

July 29, 1941.

R. M. BOWIE

2,250,622

CATHODE-RAY TUBE AND METHOD OF MANUFACTURE THEREOF

Filed Feb. 17, 1939

4 Sheets-Sheet 1

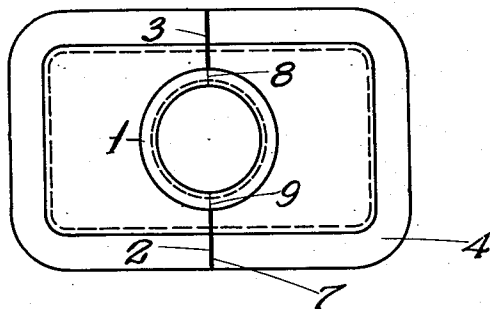


Fig. 2

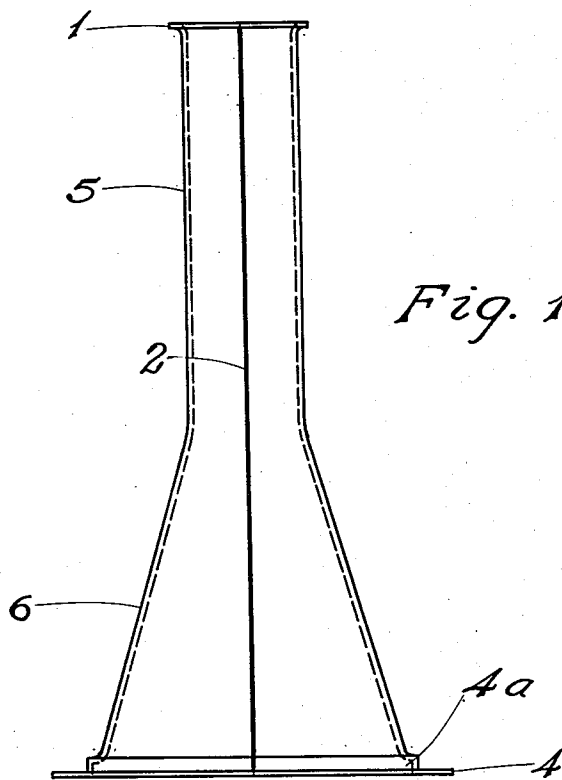


Fig. 1

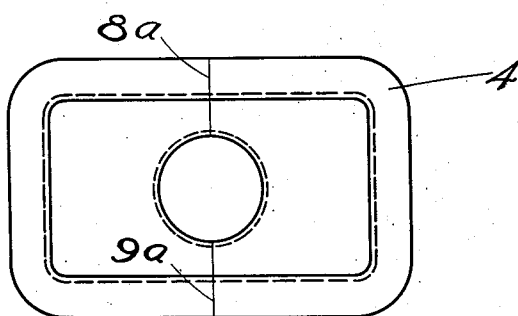


Fig. 3

Robert M. Bowie
INVENTOR.

BY *John J. Rogers*
ATTORNEY

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R. M. BOWIE

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4 Sheets-Sheet 2

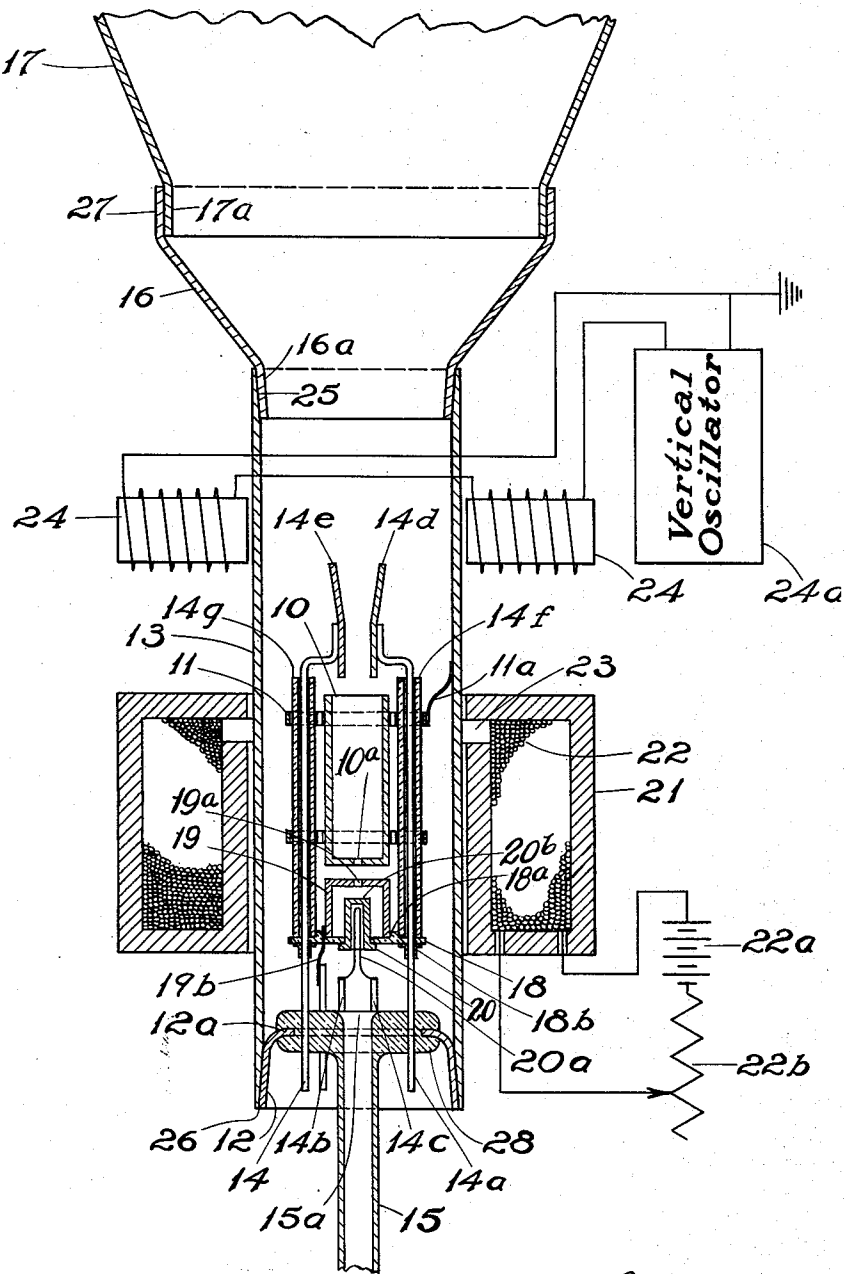


Fig. 4

Robert M. Bowie
INVENTOR.

BY John J. Rogan
ATTORNEY

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R. M. BOWIE

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4 Sheets-Sheet 3

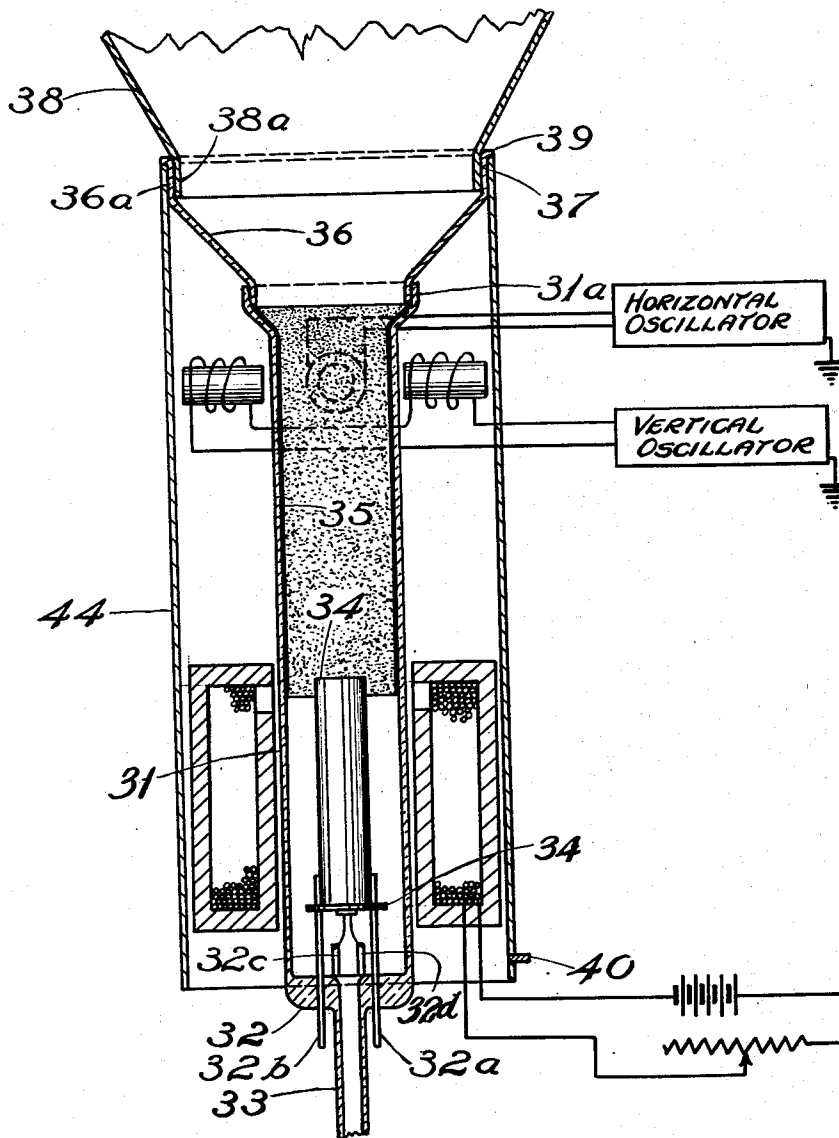


Fig. 5

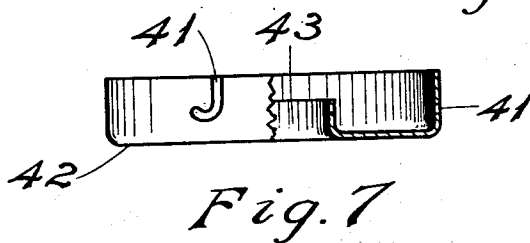


Fig. 7

Robert M. Bowie
INVENTOR.

BY John J. Rogan
ATTORNEY

July 29, 1941.

R. M. BOWIE

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4 Sheets-Sheet 4

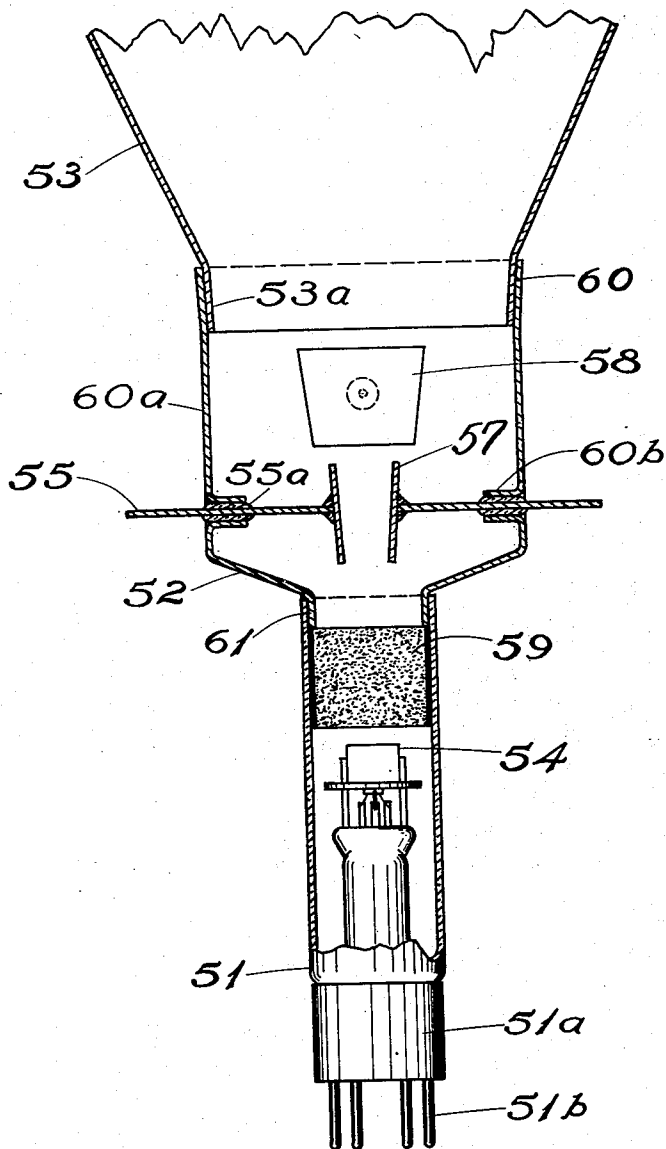


Fig. 6

Robert M. Bowie
INVENTOR.

BY John J. Logan
ATTORNEY

UNITED STATES PATENT OFFICE

2,250,622

CATHODE-RAY TUBE AND METHOD OF
MANUFACTURE THEREOF

Robert M. Bowie, St. Marys, Pa., assignor to Hy-
grade Sylvania Corporation, Salem, Mass., a
corporation of Massachusetts

Application February 17, 1939, Serial No. 256,924

3 Claims. (Cl. 250-141)

This invention relates to cathode-ray tubes and more especially to such tubes as have a bulb composed at least in part of a tubular metal portion.

A principal object of the invention is to provide a cathode-ray tube which is mechanically strong at all points.

Heretofore, it has been proposed to manufacture cathode-ray tubes having a main body portion of metal which is joined to an elongated neck section of glass. The glass neck was necessitated in tubes where the beam deflection or beam focussing was effected electromagnetically, because if the neck were of the same material as the main body section, for example iron, steel or the like, the loss of energy by eddy current action would be too great. Accordingly, it is a principal object of this invention to provide an enclosing envelope for a cathode-ray tube wherein both the main body portion as well as the neck portion are of metal.

Another object is to provide a cathode-ray tube of the type having a main body portion of metal joined to a glass neck portion, with means to shield the glass neck mechanically and electrically.

Another object is to provide an improved header or closure member for a metal wall cathode-ray tube whereby the lead-in members and electrodes of the electron gun can be insulatingly supported from the metal tube wall.

A feature of the invention relates to a cathode-ray tube having a metal bulb or envelope formed of two separate cylindrical half shells joined together to form a single tubular metal unit.

Another feature relates to a cathode-ray tube having an elongated metal neck of non-magnetic material.

A further feature relates to a metal neck cathode-ray tube having welded thereto a metal-framed glass header in the form of a thick button-like glass body through which the lead-in and support wires are directly sealed.

A further feature relates to a cathode-ray tube having a main funnel-shaped body portion of metal, sealed in a vacuum-tight manner to an elongated glass neck, the neck being enclosed within a separate metal tubular sheath which is welded to the constricted end of the said body section.

A further feature relates to the novel manner of enclosing and supporting the electro-magnetic focussing and electromagnetic deflecting coils around the neck portion of a cathode-ray tube.

A further feature relates to an improved

method of sealing-in and of supporting electrostatic deflector plates from a metal wall section of a cathode-ray tube.

A still further feature relates to the novel organization, arrangement and relative location of parts whereby a cathode-ray tube of the type having a metal wall section can be economically manufactured.

Other features and advantages not specifically enumerated will be apparent from the following detailed descriptions and appended claims. While various features of the invention will be described in connection with certain specific constructions and materials, it will be understood that the invention is not necessarily limited thereto. Furthermore, only those parts of a cathode-ray tube are shown as are necessary to understand the various features and objects of the invention. Accordingly, in the drawings:

Fig. 1 is a plan view of an improved form of metal bulb for cathode-ray tubes according to the invention.

Fig. 2 is a top end view of Fig. 1.

Fig. 3 is a bottom end view of Fig. 1.

Fig. 4 is a sectional view of another embodiment of a metal cathode-ray tube embodying features of the invention with portions broken away for the purposes of simplicity in the drawing.

Fig. 5 is a sectional view of a cathode-ray tube of the composite glass neck and metal body type, having a special neck enclosing and protecting arrangement according to the invention.

Fig. 6 is a partial sectional view of another embodiment of the invention to illustrate the improved manner of sealing-in and supporting the deflector plates through the metal wall of the cathode-ray tube.

Fig. 7 is a detailed view, partly in section, of a preferred form of metal closure cap that may be used with the tubes of Fig. 5.

Referring more particularly to Figs. 1 to 3, there is shown the tubular portion of a metal walled cathode-ray tube envelope according to the invention. This tubular portion of the envelope consists of an elongated neck section 5 terminating in a tapered or funnel-like main body section 6. Preferably, although not necessarily, the end of section 5 is formed with a radially extending flat flange 1, and similarly the larger end of section 6 is provided with a radially extending flat flange 4. Preferably, there is provided between the flange 4 and the wall of section 6 a shoulder 4a to receive and bear the thrust of a relatively thick glass window (not

shown) having sealed therearound a metal frame as described in detail in U. S. Patent No. 2,219,573. As described in said application, the metal frame sealed into the glass window is provided with a radially extending flat flange similar to flange 4 to which it is seam or arc-welded to provide a vacuum-tight seal between the window and the section 6. The open end of section 5 may likewise be closed off by a metal framed glass header through which are sealed the various lead-in and electrode support wires as will be described hereinbelow in connection with the embodiment of Fig. 4. It will be understood of course, that when the device is to be used as an oscilloscope, television reproducer or the like, the inside surface of the glass window is provided with a suitable fluorescent coating and there is mounted within the neck portion 5 and connected to the various lead-in wires, a suitable electron gun and beam deflecting arrangement well known in the cathode-ray tube art.

While it has been proposed heretofore to provide cathode-ray tubes wherein the section 6 is of metal, in these prior tubes the neck section 5 has been of glass. In these prior arrangements, it is feasible to form the section 6 from a metal blank in successive steps by a deep drawing operation as described for example in U. S. Patent No. 2,232,098. However, this deep drawing method is not entirely feasible where the section 5 is to form an integral part of section 6. This is particularly true where the section 6 as shown in Figs. 1 to 3 for example, is rectangular in cross section and the section 5 is round in cross section. I have found that these parts can be formed as an integral unit while preserving the necessary dimensional accuracy and coaxiality between the neck and funnel sections, by forming these sections as two separate symmetrical half shells. Thus as shown in Figs. 1, 2 and 3, the envelope is formed by the two half sections or shells from suitable sheet metal and the two shells are joined together, preferably by flash welding, along the abutting edges 2, 3. During the formation of the half shells, the funnel-shaped half sections 6 may be given any desired shape. Thus, in the tube shown in Figs. 1 to 3, the half sections 6 are formed so that when they are assembled together, the funnel-shaped section 6 is substantially rectangular in cross section with rounded corners and gradually tapers down until it approaches a round or cylindrical shape at its constricted end where it joins the neck section 5. Since it is highly important that the flanges 1 and 4 be flat and free from ridges, and since the flash welding operation mentioned above leaves a ridge, this ridge should be ground away as indicated by the numerals 8, 9, and 9a. While the invention is not limited to any particular metal for the bi-part envelope, it may be made from sheet steel or sheet iron in which event the focussing and deflection of the beam should be effected electrostatically.

If it is desired to effect the focussing and deflecting actions by electro-magnetic means external to the neck 5, the bi-part envelope may be made of suitable non-magnetic alloy such for example as "18-8 Stainless Steel" or an alloy known as "K Monel" made by International Nickel Company.

Instead of making the entire envelope out of the non-magnetic material, only the neck portion where the magnetic focussing and magnetic deflecting means are located, may be of such non-magnetic metal or alloy. Such an arrangement

is disclosed in Fig. 4. In this embodiment, the funnel-shaped metal body section 17 which is shown broken away, is formed of steel or iron as a separate unit, preferably as described for example in U. S. Patent No. 2,232,098, the larger end of section 17 being closed off in any well-known manner, for example by a metal-framed glass window. If section 17 is rectangular in cross-section, then it preferably tapers down to a circular cross-section at its smaller end, terminating in a ring neck 17a. Joined to ring 17a by seam-welding or in any other suitable vacuum-tight manner, is a more steeply tapered frusto-conical metal member 16 having a ring neck 27 where it is welded to ring 17a. Member 16 also has a ring section 16a at its smaller end where it is joined in a vacuum-tight manner, for example by seam-welding, to the end of the metal neck 13. It will be understood that the support member 16 is not absolutely necessary and that the section 17 may be drawn down so that the ring 17a fits directly into the neck 13 where it is welded thereto. Likewise if desired, the neck 13 may have its upper end spun to form an integral cone similar to member 16 whereby this spun end of the neck can be welded directly to the ring 17a, thus eliminating the weld 25. Preferably, the neck 13 is of a non-magnetic metal or alloy such as "18-8 Stainless Steel" or "K Monel" metal alloy sold by International Nickel Company. The lower end of neck 13 is closed by a metal-framed glass header in the form of a button 28 having a metal ring 12 sealed therein in a vacuum-tight manner. Preferably, the ring 12 is sealed into the button 28 by a method such as described in detail in U. S. Patent No. 2,219,573. In general, this method consists in clamping the ring 12 so that the inwardly extending rim or margin 12a extends into a mold cavity, the mold cavity being substantially circular in shape. A quantity of molten glass, preferably in the form of an incandescent "gather" is then deposited in the mold and immediately subjected to molding pressure to cause it to flow outwardly into engagement with the rim 12a which has been previously oxidized as is wellknown in the art. The temperature of the glass "gather" when it contacts with this oxidized rim 12a is sufficient to raise the latter to a temperature where a vacuum-tight seal results upon the subsequent cooling of the gather. Preferably, the glass is charged into the mold at such a temperature that it raises the rim 12a to a temperature of the order of 1000° C. During the molding pressure on the glass gather, the mold is also provided with a plurality of projections whereby the button 12a is formed with transverse bores or perforations preferably distributed in a circle around the center of the button 28 and at the same time a central exhaust hole 15a is formed in the button. After annealing and cooling of the formed button with the rim 12a sealed therein, the excess glass can be ground from the faces of the button, the button therefore having openings extending completely therethrough to receive the lead-in wires preferably in the form of rigid metal rods 14, 14a, 14b, 14c, etc. The header or button 28 with its sealed-in frame 12 is then placed on a suitable rotating head provided with holes in alignment with the holes in the button 28 through which the lead-in wires can be inserted at the desired time. When the lead-in wires have been thus inserted with their ends extending from opposite faces of the button 28, the button 28 is heated until the glass around the lead-in wires is softened. A female member

of a mold having the exact contour of the top side of the header 28 and provided with holes to receive the upwardly projecting ends of wires 14, 14a, 14b, 14c, etc., is then lowered from above and presses the softened glass around the pins. After removal of the female mold member, a chuck is lowered carrying a piece of exhaust tubing 15 which is then molded or welded to the edge of the exhaust opening 15a. The completed header consisting of the glass button 28 with the rigid wires or prongs 14, 14a, 14b, 14c, etc., sealed therethrough, and with the surrounding metal frame 12 sealed therein and with the depending exhaust tubulation 15, may be suitably annealed and cooled.

Where the neck 13 is of non-magnetic material, it is possible to energize the scanning coils or windings 24 at low frequency. If high frequency scanning is desired, electrostatic deflection may be employed. Thus in Fig. 4, the low frequency vertical scanning may be effected electromagnetically and the high frequency horizontal scanning may be effected electrostatically.

Any wellknown type of cathode-ray gun may be mounted on the metal framed header shown. A simple but satisfactory gun is shown in Fig. 4. In the center of a circular ceramic insulator 18 is riveted a hollow metal cathode tube 20 having its upper end flat and closed. A heater filament 20a has its ends welded to the prongs 14b, 14c, and is supported within the cathode sleeve 20 but insulated therefrom in any wellknown manner. The ceramic insulator 18 is provided with a circular shoulder 18a against which is seated the inverted circular metal cup 19 having a perforation 19a in its top in alignment with the axis of member 20. The member 19 serves as a control grid and is fastened to insulator 18 in any suitable manner. A connector tab 19b for the grid, passes through an opening in insulator 18 and is connected to the grid prong sealed through the glass header. The assembly is fastened in place on the prongs 14, 14a, in any manner wellknown in the art, for example by eyelets 18b. The rods 14 and 14a extend upwardly through ceramic or glass tubes 14f, 14g, and have the electrostatic deflector plates 14d, 14e, welded thereto. In order to insure the circular symmetry of the accelerating electric field penetrating through grid hole 19a, a tubular anode 16 with a hole 10a in front of grid hole 19a may be attached to the glass rods 14f and 14g by means of clamps 11, which in turn are metallically connected to neck 13 by connector 11a. After the gun has been assembled on the header 28, it is inserted through the lower end of metal neck 13 and the frame 12 is welded or otherwise sealed in a vacuum-tight manner to the end of neck 13 as indicated by the numeral 26.

It is of course understood that cathode 20 is connected to a prong (not shown in the drawing) which is sealed through header 28 in order to provide the necessary cathode connection for the return leads of the potentials applied to grid 19 and anode 20. Preferably, the top end of the cathode is coated with electron-emissive materials wellknown in the electron discharge tube art. The electrons leaving the cathode are drawn through the grid aperture 19a by the accelerating anodes and are then focussed into a pencil converging on the screen (not shown) by means of the magnetic focussing device 21. This device consists of an iron frame 21 which substantially surrounds and encloses the windings 22 except for a small opening 23 extending com-

pletely around the neck 13. The type of magnetic field penetrating through slot 23 into the path of the electron beam is known as thin magnetic lens. The focal length or focussing power of the device 21 can be varied or adjusted by adjusting the magnetizing current through the windings 22 as for example by means of the battery 22a and variable resistance 22b. Any one of a number of wellknown forms of low frequency magnetic deflecting coils may be used, as indicated schematically by the numeral 24. The source of the low frequency deflecting currents is indicated schematically in the drawings by the numeral 24a. The plates 14d and 14e will of course have suitable high frequency deflecting potentials applied thereto in the usual manner. It will be understood of course, that after the tube has been completely assembled and exhausted in accordance with wellknown procedures, the tubulation 15 is sealed off.

Should the loss of deflecting power in the metal neck 13 be excessive where magnetic deflection is used, it may be desirable to employ a glass neck which is provided with a suitable mechanical and electrical shield. Such an arrangement is shown in Fig. 5. In this figure, the funnel-shaped main metal body portion of the tube 38 may be the same as the portion 17 described in connection with Fig. 4, the larger end of the body portion 38 being closed off by a suitable window as above described. The tapered member 36 is provided with a rim 36a which is welded to the corresponding rim or neck 38a. Preferably, the rim 36a is provided with a spun-over flange or lip 39 for purposes to be described. Member 36 may be of any metal alloy suitable for providing a vacuum-tight seal with the glass neck 31. Neck 31 may be flared outwardly at its upper end to provide an enlarged rim 31a where it is sealed in a vacuum-tight manner to the member 36. The glass neck 31 is closed at its lower end by a glass header 32 in the form of a glass button having the lead-in wires or prongs 32a, 32b, 32c, 32d, directly sealed therethrough in a vacuum-tight manner as described in connection with Fig. 4.

A suitable electron gun designated generally by the numeral 34 may be mounted on an insulator support 34a suitably fastened to the inwardly projecting ends of the prongs 32a, 32b and if desired, the inner surface of the neck 31 may be provided with a metallic or other conductive coating 35 which extends preferably from the rim 31a downwardly and slightly overlaps the end of the electron gun 34 as shown. The coating 35 may, if desired, be of "Aquadag" and suitable electrostatic deflector plates may be mounted within the neck or within the portion 36 as will be described hereinbelow.

The tube is constructed and exhausted in the usual manner without the shielding member 14. After sealing off the exhaust tubulation 33 and after testing, member 44 is forced in place against the lip 39 where it may be soldered or spot-welded with an arc. In the particular tube shown, a type of scanning yoke is required in which two sets of scanning coils are so mounted as to scan the beam of electrons in mutually perpendicular directions. Each coil separately operates in substantially the manner described in connection with 24 (Figure 4). Yokes of this type having annular shape are wellknown in the art. Such a yoke may be fitted into the space between the neck 31 and member 44. In the event a magnetically focussed gun is employed,

both a deflecting yoke and a focussing coil may be inserted between members 31 and 34 as described above in connection with Fig. 4.

In order to improve the mechanical strength of the neck assembly and to hold the deflecting and focussing yokes in place, a cap 42 (Fig. 7) may be provided. Cap 42 has an aperture 43 to fit snugly over the neck 31 and the rim of member 42 may be provided with three or more bayonet type slots 41 to engage the corresponding pins 40 on the member 44. A spring or other suitable means may be provided (not shown) within the cap 42 to force the magnetic yoke such as represented by 21 and 22 (Fig. 4) against the flared end of neck 31. In certain cases, it is undesirable to support the electrostatic deflecting plates and the gun assembly from the same header or stem as would be required for instance in the case of the metal tube of Fig. 1, because such an arrangement frequently introduces excessive capacity between the deflection plate leads or between the deflection plate leads and the grid lead. In glass bulb cathode-ray tubes, it is customary in such cases to take the deflection plate leads directly through the side of the glass bulb. In the case of metal cathode-ray tubes however, this method of sealing is much more difficult since a suitable alloy must be provided to which to seal the glass through which the leads pass. Fig. 6 shows a construction wherein this difficulty is overcome while providing an excellent means of locating the lead holes with respect to each other and with respect to the gun. In this embodiment, the metal frusto-conical or tapered body portion 53 may be similar to the corresponding portions 6 (Fig. 1); 17 (Fig. 2); and 38 (Fig. 3). The portion 53 is provided with a slightly tapered rim 53a which is welded to the correspondingly slightly tapered rim 60 of a metal member 60a. Member 60a is preferably made of an alloy which seals readily to the glass beads 55a. If beads 55a are of "705AJ glass," the member 60a may be of an alloy sold by the General Electric Company under the name "Fernico," or it may be desired to employ "Corning G-12 glass" for the beads 55a in which event an alloy such as "Alleghany member 55" may be used for the member 60a. Member 60a is provided with a plurality of struck-up reentrant eyelets 60b to receive the glass beads 55a which have been previously sealed on to the respective support wires 55 which may be of the same metal as member 60a. Wires 55 carry at their inner ends the usual deflector plates 57. A similar set of deflector plates 58 are mounted at right angles to the plates 57 and the wires supporting these plates are insulatingly sealed through the wall of member 60a similarly to the sealing-in of the wires 55.

The glass neck 51 is sealed at its upper end to the reduced end or collar portion 61 of member 60a and within the neck 51 is mounted any well-known form of electron gun 54. The gun shown consists simply of a ceramic disk similar to 18 (Fig. 4) on which are mounted a cathode and a grid similar to 20 and 19 (Fig. 4). The anode 10 (Fig. 4) is replaced, however, by the conductive coating 59 on the interior of the neck. The

interior of neck 51 may be provided with a conductive coating 59 and suitable magnetic focussing coils may surround the neck as described above in connection with Fig. 4. It will be understood of course that if the gun 54 is of the electrostatic focussing type, that the magnetic focussing coils are not necessary. If desired, a member such as member 44 (Fig. 5) may surround and enclose the neck 51 although in the embodiment of Fig. 6, the tube as shown with the conventional insulator shell base 51a carrying the usual contact prongs 51b which are connected to the various electrodes of the electron gun.

While in the foregoing description, it has been mentioned that the larger ends of the metal section 6 (Fig. 1); 17 (Fig. 4); 38 (Fig. 5) and 53 (Fig. 6), are closed by transparent glass windows, it will be understood that this is not necessary unless the device is to be used as a television receiving tube or the like. For example, the tube may be used to provide television picture signals corresponding to a stationary picture or view in which event the glass window may be replaced by a steel sheet welded to the larger end of the main body section. This plate may carry on its inner surface an aluminum screen bearing the figures or other design painted thereon with carbon or other similar material. In such an arrangement, the screen when scanned by the electron gun will yield television signals which may be used for advertising, testing or the like. In this latter embodiment, it is not even essential that the main body sections have a frusto-conical shape or that they be closed at the larger end by a welding operation. If an aluminum advertising or testing screen of the type referred to is employed, it can be introduced into the bulb 38 (Fig. 5) for instance through the neck 31 before the weld 37 is made.

Various changes and modifications can be made in the disclosed embodiments without departing from the spirit and scope of the invention.

What I claim is:

1. A cathode-ray tube having a flared body portion of metal with a glass window hermetically sealed to the larger end, a neck composed at least in part of tubular glass, an electron gun mounted in said neck and a tubular metallic protective casing for said glass neck, said casing being integrally fastened to said metal body portion to form a continuation thereof but radially spaced from said glass neck.

2. A cathode-ray tube according to claim 1 in which said casing is of larger diameter than the glass neck and at least one magnetic yoke surrounds the glass neck and is interposed between the neck and said casing.

3. A cathode-ray tube comprising a metal body section having sealed thereto a tubular glass neck, a magnetic focussing coil and a magnetic deflecting coil surrounding said neck, a tubular metal protective casing surrounding said coils and fastened at one end to said metal body portion to form an integral continuation thereof, and a removable metallic closure cap for the other end of said casing.

ROBERT M. BOWIE.