

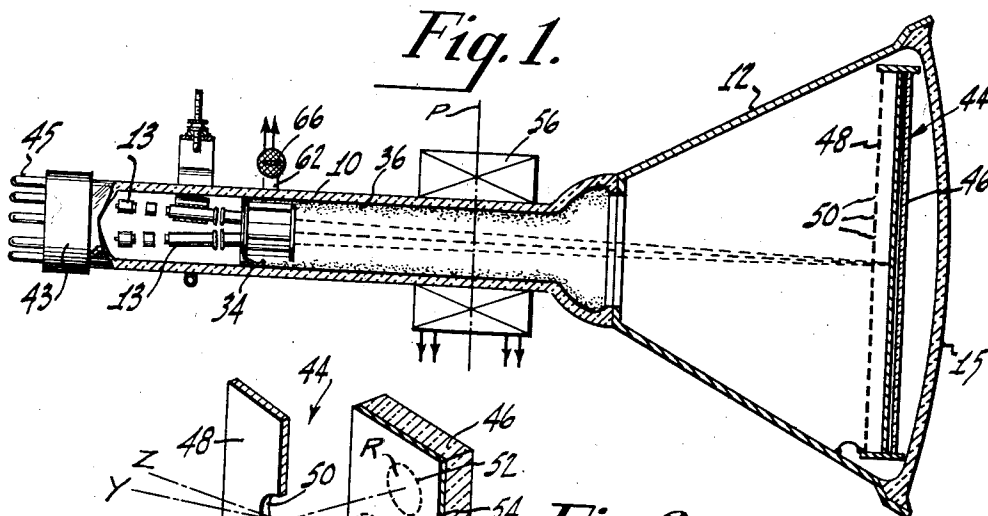
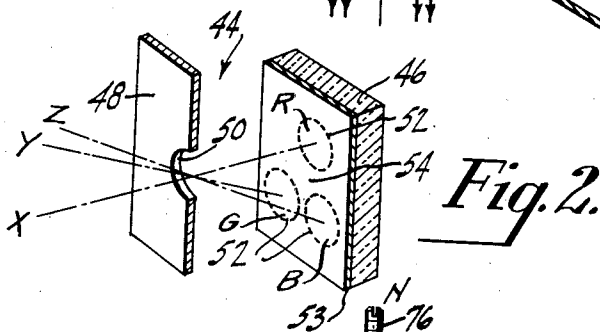
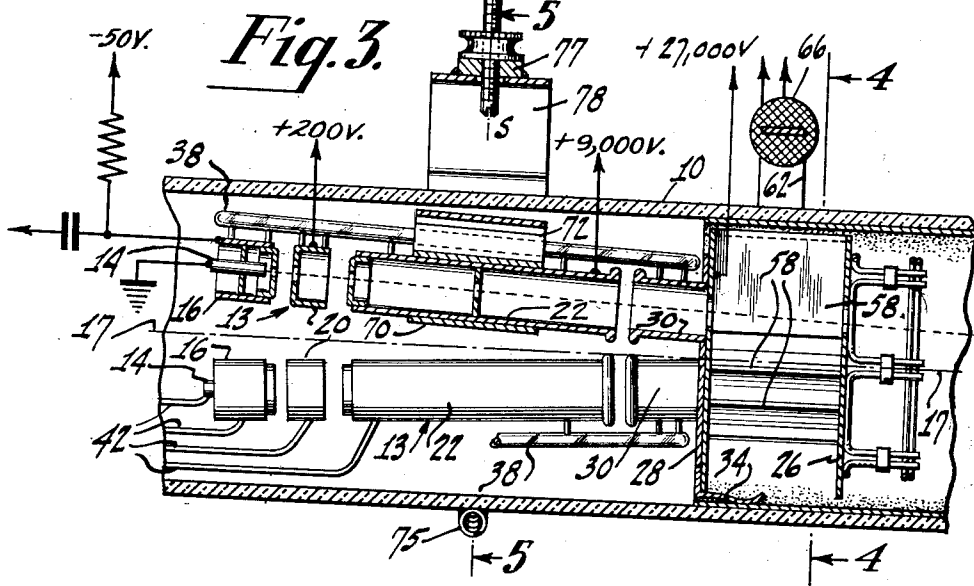
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ELECTRON BEAM CONTROL MEANS

2,769,110

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2 Sheets-Sheet 1



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Fig. 4.

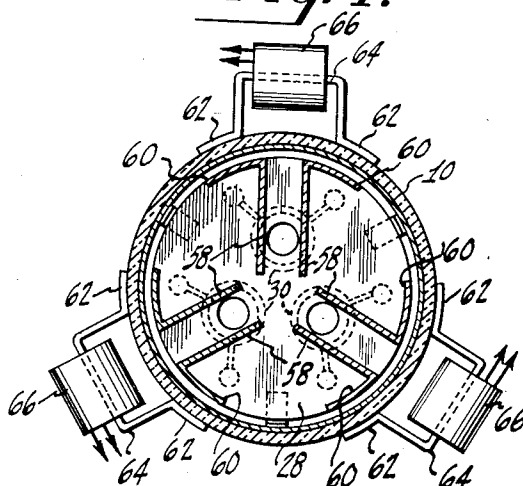


Fig. 5.

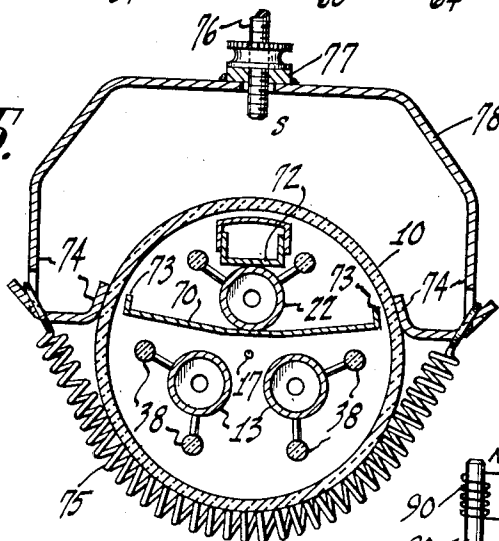


Fig. 6.

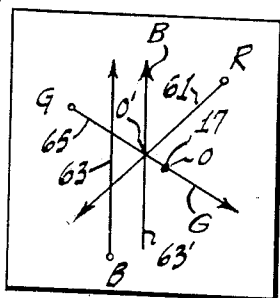
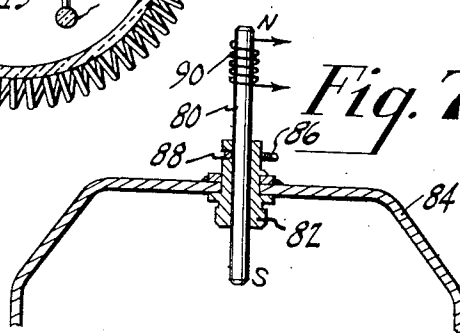


Fig. 7.



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2,769,110

ELECTRON BEAM CONTROL MEANS

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Application January 21, 1954, Serial No. 405,445

4 Claims. (Cl. 313—70)

This invention is directed to a cathode ray tube and more specifically to a cathode ray tube having a plurality of electron beams which are converged to a common point on a target electrode.

One type of cathode ray tube which uses a plurality of electron beams is the television picture tube for color of the type disclosed in U. S. Patent 2,595,548, Alfred C. Schroeder. It has been found advantageous in tubes of this type to utilize an electron gun assembly of the type disclosed in the copending application of Albert M. Morrell, Serial Number 383,340, filed September 30, 1953. The tube described in this copending application has three electron guns mounted in the neck of the tube envelope symmetrically about the tube axis and inclined to the tube axis by a small angle to provide three beams converging to a common point on a target electrode mounted normal to the tube axis.

The target electrode, of the Morrell application device; cited above, includes a masking apertured electrode formed of sheet metal such as a copper-nickel alloy and having a large number of small apertures therethrough. Closely spaced from the surface of the masking electrode, opposite the electron guns is a glass sheet having on its adjacent surface a large number of phosphor dots in groups of three, with each dot of each group fluorescing when struck with high energy electrons with a different color of light than the other dots of the group. Each group of three dots is positioned relative to one aperture of the masking electrode so that the center about which the three dots of each group is positioned is aligned with the respective aperture of the mesh. Electrons from the three beams, passing through any one of the apertures in the masking electrode, approach the corresponding group of phosphor dots from their three different directions. In this manner, the electrons passing through an aperture of the masking electrode along one direction will strike only one phosphor dot and will be prevented by the masking electrode from striking the other two dots of the group. The arrangement provides, then, that an electron beam from each gun of the tube will cause the phosphor screen to luminesce in only one color.

Accurate convergence of the three electron beams at the target depends upon precise alignment of each gun and gun parts. Misalignment of the guns or gun parts results in displacement of one or more of the beams from the point of common convergence. The device shown in the copending application of Albert M. Morrell uses independent magnetic fields for correcting for any mis-convergence of the beams on the target. Independent convergence control for each beam is provided by a plurality of pairs of pole pieces extending transversely of and on opposite sides of each beam path. Portions of the pole pieces are positioned adjacent the envelope neck of the tube whereby an electromagnet mounted on the tube neck adjacent each pair of pole pieces can be used to establish a convergence correcting magnetic field across each beam path. An additional pair of magnetic field form-

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ing pole pieces is mounted adjacent one of the three guns to provide a second correcting magnetic field at right angles to the other field of that gun to complete the convergence control of the beams, to be described.

The tube of the above cited application to Morrell uses an external electromagnet with appropriate armature portions for providing the second correcting magnetic field to provide convergence of all three beams at the target.

It is an object of this invention to provide permanent magnetic means for providing the second correcting magnetic field of the tube described.

It is another object of this invention to provide an adjustable permanent magnetic means to form a convergence correcting magnetic field for a tube of the type described.

It is a further object of the invention to provide a simplified low cost permanent magnetic means for forming the convergence correcting field of the tube of the type described.

The invention is in a low cost simplified adjustable permanent magnet for forming a convergence correcting field in a cathode ray tube utilizing a plurality of electron beams for color television reproduction. A threaded magnet is mounted exteriorly of the cathode ray tube neck over the electron gun which furnishes the blue component of the television picture. The threaded magnet is mounted in a holder comprising a permeable flux conductor member, the ends of which rest on the tube neck adjacent to internal portions of a pole piece element. The design and arrangement of the magnet enables the forming of a magnetic field which may be varied or adjusted to correct for misconvergence of the blue beam at the target. Furthermore, the magnet is arranged to provide a field adjustment passing through zero to both sides so that beam deflection of the blue gun can be in either direction.

Figure 1 is a sectional view of a cathode ray tube utilizing the invention.

Figure 2 is an enlarged perspective view of a portion of the target of the tube in Figure 1.

Figure 3 is an enlarged sectional view of part of the gun structure of the tube of Figure 1.

Figure 4 is a cross sectional view along line 4—4 of Figure 3.

Figure 5 is a cross sectional view along line 5—5 of Figure 3.

Figure 6 is a schematic representation of beam convergence at the target electrode of the tube of Figures 1—5.

Figure 7 is a view of a modification of the invention.

Figure 1 represents a cathode ray tube of the type disclosed in the copending application of Morrell. The tube has a plurality of electron beams and is used as a picture viewing tube for color television. The tube consists of an evacuated envelope having a neck portion 10 and a large metal shell portion 12. Within the neck portion 10 of the envelope are three electron guns 13, each consisting of a cathode electrode 14 (Figure 3), a control grid electrode 16 and an accelerating electrode 20. Spaced along the axis of each gun from accelerating electrode 20 is a relatively long tubular accelerating electrode 22, and a short focusing electrode 30. The electrodes 30 are mounted on a common support plate 23. Mounted on the opposite face of plate 23 from electrodes 30 and between it and another support plate 26 are a plurality of pole pieces 58. The pole pieces 58 are arranged in pairs, with one pair positioned on opposite sides of each beam as shown in Figure 4.

The electrode assembly of plates 26 and 23 is supported from and electrically connected by spring fingers or spacers 34 to the wall of the envelope neck 10 to make

electrical and physical contact with a conductive wall coating 36, which extends over the inner surface of the tubular envelope neck portion 10 from plate 28 into the conical envelope portion 12 to make contact with the metal shell 12.

The several electrodes are mounted within the neck portion 10 by rigidly fastening them together by means of a plurality of glass mounting rods 38. Lead wires 42 extend from each electrode respectively, and are connected to base pins 45 extending through base 43 to make electrical contact to external sources of potential. Lead wires 42 and the spring spacing fingers 34, rigidly support the gun assembly within the envelope neck portion 10.

In Figure 3, voltages are indicated as those which are applied to the respective gun electrodes. These voltages are those which have been successfully used in tubes of the type described and need not be limiting.

During the operation of the tube described, potentials are applied to several gun electrodes in the amounts indicated. The electron emission from each cathode 14 is formed by electrostatic fields respectively between electrodes 16, 20, and 22 into an electron beam directed through the apertured portions of the gun electrodes. The difference of potential between electrodes 22 and the corresponding electrode portions 30 provide a principal focusing lens field in the path of each electron beam, whereby the electrons of each beam are converged to a fine focus at the target electrode 44 mounted in the large shell portion 12 of the envelope.

Target electrode 44 consists of a glass support plate 46 and a metallic masking electrode 48 closely spaced from the surface of plate 46 facing the electron guns. Masking electrode 48 is a thin copper-nickel sheet having a large number of small apertures 50. Fixed to the adjacent surface of the glass plate 46 is a luminescent screen consisting of groups of phosphor dots 52, with each group consisting of three dots positioned in a triangular arrangement about a center point 54, as shown in Figure 2. The positioning of each group of phosphor dots is such that the center of each aperture 50, in the masking electrode 48, will be aligned with the point 54 of the corresponding group of phosphor dots.

The phosphor dots 52 of each group are formed of phosphor material fluorescing with a different colored light when struck by the high energy electrons from guns 13. As indicated in Figure 2, the dots of each group have a red, green, or blue fluorescence under electron bombardment and indicated respectively by R, G, and B. Furthermore, the positioning of the phosphor dots 52 is that in which each dot is aligned with its corresponding aperture 50 in electrode 48 along a different directional line X, Y, and Z, respectively. The fluorescent screen is covered with a thin film 53 of reflective metal to intensify the luminescence of the phosphor by reflecting light from the phosphor screen through plate 46 toward the observer.

The three electron beams leaving the electron guns 13 are caused to converge toward the common axis 17 of the tubular envelope portion 10 by mounting each gun 13 at a small angle to axis 17 so that the axes of the three guns will converge to a common point on the masking electrode 48. Thus, each beam, normally following the axis of its gun, will approach the masking electrode 48 at a small angle of incidence and from one of the different directions X, Y, or Z. Electrons from each beam passing through the apertures 50 of electrode 48 along one of the paths extending in the directions X, Y, or Z, will strike one phosphor dot in each group of dots. The arrangement is such that the electrons from each gun can strike only those phosphor dots 52 luminescing with a single color of light. The angle which each gun makes with tube axis 17 is small and is determined by the dimensions of the tube. In tubes of the type described which have been successfully operated, this angle is in

the order of $1^\circ 10'$. The Figure 3 exaggerates the angle between the guns and axis 17 for purpose of illustration.

The three beams are simultaneously scanned over the surface of the masking electrode 48 by conventional scanning means indicated as a neck yoke 56, which consists of two pairs of deflecting coils, with the coils of each pair mounted on opposite sides of the envelope neck 10. Each pair of deflecting coils of yoke 56 is connected in series to sources of saw tooth currents for providing line and frame scansion of the three electron beams simultaneously over the surface of the masking electrode 48. The scanning coils of yoke 56 are conventional and do not constitute a part of this invention and need not be further described. The scansion of electron beams may be in any desired manner but for color television viewing is as a rectangular raster. The operation of tubes of the type described are more fully set forth in copending application Serial Number 231,925, filed June 16, 1951, Pat. No. 2,663,821, by Harold B. Law.

Due to any misalignment of the gun parts as well as non-uniformity of any field affecting the beams, the three beams may not normally coincide accurately at the same point. Figure 6 indicates that if the three beams are accurately positioned symmetrically about axis 17, and with no deflection fields acting on the beams, they will strike a single spot O on axis 17. However, due to misalignment of gun parts or non-uniformity of fields through which the beams pass or both, one or more of the spots R, B, and G may be displaced from the spot O, which they all should theoretically strike and will strike in new spots R, G, and B, for example.

Beam converging means are provided consisting of the pairs of pole pieces 58 mounted on opposite sides of the electron beam paths. As shown specifically in Figure 4, the pole pieces 58 include parallel portions extending substantially radially to the axis 17 of the envelope neck 10. Also, the pole pieces 58 each have an arcuate portion 60 extending along the inner wall portions of the tubular neck 10 and as shown in Figure 4. The arcuate pole pieces portions 60 are matched with arcuate portions 62 of armatures 64 forming respectively a part of the electromagnets 66 mounted on the outer wall portion of the tubular neck 10.

A direct current is passed through each coil 66 to provide a constant magnetic field between each pair of plates 58. By adjusting the strength and direction of the direct current in each coil 66, each electron beam is moved radially toward tube axis 17. This will move the three spots R, B, and G together along the lines 61, 63 and 65 respectively, and in the direction indicated by the arrows, shown in Figure 6. However, the three beams can not now be converged to a single common point, although the red and green beam spots can be converged to a common spot O'.

Accordingly, then a correction is introduced into the deflection of one of the beams by a magnetic field established between pole pieces 70 and 72, shown in Figures 3 and 5. Pole pieces 70 and 72 are fixed to the tubular electrode 22 of the blue gun 13 and are mounted at substantially right angles to the corresponding plates 58 of the gun. A magnetic field between the parallel pole pieces 70 and 72 will introduce a beam deflection at right angles to that produced by plates 58 on the same beam. As shown in Figure 6, this shifts the convergence path 63 of beam B to a new position 63', and thus allows beam B to be converged along path 63' to the intersection of spots R and G at the point O'. The point O' is not greatly displaced from the theoretical point O. The displacement can be compensated for by other means if necessary. Additional correcting plates (not shown) similarly to 70 and 72, for each beam, may be used if necessary or desirable.

The correcting magnetic field established between parallel plates 70 and 72 may be formed by extending

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pole piece 70 adjacent to the neck portion of the tube envelope to form flanged end portions 73. Pole piece 72 is a box-like construction and the wall of the box opposite gun electrode 22 is arcuate to follow the curvature of the tube neck 10.

In accordance with this invention, the correcting magnetic field for the blue gun 13 is established between plates 70 and 72 by providing a permanent magnet means exteriorly of the tube envelope. As shown in Figure 5, the magnet means consists of a permanent magnet rod 76 mounted in the central portion of an arcuately formed flux conductor member 78. The magnet 76 may be threaded through a supporting stud or positioning block 77 mounted on the central portion of the flux conductor 78 so that the magnet extends radially of the tube axis 17. One end of the magnet 76, as shown in Figure 5 is positioned over pole piece 72. The flux conductor 78 has a pair of end portions 74 which are bent in the manner shown in Figure 5 to overlie the flanged end portions 73 of pole piece 70. Pole piece 72 is of a soft magnetic material such as a nickel-iron alloy having high permeability. Also pole piece 70 may be of the same material. The flux conductor 78 may be made of a soft magnetic material such as low carbon steel and is used to support the magnetized rod 76. A nonmagnetic spring 75 is attached to both of the end portions of the flux conductor 78 and extends around the tube neck to hold the assembly in position during operation.

The magnet rod 76 is magnetized axially and is long enough so that each end may be considered a point source of magnetic flux. The flux conductor 78 shapes and directs the magnetic flux of magnet 76 and acts as a shield when the magnet 76 is in retracted position. With magnet rod 76 in position, as shown, the magnetic flux will extend from the magnetized rod through both legs 74 of the flux conductor through the glass wall of the tube and into the adjacent flanged ends 73 of pole piece 70, through the tubular electrode structure to the pole piece 72 and from this pole piece through the glass wall of the tube back to the end of the magnet rod. The distance of the end of the magnet rod from pole piece 72 can be adjusted by the threaded construction of the rod.

The insertion of the magnet rod into the threaded assembly 77 causes the magnetic flux lines in the electrode of the blue gun to move the electron beam of this gun laterally until convergence is achieved, as is described above relative to Figure 6. By reversing the magnet, adjustment on either side of the uncorrected blue beam position can be achieved as required by the characteristics of the tube used. Upon insertion of the end of the magnet into the support assembly, the blue beam is first displaced a small amount in one direction which is opposite to the displacement of the beam when the magnet is positioned farther into the assembly. The red and green beams are also displaced slightly laterally, at the first insertion of the magnet into the assembly. However, after this first displacement, the red and green beams are not displaced upon moving of the magnet through its threaded support toward the tube neck, since the red and green beams are shielded from the flux of the magnet rod by the plate 70 and their own gun structures. The fact that the blue electron beam can be moved in both directions depending upon the amount of insertion of the magnet rod into the assembly permits the adjustment of the electron beam through a zero position and as well as adjustment of the beam to zero position. The reasons that the electron beam of the blue gun is first deflected in one direction when the magnet rod 76 is first inserted in the assembly can be explained if, for example, the south pole end of rod 76 is inserted in block 77. In this position of the magnet, the flux lines between the ends of the rod 76 pass through the open ends of the arcuate flux conductor 78, and in the region of the blue gun have a weak component in the downward direction. However, as the south pole end of the magnet rod is inserted

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through the support assembly 77, flux between the pole piece 70 and the adjacent south end of the magnet rod increases in strength to neutralize the downward component of the flux and finally results in a strong upward component of the flux, which continues to increase as the south end of the magnet rod more closely approaches the pole piece 70. This change in the direction of the flux within the tubular electrode of the blue gun permits the above described ability to adjust the displacement of the beam of the blue gun to either side of a zero position as well as to a zero position.

Figure 7 discloses a modification of the invention in which the permanent correction magnet consists of a rod 80 slidably mounted in a supporting stud 82 mounted in turn on a flux conductor 84. The magnet rod 80 is releasably held in position by a spring 86 spring-pressed against rod 80 through a slot 88 formed in the side of the supporting stud 82. A coil 90 may be mounted around magnet 80 to provide a variable magnetic flux field to modulate the permanent magnetic flux of the magnet. For example, a parabolic wave form of current could be driven through coil 90, at horizontal or vertical deflection frequencies, in order to modulate the magnetic flux of the magnet and thus provide a dynamic adjustment of the blue beam position relative to the deflection of the beam. Such adjustments can be used to correct misconvergence of the blue beam with the red and green beams at the edges of the target, where misconvergence results from the characteristics of the deflection yoke or of the tube itself.

The invention described above is one which provides beam convergence without the use of an electrical current and the circuits, which would be required. The invention is one which provides beam convergence with an optimum simplicity of structure. The use of the permanent magnet provides a compensating means which is stable with temperature, in contrast to an electric coil, for example, which becomes heated, during use, with a resulting current change and a corresponding change in flux density. The use of a permanent magnet as a convergence correction means is one that is not dependent upon line voltage changes and does not require separate controls for adjustment, as would be required with an electrical current means. The invention is one which is low in cost as well as simple in construction and operation.

What is claimed is:

1. A control device for positioning an electron beam in a cathode ray tube, said control device comprising a flux conductor member having a central portion and pair of end portions extending in substantially the same direction from said central portion, a magnetized rod adjustably mounted through said central portion and extending in said direction and an electrical coil mounted around said magnetized rod for providing a magnetic flux to modulate the flux of said magnetic rod.
2. An electron discharge device comprising an envelope having a tubular portion, an electron gun mounted within said tubular envelope portion, said gun including a plurality of electrodes mounted along a common axis for forming a beam of electrons, a pair of magnetic pole pieces mounted adjacent one of said electrodes for forming a magnetic correcting field in the path of said electron beam, said pole pieces including at flat plate extending across said tubular envelope portion and including portions positioned adjacent the wall of said tubular envelope portion and a pole piece member fixed to the opposite side of said one electrode between said electrode and the wall of said tubular envelope portion, magnetizing means mounted on said tubular envelope portion and including a flux conductor having end portions adjacent the wall of said tubular envelope portion and overlying said adjacent portions of said pole pieces, and a permanent magnet mounted on said flux conductor, said magnet being adjustable to vary said correcting field.
3. An electron discharge device comprising an envelope

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having a tubular portion, an electron gun mounted within said tubular envelope portion, said gun including a plurality of electrodes mounted along a common axis for forming a beam of electrons, a pair of pole pieces mounted on one of said electrodes for forming a magnetic correcting field in the path of said electron beam, said pole pieces including a flat plate extending across said tubular envelope portion and having flanged edge portions positioned adjacent the wall of said tubular envelope portion and a tubular pole piece member fixed to the opposite side of said one electrode from said flat plate, said tubular pole piece having an arcuate wall extending adjacent to the wall of said tubular envelope portion, and an armature mounted on said tubular envelope portion, said armature including a median portion extending over said arcuate wall of said tubular pole piece and end portions extending to the wall of said tubular envelope portion, each of said armature end portions being flanged and overlying one of said flanged edge portions of said flat plate pole piece, and a magnetized rod adjustably mounted through said median armature portion.

4. An electron discharge device comprising an envelope having a tubular portion, a target electrode structure mounted within said envelope, a plurality of electron gun structures within said tubular portion spaced from said target electrode, each of said gun structures including a plurality of electrodes mounted along a common axis for

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forming a beam of electrons, said gun structures being arranged so that said respective common axes converge to a point at said target electrode, a pair of magnetic pole pieces mounted adjacent one of said guns for forming a magnetic correcting field in the path of the respective electron beam, said pole pieces including portions positioned adjacent the wall of said tubular envelope portion, magnetizing means mounted on said tubular envelope portion including a flux conductor having end portions adjacent the wall of said tubular envelope portion and overlying said adjacent portions of said pole pieces, and a permanent magnet means mounted on said flux conductor, said magnet means including structure for adjustably varying said correcting field.

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