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SECOND ANODE FOCUSING ELECTRODE

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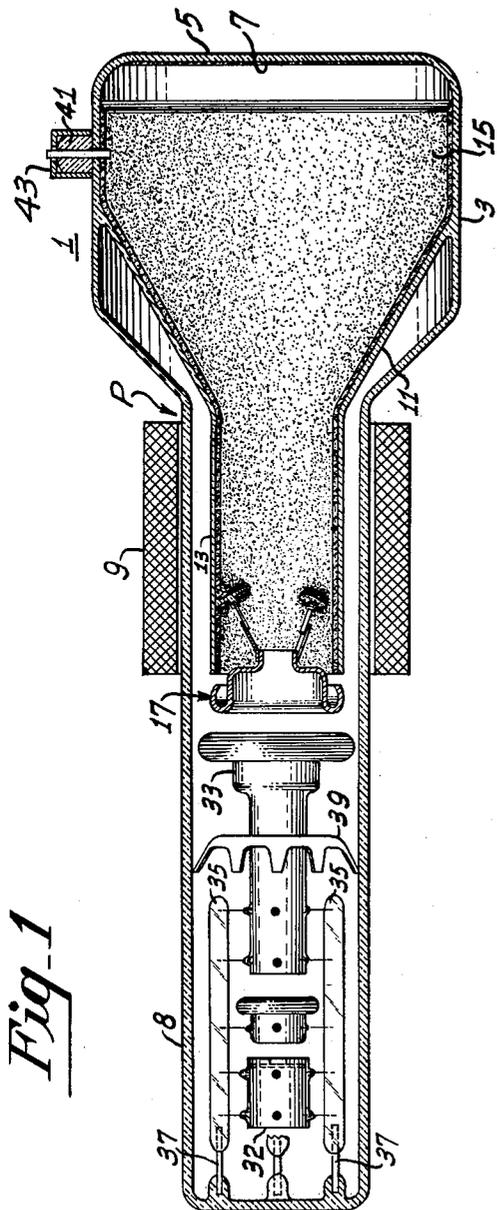


Fig. 1

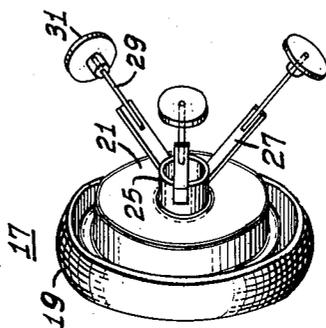


Fig. 2a

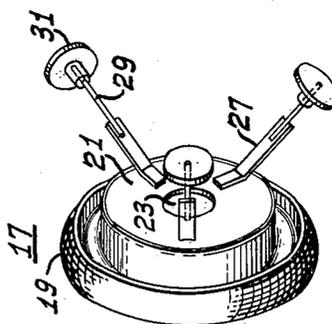


Fig. 2b

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2,734,141

SECOND ANODE FOCUSING ELECTRODE

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Continuation of application Serial No. 96,017, May 28, 1949. This application June 12, 1952, Serial No. 293,175

15 Claims. (Cl. 313—82)

This is a continuation of a co-pending application, Serial Number 96,017, filed May 28, 1949, now abandoned.

This invention relates to improvements in high-voltage cathode ray tubes, such as projection tubes, and more particularly to an improved second anode structure and a process for making it.

In the art of projection-type cathode ray tubes it has been a known practice to operate the final one of a succession of electron-accelerating anodes which are positioned along the path of the electron beam (usually the final anode is the second one of two) at a potential of as high as 100,000 volts and, because of this high voltage, to use a double-walled envelope for the tube and to form this anode as a conductive coating on the inside surface of a part of the inner glass structure of the double-walled tube.

For example, the use of a double-walled envelope to reduce the possibility of an insulation breakdown from the second anode layer on the inside wall of the tube to some external element such as the deflection yoke or magnetic focusing coil is disclosed in U. S. Patent 2,289,906. In this patent it is pointed out that, in addition to increasing the spacing between the second anode layer and the outside surface of the tube, this construction also assures long glass-surface leakage paths between the second anode and the lower-voltage elements of the tube. In order to obtain an appropriate inner wall for supporting the second anode layer there is fused to the inside of the bulb of the envelope an inner glass structure which is re-entrant into the bulb in the direction toward the electron gun and comprises a frusto-conical portion with its large end fused to the bulb and its small end terminating in a short inner neck which extends for a little distance within the outer neck towards the gun. Since there was usually a ragged edge on the second anode conductive coating where it terminated at the end of the inner neck and since this tended to cause electrical discharges and distortions of the electric field, i. e., of the electrostatic lens, between the first and second anodes, a smooth metal ring-cap was placed over the end of the inner tube neck.

However, certain disadvantages have been encountered in seeking to practice the invention taught in this patent. One of these has been that during radio frequency heating, such as for de-gassing and/or exhausting the tube, expansion of the close-fitting metal ring-cap often cracked the end of the inner neck. This required that the ring-cap be very light to avoid its being excessively rigid and strong with respect to the glass.

Another disadvantage has been that the ring-cap was often out of alignment with the other elements of the electrostatic lens system since its position depended upon the accuracy with which the inner glass structure was attached to the outer tube envelope. In practice the inner glass structure is ordinarily attached by fusing the large end of the frusto-cone to the inside of the bulb so that most of its structure extends without other support for a

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considerable distance toward the gun. Therefore, the slightest inaccuracy in fusing together the inner and outer portions of the envelope results in a noticeable misalignment between the inner and outer necks.

Still another disadvantage has been that where the ring-cap was mounted in direct contact with the glass, considerable heat transfer occurred during radio frequency heating and this often damaged the conductive coating comprising the second anode.

Finally, since the ring-cap has usually been made as an inner neck rim which is as narrow and light-weight as possible to reduce the amount of breakage caused during radio frequency heating, it has not been effective to reduce the opening into the inner neck. This leaves a large entrance into the final anode which permits cold-emission electrons to enter and positive ions to leave. If unfocused cold-emission electrons reach the fluorescent screen they will reduce the picture contrast. On the other hand if positive ions existing within the final anode are free to "see" the lower potentials existing further back in the tube and to move out of the second anode towards them, they will probably harmfully bombard the cathode.

It is an object of the present invention to devise for a cathode ray tube an improved second anode ring-cap (herein designated the second anode focusing electrode) and means for attaching it to an inner glass structure of the tube in such a manner that there is no possibility that heating or cooling will damage the glass by unequal expansion or contraction of the electrode.

It is a further object of this invention to devise a second anode focusing electrode with attaching means as set forth above in which the electrode includes, in addition to a rim-portion for covering the end of the final anode coating, a diaphragm portion for impeding the free entry of unfocused cold-emission electrons into the final anode and for impeding the free egress of positive ions therefrom.

It is a further object of this invention to devise an electrode as set forth above and a means for attaching it to an inner glass structure of the tube in such a manner hat radio frequency heating of the electrode will not cause overheating of the glass structure sufficient to damage a conductive coating supported thereon.

It is a further object of the present invention to devise a process for attaching a second anode focusing electrode for a double-walled cathode ray tube to an inner glass structure for supporting the second anode so that, in the completed tube, the second anode electrode will be in proper alignment with a corresponding focusing electrode of the first anode irrespective of the alignments of the axes of inner and outer necks comprising parts of said double-walled envelope.

It is a further object of the present invention to devise a process for attaching a second anode focusing electrode for a double-walled cathode ray tube to an inner glass structure for supporting the second anode so that the electrode will be in proper alignment with a predetermined axis of the tube and for thereafter mounting the electron gun in proper alignment with the same axis.

It is a further object of this invention to devise a novel means for supporting the focusing electrode for the final anode of a double-walled cathode ray tube as set forth above to the end that the electrode may be of larger and more rigid construction than in the prior art in which it was made structurally weaker than an inner neck of the double envelope.

Other objects, features and advantages of the present invention will be apparent to those skilled in the art from the detailed description which follows and from the drawings in which:

Figure 1 is a sectional view of a projection-type cathode ray tube embodying the present invention;

Figure 2 is an enlarged perspective view of the second anode focusing electrode on an enlarged scale to illustrate suitable structural details; and

Figure 2a is an enlarged perspective view of an alternate construction for a second anode focusing electrode according to the present invention.

Figure 1 is a sectional view of a "double wall" projection-type cathode ray tube (or kinescope) 1 embodying the present invention. The outer envelope of kinescope 1 consists of a bulb portion 3 having an end wall 5 which is relatively flat and has a fluorescent screen 7 formed on its inner surface and a neck portion 8 enclosing the principal elements of an electron gun arranged to project a beam of electrons through bulb portion 3 onto the screen 7.

As shown in Figure 1, most of the elements of the electron gun, i. e., all of them except the final anode 15 and its focusing electrode 17, are enclosed within the outer neck 8. It may be assumed that these elements are accurately supported therein and that this is accomplished by any suitable one of several known types of construction. The particular gun elements shown in Figure 1 by way of example include an indirectly heated cathode 32 and a first anode 33, and, in the particular supporting arrangement shown in this figure, the gun elements are supported as a unitary structure by elongated beads 35, some of which are not shown. Each of the beads 35 is fused to one end of a wire 37 the other end of which is fused into a press at the socket end of the neck 8, thus supporting the rear end of the above-mentioned unit. The front end of the unit is held centered within the neck 8 by a spreader 39 which, for this purpose, has a number of spring fingers engaging the inner wall of this neck. All of the structure may be of any alternate type since the particular structural details of the gun, except for those of the focusing electrode of the final anode, do not constitute any part of the present invention.

It is to be assumed that lead-in wires to the various elements of the electron gun pass through the press and are connected to appropriate base terminals. However, lead-in wires, the base fixture, and the base terminals are all excluded from the present showing as they may be of any conventional kind. There is shown in Figure 1, the terminal for applying high voltage to the final anode. This terminal comprises a glass nipple 41 fused to the bulb portion 3, a metal terminal cap 43 fitted over the glass nipple 41, and a conductive element sealed through the nipple and the bulb to provide a connection between cap 43 on the outside and the coating 15 on the inside.

A deflection yoke 9 is carried outside of the neck portion 8 closely adjacent to its outer surface. In the operation of a projection tube according to usual standards the yoke 9 may be at ground potential whereas the final anode may be at 100,000 volts above ground. To avoid a breakdown through the glass between these elements an inner glass structure is employed for carrying the final anode (which both in the example shown herein and that shown in U. S. Patent 2,289,906 is the second anode). The inner structure may consist of a frusto-cone 11, which has the rim of its large end fused to the inner wall of bulb portion 3 and diminishes in diameter in the direction away from the screen 7, and an inner neck 13 which extends from the small end of the frusto-cone for a short distance into the outer neck 8. On the inner surface of the inner glass structure 11 and 13 there is deposited a conductive coating 15 which serves as the principal portion of the second anode. All of this structure is well known and therefore will not be further described herein. However, additional information as to double-walled high voltage kinescopes can be found in various publications, for example, in the United States Patent 2,289,906 mentioned above.

Figure 1 and 4 of that patent exemplify how the ring-cap, which it is customary to use on the small end of

the final anode, is made quite small, and is made of light material in order to reduce the amount of breakage caused during radio frequency heating for degassing and/or exhausting. In practice, not only does this fail to eliminate all breakage but it has the disadvantage of leaving a very wide opening at the entrance of the final anode. As a result, the cold emission caused by the extreme potential difference between this anode and low potential portions of the electron gun causes unfocused electrons to move unimpeded to the fluorescent screen (screen 7 of Figure 1 herein) thus reducing the contrast of any image produced thereon. Moreover, the open entrance to the final anode permits an unnecessarily large number of any positive ions existing within the final anode to "see" the lower potentials existing further back in the tube, as a result of which the positive ions will move in a direction to bombard the cathode. In this connection it may be of interest to note that, to begin with, the number of positive ions produced in the space surrounded by the final anode will be sensibly increased by cold-emission electrons which succeed in entering the area enclosed by the final anode and travelling to the screen. However, quantitatively the increase is relatively very slight since the cold emission current at best will be very small compared to that of the focused beam.

For this reason I have devised a ring-cap, herein to be designated as the final anode focusing electrode 17, which includes, in addition to a rim-portion for covering the ragged end of the final anode coating, a diaphragm portion (for impeding the free entry of unfocused cold-emission electrons into the final anode, for collecting cold-emission electrons after they have travelled very short distances thus limiting their paths of travel, and for impeding the free egress of positive ions from the final anode) and a means for attaching the focusing electrode to the final anode in an arrangement which does not have the disadvantages encountered in the prior art. Of course, the diaphragm must be provided with a central orifice large enough to permit passage of the focused beam.

Embodiments of the invention are shown in Figures 2a and 2b. Figure 2a is a perspective view of a focusing electrode 17 comprising a rim 19 and a diaphragm 21, which is formed to define a central orifice 23. The electrode shown in Figure 2b is similar in all respects except that the central orifice is defined by a short cylindrical extrusion 25 from the diaphragm 21 rather than by a simple opening through it. The construction shown in Figure 2b results in smoother edges for the orifice 23 on its side facing the first anode.

It is to be noted that the configuration of electrode 17 is such that all of its surfaces which face away from screen 7 are smooth. This reduces the likelihood of arc-over to the first anode and also lessens the amount of cold emission. On the other hand, a number of sharp corners and projections which, for reasons of manufacturing economy, come into being as parts of the focusing electrode structure, are on the side of the focusing electrode which is within the field free space surrounded by the final anode 15 and therefore do not increase the likelihood of arc-over or other undesired effects.

To avoid breakage during radio frequency heating in the manufacturing process, despite the rigidity of electrode 17 which results from its large size and thimble-like shape, and to attain good axial alignment of the focusing electrode independently of the alignment of the inner neck 13, I have devised the supporting structure and the manufacturing process described below.

A number of small angle pieces 27 are welded to the inside of the focusing electrode, e. g., to the diaphragm 21 or to the cylindrical extrusion 25, and to each angle piece 27 there is welded a support wire 29 carrying a glass bead 31 at its outer end. Preferably, the angle pieces 27 and/or support wires 29 should be of a material which is primarily compliant rather than resilient so that when

the beads 31 are inserted within the open end of inner neck 13 during assembly no significant forces will be stored in them to oppose completely free movement of the electrode 17 for orienting it independently of the orientation of the inner neck. However, a small amount of resiliency is desirable so that the beads 31 will be urged outward to contact the inside of inner neck 13, this being necessary so that the beads 31 may be fused thereto.

For assembling a tube of the kind shown in Figure 1 according to the present invention the outer envelope is initially formed in two parts, one, the double-walled bulb portion, and two, the neck portion 8 which is intended to be fused to the bulb portion 3 at a point, P, near the start of the flare. It may be assumed that the screen 7 has been formed on the wall 5 in any suitable manner. The bulb is mounted in the head-stock chuck of a glass-blower's lathe and, while being slowly rotated, it is trued-up until screen 7 lies in a plane normal to the rotational axis of the lathe and the portion of the bulb 3 to which the neck portion 8 will be ultimately sealed is coaxial with the rotational axis of the lathe. If the inner structure 11 and 13 has been accurately fused to the inside of the bulb 1, the axis of the inner neck 13 will then coincide with said rotational axis. However, in a large percentage of cases this condition will not exist. The rotation of the lathe is stopped. If this condition does not exist, focusing electrode 17 is then placed over a mandrel which is carried in the tail-stock chuck of the lathe so that a plane adjacent to all parts of the front edge of the rim-portion 19 will be normal to the lathe axis and the center of the orifice 22 will coincide therewith. The tail stock is then run forward until the glass beads 31 are within the inner neck 13 and the rim-portion 19 nearly touches the end of inner neck 13. Heat, which may be provided by one or more gas flames, is applied to the outside surface of that part of inner neck 13 against the inside surface of which the glass beads 31 are impinging. Preferably the several beads may be fused to inner neck 13 in a single operation by applying heat while continuously revolving the chucks. However, they may be fused one at a time by heating a single area, pulling the chuck around by hand, heating another area, etc.

After the work has cooled, some of the aquadag will have been removed by the heating. This is replaced with silver paste by the use of a small brush inserted through the orifice 23. The touch-up silver paste should cover enough of the original aquadag 15, the beads 31, and the support wires 29 to repair the damage to the original aquadag and to provide a conductive connection between the aquadag and the focusing electrode 17. Silver paste is used in preference to aquadag for a connection which will not burn out due to passage of arc-over current which may be encountered either during spot-knocking or operation of tube.

After the electrode 17 has been attached to the inner neck 13 in the manner described above, the tail stock is backed away to disengage the mandrel, the mandrel is removed from the tail-stock chuck of the lathe and the neck 8 along with its enclosed electron gun elements is placed therein in its stead. While the chuck is rotating slowly, the neck 8 is trued-up so that the axis of the electron gun is brought into line with that of the lathe. The tail stock is moved forward until the open ends of the neck 8 and the bulb 3 respectively are adjacent to one another and then, with the lathe rotating, heat is applied to fuse the neck and bulb together.

If it should be preferred to follow a different sequence for the steps of assembling the tube which is such that it is not possible to use gas flame heating for fusing the beads 31 to the inner neck 13 (because the inner neck 13 will have already been enclosed within the outer neck 8 when the time for performing this fusing operation is reached), radio frequency heating may be employed. However, for optimum results it is then desirable that the supporting wires 29 be fairly heavy so that a sufficient

amount of heat can be generated within them to melt the beads, as well as some of the neck-glass adjacent thereto, for fusing the beads to the inner neck or, if no beads are used, directly to fuse the wires 29 into the inner neck.

It is apparent that the focusing electrode 17, when supported in the manner described herein, is free to expand or contract without exerting forces which may tend to shatter the end of the inner neck 13. Moreover, there is excellent thermal isolation between this electrode and the inner neck 13 since the heat conductivity of the angle pieces 27 and support wires 29 is very small due to their small cross-sectional areas. Thus, during radio frequency heating of a kinescope constructed in this manner, the electrode 17 may become very hot without communicating enough heat to the inner neck 13 to harm it, or distort it, or to damage the aquadag coating.

It is also apparent that all the sharp corners or projections which exist in this structure are inside the field-free space within the second anode 15, as a result of which there is little likelihood of arc-over to either internal or external parts of the tube.

While I have indicated the preferred embodiments of my invention of which I am now aware and have also indicated only one specific application for which my invention may be employed, it will be apparent that my invention is by no means limited to the exact forms illustrated or the use indicated, but that many variations may be made in the particular structure used and the purpose for which it is employed without departing from the scope of my invention as set forth in the appended claims.

What I claim as new is:

1. A focusing electrode for the final anode of a kinescope comprising a unitary metallic structure including an annular rim-portion formed on one side as an element of an electrostatic lens, a diaphragm portion having a relatively small orifice at the center thereof, a plurality of relatively compliant conductive supporting members each attached at one of its ends to the opposite side of the focusing electrode, and a glass bead at the other end of each supporting member for attachment of the electrode to a portion of the envelope of the kinescope by fusing the bead thereto.

2. A kinescope having an envelope including a glass structure having a substantially frusto-conical portion terminating in a neck portion, a conductive coating on the inside surface of the glass structure, a focusing electrode within said envelope and comprising a unitary metallic structure including an annular rim-portion formed on one side as an element of an electrostatic lens, a diaphragm portion having a relatively small orifice at the center thereof, a plurality of relatively compliant conductive supporting members each attached at one of its ends to the focusing electrode, a glass bead at the other end of each supporting member, the focusing electrode being supported from said neck portion by fusion of the other end of each of said supporting members to the inside of the neck portion.

3. A kinescope having an envelope, an electron gun within said envelope, said envelope having an inner surface supporting a conductive layer to serve as an anode for said electron gun, a focusing electrode for said anode having an annular rim portion formed on one side as an element of an electrostatic lens, a plurality of relatively compliant supporting members each attached at one of its ends to the opposite side of the focusing electrode, a bead of fusible material at the other end of each supporting member, said beads being fused to an inner surface of said envelope to support the rim portion in a predetermined position with respect to the conductive layer and to the axis of said electron gun of the kinescope.

4. A kinescope comprising an outer envelope including a bulb portion and a neck portion and an inner structure including a frusto-cone with its large end fused to the

inside of said bulb portion and an inner neck attached to the small end of the cone, the frusto-cone being positioned within the outer envelope to diminish in diameter in the direction from said bulb portion toward said neck portion and so that the inner neck extends into said neck portion, a final anode comprising a conductive coating on the inside surface of said inner structure and a focusing electrode for said anode, said focusing electrode comprising an annular rim formed on one side with a smooth surface to serve as an element of an electrostatic lens, a plurality of relatively compliant conductive supporting members each attached at one of its ends to the opposite side of the focusing electrode, the other end of each supporting member being fused to an inner surface of said envelope to support said rim portion in a predetermined position with respect to the axis of the electron gun of the kinescope independently of the axes of said neck portion and of said inner neck.

5. A double-walled kinescope comprising an outer envelope including a bulb portion and a neck portion, an inner structure including a frusto-cone with its large end fused to the inside of said bulb portion and an inner neck attached to the small end of the cone, the frusto-cone being positioned within the outer envelope to diminish in diameter in the direction from said bulb portion to said neck portion and so that the inner neck extends into said neck portion, a conductive coating on the inside surface of the inner structure to serve as an anode for the kinescope, a focusing electrode for said anode comprising a unitary structure including an annular rim portion formed on one side as an element of an electrostatic lens, a diaphragm portion having a relatively small orifice concentric with the rim portion, a plurality of relatively compliant conductive supporting members each attached at one of its ends to the opposite side of the focusing electrode and at its other end fused to the inner surface of said inner neck.

6. A double-walled kinescope comprising an outer envelope including a bulb portion and a neck portion, an electron gun at least partly enclosed within the neck portion, an inner structure including a frusto-cone with its large end fused to the inside of said bulb portion and a relatively short inner neck attached to the small end of the cone and extending into said neck portion, a conductive coating on the inside surface of the inner structure to act as an anode for said electron gun, a focusing electrode for said anode comprising a rigid unitary metallic structure including a rim portion formed on one side as part of an electrostatic lens, a diaphragm carried within the rim portion and having a small central orifice and means for supporting the electrode in a predetermined position with respect to the axis of said electron gun independently of the axes of said neck portion and said inner neck and so that said rim serves as the effective termination of the small end of said anode without being in close thermal contact with said inner structure or in such close mechanical contact therewith as to harm it by expansion or contraction.

7. In a high voltage double-walled kinescope comprising an inner structure including an inner neck and having an inside surface for supporting a second anode conductive coating which terminates at an open end of said inner neck, a focusing electrode formed with an annular rim to provide a smooth termination for said open end and a diaphragm for preventing the free entry of cold emission electrons into the space surrounded by said anode as well as the free egress of positive ions out from said space and for defining a central orifice to permit passage of a focused electron beam of the kinescope, and means for supporting said electrode within the envelope of the kinescope in a predetermined position with respect to the axis of its electron gun independently of the axis of said inner neck, said supporting means providing substantial thermal isolation between said electrode and said inner neck and permitting free expansion and contraction of the electrode

without harm to said neck, and means for electrically interconnecting said electrode and said coating.

8. An electron discharge device of the cathode ray type including an elongated envelope, an electron gun structure at one end of said envelope for directing a stream of electrons along a predetermined path, an elongated structure within said envelope serving as an electrode through which the electron stream is directed, said elongated structure being fixed to the envelope at its end remote from said cathode, a conducting structure having an aperture aligned with said stream of electrons, and means for supporting said conducting structure from said elongated structure and including compliant elements having opposite ends fixed to said elongated and conducting structures.

9. An electron discharge device of the cathode ray type including an elongated envelope, an electron gun structure at one end of said envelope for directing a stream of electrons along a predetermined path, an elongated structure within said envelope serving as an electrode through which the electron stream is directed, said elongated structure being fixed to the envelope at its end remote from said cathode, a conducting structure having an aperture aligned with said stream of electrons, and means for supporting said conducting structure from said elongated structure and including compliant conducting elements having opposite ends fixed to said elongated and conducting structures.

10. An electron discharge device of the cathode ray type including an elongated envelope, an electron gun structure at one end of said envelope for directing a stream of electrons along a predetermined path, an elongated structure within said envelope serving as an electrode through which the electron stream is directed, said elongated structure comprising a hollow body of insulating material having a conductive coating on the inside thereof and being fixed to the envelope at its end remote from said cathode, a conducting structure having an aperture aligned with said stream of electrons, and means for supporting said conducting structure from said elongated structure and including compliant elements having opposite ends fixed to said elongated and conducting structures.

11. An electron discharge device of the cathode ray type including an elongated envelope, an electron gun structure at one end of said envelope for directing a stream of electrons along a predetermined path, an elongated structure within said envelope serving as an electrode through which the electron stream is directed, said elongated structure comprising a hollow body of insulating material having a conductive coating on the inside thereof and being fixed to the envelope at its end remote from said cathode, a conducting structure having an aperture aligned with said stream of electrons, and means for supporting said conducting structure from said elongated structure and including compliant elements each having one end fixed to said conducting structure and the other end fixed to said hollow body of insulating material.

12. An electron discharge device of the cathode ray type including an elongated envelope, an electron gun structure at one end of said envelope for directing a stream of electrons along a predetermined path, an elongated structure within said envelope, a coating carried by said elongated structure and serving as an electrode through which the electron stream is directed, said elongated structure being fixed to the envelope at its end remote from said cathode, a conducting structure having an aperture aligned with said stream of electrons, and means for supporting said conducting structure from said elongated structure and including compliant elements having opposite ends fixed to said elongated and conducting structure, said conducting elements providing an electrical connection between said conducting structure and said coating.

13. The process for assembling an electron beam device which is to include a metallic electrode having an aperture aligned on and surrounding a beam axis of the device and a hollow vitreous structure also surrounding

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said axis comprising the steps of: attaching each of a plurality of elongated compliant supporting members to one side of said metallic electrode at one of its ends with the members extending both radially from said axis and along it in directions more divergent than necessary for causing their other ends to contact the inside surface of said hollow vitreous structure in the completed assembly, supporting said metallic electrode in a predetermined desired position with said other end of each of said supporting members inserted within said hollow structure and with said aperture aligned on and surrounding said axis whereby each of said compliant members will become deformed inwardly from its original shape and its said other end will assume a position against a point on said inside surface in accordance with said position in which the electrode is supported; and applying heat to fuse said other end of each of said supporting members to said inner surface.

14. The process set forth in claim 13 and including the step of fusing a bead of vitreous material to said other end of each of said members prior to the steps of supporting the electrode in a desired position and of applying heat to fuse said other ends to said inner surface.

15. A cathode ray tube comprising an envelope including a bulb portion and a neck portion, a conductive coat-

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ing on the inside surface of said envelope to serve as an anode for the cathode ray tube, an electron gun mounted within the neck of said envelope, a focusing and shielding electrode for said anode comprising a unitary structure including an annular rim portion formed on one side as an element of an electrostatic lens and a diaphragm portion having a relatively small orifice concentric with the rim portion, and a plurality of flexible conductive supporting members for supporting said electrode within said envelopes, said flexible members being in electrical contact with said conductive coating.

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