathode and anode and through which said beam is directed, and magnetic focussing means supported by said member, said member also supporting said anode and deflecting plates.

3. An electric discharge device comprising a vessel having a fluorescent screen at one end, a cathode and an anode for projecting a cathode ray beam toward said screen along the axis of said vessel, deflecting plates for acting on said beam, magnetic focussing means between said plates and anode, and a hollow mount within said vessel supporting said anode, magnetic means and plates coaxially with respect to said cathode and screen.

4. An electric discharge device comprising a vessel having a fluorescent screen at one end, a cathode adapted to project a cathode ray beam towards said screen, a cylindrical mount supported beyond said cathode, a magnet winding thereon, a tubular anode supported on one end of said mount, and a plurality of deflecting plates supported on the other end of said mount.

5. An electric discharge device comprising a vessel having a fluorescent screen at one end, a cathode adapted to project a cathode ray beam toward said screen, a cylindrical mount supported in said vessel adjacent said cathode, a tubular anode supported by said mount at one end, a plurality of deflecting plates supported by said mount at the other end, a magnet winding surrounding said mount, and confining means on said mount for said winding.

6. An electric discharge device comprising a vessel having a fluorescent screen at one end, a cathode adapted to project a cathode ray beam toward said screen, a cylindrical mount supported in said vessel, a tubular anode within said mount at one end, a plurality of deflecting plates supported on the other end of said mount, and a magnet winding on the exterior surface of said mount, said mount having integral projections for maintaining said winding in position.

7. An electric discharge device comprising a vessel having a fluorescent screen at one end, a cathode adapted to project a cathode ray beam toward said screen, a cylindrical mount supported in said vessel, a tubular anode within said mount, a plurality of deflecting plates supported by said mount at one end, a magnet winding surrounding said mount, confining means on said mount for said winding, and anchoring means on said confining means for the terminations of said winding.

8. An electric discharge device comprising a vessel having a fluorescent screen at one end, a cathode at the other end adapted to project a cathode ray beam toward said screen, a cylindrical mount supported adjacent said cathode, said mount having a separate hollow portion surrounding said cathode, a tubular anode forming a communicating passageway between said hollow portion and said mount, a plurality of deflecting plates supported by said mount at one end, and a magnet winding supported on the exterior surface of said mount.

9. An electric discharge device comprising a vessel having a stem at one end, a fluorescent screen at the other end, a cathode supported from said stem adapted to project a cathode ray beam toward said screen, a cylindrical mount in said vessel, a tubular anode within said mount, a plurality of deflecting plates supported on one end of said mount, a magnet winding supported on the external surface of said mount, and means

forming the sole support for said mount from said stem.

10. An electric discharge device comprising an enclosing vessel having a fluorescent screen at one end, a cathode at the other end adapted to project a cathode ray beam toward said screen, a cylindrical mount supported in said vessel coaxial with said cathode, a tubular anode within said mount, a magnet winding on the exterior surface of said mount, a plurality of deflecting plates disposed on one end of said mount, and leading-in wires sealed in said vessel in direct line with the center of each of said deflecting plates.

11. An electric discharge device comprising an enclosing vessel having a stem at one end, a fluorescent screen at the other end, a member forming a plurality of contiguous hollow chambers supported from said stem, a tubular anode positioned between said chambers, a cathode supported within said chamber adjacent said stem, a plurality of deflecting plates supported from the other end of said member, and a magnetic coil supported by said member intermediate said anode and deflecting plates.

12. An electric discharge device comprising an enclosing vessel having a stem at one end, a fluorescent screen at the other end, a cathode supported from said stem and adapted to be heated to emit a stream of electrons toward said screen, a tubular anode adjacent said cathode through which said stream is projected, a plurality of deflecting plates parallel to the axis of said vessel, and an internal magnetizing winding extending subtantially the distance between said plates and anode and surrounding a path therebetween for focussing said cathode stream toward said screen.

13. A cathode ray tube comprising an enclosing vessel having a stem terminating in a tubular portion, a cathode supported in said tubular portion, a perforated disc on one end of said tubular portion, a refractory hollow column supported from said stem, said column having a bell-shaped portion surrounding said tubular stem portion, an anode supported by said column adjacent said disc, a magnetic coil supported by the major portion of said column, a plurality of deflecting plates extending from one end of said column, and a fluorescent screen located on the end of said vessel opposite said stem.

14. A cathode ray tube comprising an evacuated vessel having a stem, an integral extension on said stem forming a hollow portion, an electron emitting cathode supported in said hollow portion adapted to emit a cathode ray beam, an apertured metallic disc closing said hollow portion, an elongated refractory column having a bell-shaped portion, a bobbin portion and a flared termination, said bell-shaped portion surrounding said hollow stem portion, a magnet winding on said bobbin portion, a tubular anode, said anode being sealed in an intermediate portion of said column between said bobbin and bell-shaped portions, a plurality of deflecting plates supported from said flared termination, supporting arms joining said column to said stem, leading-in wires for said cathode and disc extending between said stem extension and said bell-shaped portion, a leading-in wire for said anode extending from said stem to said anode exterior of said bell-shaped portion, leading-in wires for said magnet winding sealed in said vessel adjacent the terminations of said winding, leading-in wires for said plates sealed in said vessel in direct line with the center of each of said plates, and a fluorescent screen on the end of said vessel adapted to indicate the trace of said cathode ray beam.

15. A cathode ray tube comprising an enclosing vessel, a cathode adapted to emit a stream of electrons supported in said vessel at one end thereof, a fluorescent screen at the opposite end of said vessel, an accelerating anode between said screen and said cathode and positioned to impart when energized the final acceleration to said stream of electrons, thereby enabling said stream to impact said screen, and an electromagnetic coil supported within said vessel and located to surround said stream of electrons after it has been finally accelerated by said anode.

16. A cathode ray tube comprising an enclosing vessel, a cathode adapted to emit a stream of electrons supported in said vessel, a fluorescent screen at the opposite end of said vessel, an anode between said screen and said cathode and having a beam canal therein shaped to finally define the cross-sectional shape of said stream, and an electromagnetic coil supported within said vessel and located to surround said stream after said stream has been finally defined.

17. A cathode-ray tube comprising an electron source, a control electrode, an anode, deflecting plates, means for rigidly securing said electron source, control electrode, anode and plates together in spaced insulated relation, an evacuated vessel for enclosing and supporting said elements, a stem extending into said vessel, means for supporting said electron source on said stem, hollow arms projecting radially from an intermediate portion of said vessel adjacent said plates, and a conductor extending from each plate through an adjacent arm.

18. A cathode-ray tube comprising an evacuated vessel, a stem extending thereinto, a unitary structure supported on said stem comprising an electron emitter, a control electrode, an accelerating anode and sets of deflector plates, arms projecting from a portion of said vessel adjacent said plates, and conductors extending from said plates through said arms.

19. A cathode-ray tube comprising an electron source, a control electrode, an anode, deflecting plates, means for rigidly securing said electron source, control electrode, anode and plates together in spaced insulated relation, an evacuated vessel for enclosing and supporting said elements, a stem extending into said vessel, means for supporting said electron source on said stem, hollow arms projecting radially from an intermediate portion of said vessel adjacent said plates, a terminal cap on the end of each arm, and a flexible conductor extending from each plate through an adjacent arm to the associated terminal cap.

20. A cathode-ray tube comprising an evacuated vessel, a stem extending thereinto, a unitary structure supported on said stem comprising an electron emitter, a control electrode, an accelerating anode and sets of deflecting plates, arms projecting from a portion of said vessel adjacent said plates, and flexible conductors extending from said plates through said arms.

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