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DEVICE FOR ADJUSTABLY POSITIONING SPACED MAGNETIC FIELDS

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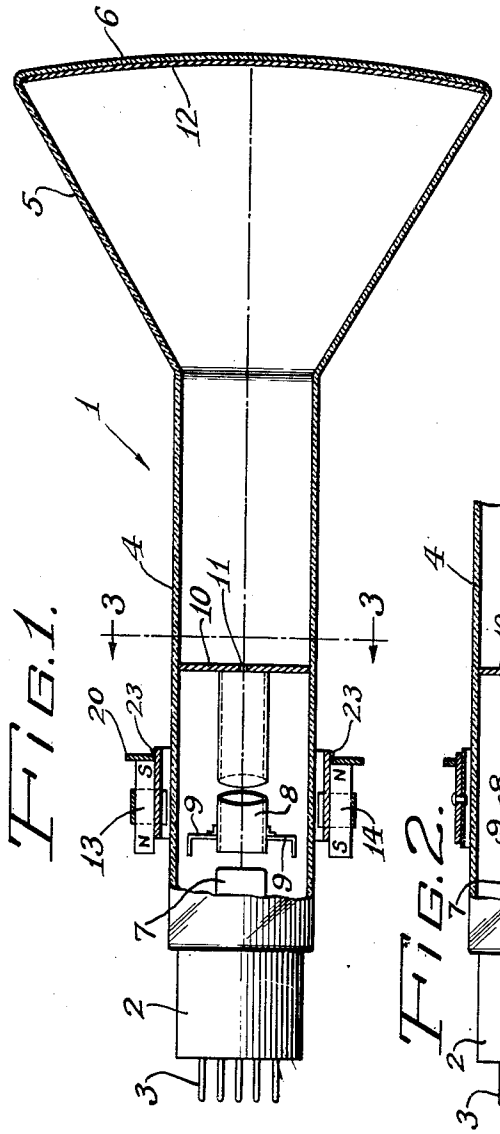


FIG. 1.

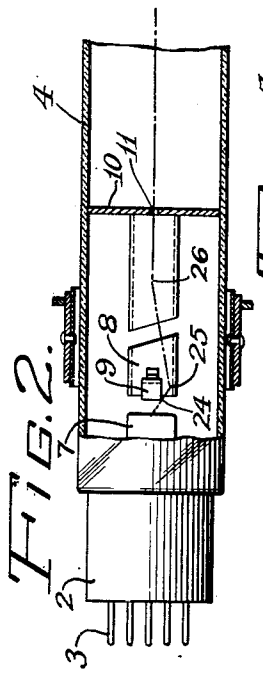


FIG. 2.

FIG. 3.

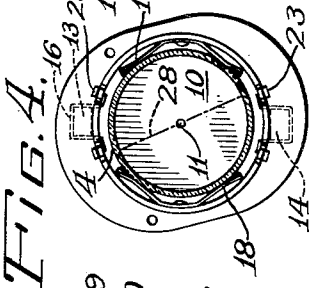


FIG. 4.

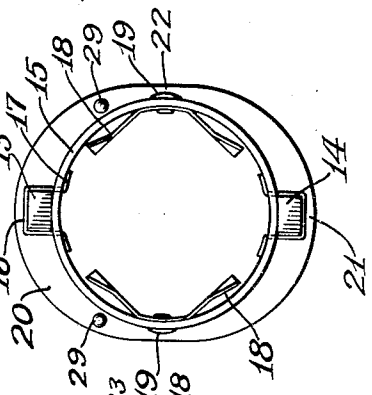


FIG. 5.

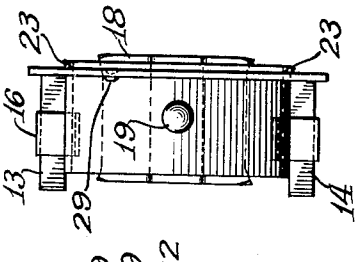


FIG. 6.

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DEVICE FOR ADJUSTABLY POSITIONING SPACED MAGNETIC FIELDS

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6 Claims. (Cl. 250—161)

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This invention relates to improvements in a device for preventing the passage of ions to the fluorescent surface of a cathode-ray tube while permitting the passage of an electron stream to said surface, and refers particularly to a device for critically adjusting the direction of travel of the electron stream.

It is known that a cathode-ray tube operates on the principle of projecting or discharging a stream of electrons from a discharge device into contact with a screen of fluorescent material. It is also known that the discharging of such electron stream is accompanied by the formation of ions which, if brought into contact with the fluorescent material comprising the screen, are detrimental to the screen. It is further known that a stream of electrons can be deflected by a magnetic field and that ions have the same characteristics. However, for a magnetic field of predetermined intensity, electrons and ions do not respond, insofar as deflection is concerned, to the same degree.

This has led to the development in a cathode-ray tube of an electron discharge device or gun which projects the stream of electrons at an angle to the axis of the tube; passing the electron stream through a plurality of magnetic fields of different intensities and directions and subsequently passing the stream through a relatively small aperture to the fluorescent screen. By subjecting both the electrons and ions to the same magnetic fields, deflection of the streams occurs to different degrees and, hence, the ion stream does not follow the electron stream through the aperture but is obstructed by the wall in which the aperture is provided.

In my copending application for United States Letters Patent Serial No. 70,053, filed January 10, 1949, I show and describe a convenient and efficient means for setting up spaced magnetic fields along the length of the electron stream, the fields being of different predetermined strength and being in opposite direction, the spaced fields being adapted to exert forces upon the electron stream such as to permit said stream to pass through the aperture in the obstructing wall and impinge upon the fluorescent surface while at the same time preventing ions from passing through said aperture.

In my present invention means for setting up spaced magnetic fields along the length of the electron stream is contemplated with the improvement comprising conveniently manipulated means for adjustably altering the radial position of the axis of greatest magnetic field intensity

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of one of said magnetic fields with respect to the axis of the electron stream.

The objects and advantages of my invention will be apparent from the accompanying drawings and following detailed description.

In the drawings:

Fig. 1 is a side view of a cathode-ray tube, parts being broken away and parts being shown in section, with my improved device mounted in operative position upon the neck of the tube.

Fig. 2 is a fragmentary sectional view, parts being shown in elevation and parts being broken away of the neck of the tube, the section being at right angles to the view illustrated in Fig. 1.

Fig. 3 is a transverse sectional view taken on line 3—3 of Fig. 1.

Fig. 4 is a view similar to Fig. 3 illustrating the flux shorting ring in a different position.

Fig. 5 is a front elevational view of my improved device, and

Fig. 6 is a side elevational view thereof.

Referring in detail to the drawing, 1 indicates a conventional cathode-ray tube having a base 2 which carries male contact elements or prongs 3 for connecting the various elements of the tube to an external circuit. The tube is constructed of glass having a neck portion 4 and a flared portion 5, the flared portion terminating in a screen or face portion 6.

Within the tube 1 an electron discharge device 7 is positioned adjacent the base 2. The function of the device 7 is to project or discharge a stream of electrons and is usually referred to as an electron gun. Adjacent the discharge device 7 is a member 8 which carries oppositely extending arms 9, the arms being positioned transversely with respect to the longitudinal axis of the neck 4. Intermediate the length of the neck 4 and within the tube is a partition 10 which is provided with a central aperture 11. The inner face of the screen portion 6 of the tube carries a fluorescent coating 12 which in the operation of the tube is acted upon by the electron stream discharged from the gun 7 to cause the material constituting the layer 12 to fluoresce and give off light. In this type of tube, the electron gun 7 is so oriented that the electron stream is projected at an angle to the longitudinal axis of the tube. As will be hereinafter more fully described, this stream is subsequently deflected in such a manner as to project through the aperture 11.

The tube 1 hereinbefore described is conventional and per se constitutes no part of the present invention. However, my invention is applicable

to a tube of this type, such tubes being commonly used for television reception.

It is known that electrons in motion can be deflected during passage through a magnetic field. It is also known that in the usual cathode-ray tube, the motion of the electrons discharged from the gun 7 gives rise to ions. The tube 1 is evacuated but within the limits of efficiency of present day vacuum pumps, a small trace of residual gas remains in the tube. In addition, occluded gases are contained in the walls of the tube. Consequently, during the passage of the electron stream, such gases are ionized. It is also known that the ions thus produced have a detrimental effect upon the fluorescent material 12 tending to de-activate such material or "burn" it.

It is further known that ions are also responsive to a magnetic field. However, for a magnetic field of predetermined intensity the electrons and ions are deflected a different degree. Consequently, the construction of tube 1 is such that it is to be used with a device for setting up magnetic fields in such fashion as to deflect the electron stream and ion stream at spaced points along the length of the streams. The angle of projection of the electron stream from the gun 7 is then so correlated with respect to the spaced magnetic field as to deflect the electron stream from its original path at an angle to the axis of the tube to a direction whereby the electron stream projects through the aperture 11 and impinges upon the material 12 carried upon the screen portion 6. In view of the fact that the ions do not respond to the deflecting force of the magnetic field to the same degree that do the electrons, it can readily be seen that a force couple correlated to bring the electron stream to a position whereby it will project through the aperture 11 would not bring the ion stream into this coincident position. Consequently, the ions are prevented from emerging through the aperture 11 and, hence, are prevented from impinging upon the layer of fluorescent material 12.

My invention is particularly directed to the setting up of magnetic fields within a conventional cathode-ray tube 1 and comprises essentially a pair of bar magnets 13 and 14. The magnets 13 and 14 are conveniently constructed of rectangular cross section. However, said magnets may be of any desired section. The magnets 13 and 14 are carried upon a ring 15 which is a non-magnetic material preferably a metal such as aluminum, copper, brass or the like. The magnets 13 and 14 are secured upon the outer face of the ring 15 and are diametrically positioned with respect to each other. To secure the magnets to the ring a strap 16 embraces an intermediate portion of each magnet, said strap being substantially U-shaped and having its ends passed through apertures in the wall of the ring and bent at the interior of the ring as shown best at 17 in Fig. 5. The straps 16 are preferably constructed of metal preferably of the non-magnetic type.

Within the ring 15 a pair of diametrically opposite disposed cantilever springs 18 are positioned, said springs being secured by means of rivets 19 to the ring 15. The arrangement is such that the ring 15 may be telescopically positioned over the neck 4 of the cathode-ray tube, the arms of the springs 18 embracing the walls of the tube and holding the ring 15 in place upon the tube.

The ring 15 is circular and is adapted to carry a plate 20 which is provided with a circular aperture slightly larger in diameter than the outer diameter of the ring 15, the arrangement being such that plate 20 may be rotated upon the outer surface of the ring 15 for a purpose to be hereinafter more fully described. The plate 20 has a substantially oval periphery and is thicker radially along the major axis of the oval than it is along its minor axis as indicated at 21 and 22 respectively in Fig. 5. The plate 20 is constructed of a ferro-magnetic material and its face is adapted to make contact with the ends of the oppositely disposed magnets 13 and 14. To prevent axial movement of the plate 20 upon the ring 15 struck-up lugs 23 may be formed upon the end of the tubular ring 15. Thus the plate 20 will be confined between the ends of the magnets 13 and 14 and the struck-up lugs 23.

The assembly illustrated in Figs. 5 and 6 when mounted upon the neck 4 of the tube is so positioned thereon as to bring two corresponding ends of the magnets 13 and 14 immediately adjacent the projecting members or flags 9. The polarity of the magnet ends positioned adjacent the flags 9 is as indicated in Fig. 1, that is, the north pole of one magnet is disposed diametrically opposite from the south pole of the other magnet. The opposite ends of the magnets, namely, those ends which are in contact with the plate 20 are positioned toward the screen-end of the tube.

When the assembly is thus mounted upon the neck of the tube 1 two magnetic fields are established across the neck of the tube, said fields being spaced from each other axially along the neck of the tube and by virtue of the disposition of the magnets the fields are of opposite direction. The plate 20 by virtue of the fact that it is constructed of a ferro-magnetic material and is in contact with the respective ends of the magnets 13 and 14 functions to provide a low reluctance path between these ends of the magnets. Consequently, the magnetic field established directly between these ends of the magnets is relatively reduced in intensity with respect to the field established between the opposite ends of the magnets.

It will be noted that the magnetic paths provided by the plate 20 are of minimum cross section adjacent the minor axis of the oval. The strength of the magnets 13 and 14 is such with respect to the cross sectional area of the plate at its narrowest portions that the plate is saturated under all conditions of operation. In this regard my present device partakes of the advantages of the invention described in my copending application, hereinbefore identified.

When the magnet assembly has been mounted upon the neck of the tube 1, those poles of the two magnets which contact the plate 20 are disposed toward the screen-end of the tube and the opposite poles are disposed toward the base-end of the tube, the latter poles being disposed in radial alignment with the flags 9. Two spaced magnetic fields are thus provided which extend diametrically across the neck of the tube. By virtue of the fact that the low reluctance path established by the plate 20 connects the two poles adjacent the screen end of the tube, the strength of the field which extends diametrically across the tube directly between the two poles will be weaker than the strength of the field which extends between the two poles adjacent the base-end of the tube.

When the tube is connected in its proper circuit and the element 7 functions to discharge a stream of electrons, said electron stream initially will be discharged at an angle to the longitudinal axis of the tube as indicated at 24 in

Fig. 2. When the electron stream encounters the magnetic field established by the ends of the magnets adjacent the base-end of the tube said electron stream will be abruptly changed in direction as indicated at 25 in Fig. 2. The stream of electrons then proceeds along the deflected line until it encounters the second magnetic field established between the opposite ends of the magnets at which time said stream will again be deflected as indicated at 26 in Fig. 2. In view of the fact that the first magnetic field encountered is stronger than the second field the degree of the first deflection will be greater than the degree of the second deflection. The magnetic fields are so correlated with respect to strength and are so spaced as to cause the stream of electrons after being deflected the second time to proceed substantially along the longitudinal axis of the tube and be projected through the aperture 11 in the wall 10.

In view of the fact that the tube 1 although evacuated contains residual quantities of gas, the moving stream of electrons gives rise to a stream of ions. These ions are also affected by the magetic fields but are not affected to the same degree as is the stream of electrons. Consequently, when the magnetic fields are so adjusted as to cause the stream of electrons to project through the aperture 11, the ion stream will be so deflected as to impinge upon the wall 10. In this manner the ions are prevented from passing through the aperture 11 and impinging upon the fluorescent surface 12.

It has been found in the operation of the usual cathode-ray tube particularly for television uses that a phenomena known as "shadow" is encountered. This phenomena exhibits itself in that a portion of the screen is devoid of illumination. The portion of the screen so effected usually occurs adjacent the periphery of the screen and it is frequently observed that the contour of the shadowed area is somewhat arcuate. Although it is not definitely known precisely what causes this effect it is believed that it is caused by a portion of the electron stream engaging a peripheral edge of the aperture 11. In this manner a portion of said stream is obstructed. However, whatever the cause of shadow may be, I have found that by slightly displacing the second magnetic field, that is the one established toward the screen-end of the tube, the shadow may be eliminated.

I have found that when shadow occurs upon the screen of a fluorescent surface it can be eliminated by rotating the plate 20 from its normal position, that is, its position with its major axis in alignment with the two magnets 13 and 14. Under normal circumstances, that is, when the major axis of the plate 20 is coincident with the line connecting the magnets 13 and 14 the direction of the magnetic field is along the broken line 27 in Fig. 3. When the plate 20 is rotated from its normal position as indicated in Fig. 4 I have found that the direction of the magnetic field shifts as indicated by the broken line 28. It can be seen that the line of direction of the magnetic field is rotated about the center of curvature of the ring 15. I have also noted that the degree of rotation of the direction line of the magnetic field is slightly greater than the degree of rotation or displacement of the major axis of the plate 20 from its normal position.

In order to prevent overshifting of the plate 20, that is, the shifting of the plate beyond the points where its influence would have any effect upon eliminating shadow, the plate may be provided with struck-up projections 27 which function as stops when the same abut against one of the magnet ends.

By the proper manipulation of the plate 20, that is its rotation in a clockwise or counterclockwise direction I have found that shadow upon the tube screen can be eliminated. In view of the fact that under normal operating conditions shadow is a constant which appears to be a characteristic of the tube and supplemental apparatus employed with the tube, the proper adjustment of the plate 20 to eliminate the shadow when once made functions to correct the defect permanently. In other words, with the magnetic assembly mounted upon the neck of the tube and the plate 20 properly adjusted the tube functions in a perfect manner so long as the adjustment of the magnetic assembly or the adjustment of the plate 20 is not altered.

I claim as my invention:

1. A device for magnetically deflecting an electron beam in a cathode-ray tube, comprising a ring constructed of non-magnetic rigid material, a pair of bar magnets carried upon said ring, said magnets being disposed upon diametrically opposite sides of said ring with the poles of one magnet disposed opposite unlike poles of the other magnet, means for removably mounting said ring upon the neck of a cathode-ray tube with the magnets disposed substantially parallel to the axis of said neck, and an endless plate of ferro-magnetic material mounted upon said ring and circumscribing the same, said plate being in movable contact with diametrically opposed ends of said magnets to provide a relatively low reluctance path for magnetic flux circumscribing said ring.

2. A device for magnetically deflecting an electron beam in a cathode-ray tube, comprising a ring constructed of non-magnetic rigid material, a pair of bar magnets carried upon said ring, said magnets being disposed upon diametrically opposite sides of said ring with the poles of one magnet disposed opposite unlike poles of the other magnet, means for removably mounting said ring upon the neck of a cathode-ray tube with the magnets disposed substantially parallel to the axis of said neck, and an endless plate of ferro-magnetic material mounted upon said ring and circumscribing the same, said plate being in contact with diametrically opposed ends of said magnets to provide a relatively low reluctance path for magnetic flux circumscribing said ring and portions of said plate intermediate said magnet ends being of restricted cross-section whereby said restricted portions are magnetically saturated by the magnetomotive force of said magnets.

3. A device for magnetically deflecting an electron beam in a cathode-ray tube, comprising a ring constructed of non-magnetic rigid material, a pair of bar magnets carried upon diametrically opposite sides of said ring with the poles of one magnet disposed opposite unlike poles of the other magnet, means for removably mounting said ring upon the neck of a cathode-ray tube with the magnets disposed substantially parallel to the axis of said neck, and an endless plate of ferro-magnetic material rotatably mounted upon said ring and circumscribing the same, said plate being in movable contact with diametrically opposed ends of said magnets to provide a relatively low reluctance path for magnetic flux circumscribing said ring, said plate being of varying cross-sectional area throughout its length.

4. A device for magnetically deflecting an electron beam in a cathode-ray tube, comprising a substantially circular cylindrical ring constructed of non-magnetic rigid material, a pair of bar magnets carried upon diametrically opposite sides of said ring with the poles of one magnet disposed opposite unlike poles of the other magnet and with the lengths of said bar magnets disposed substantially parallel to the axis of said cylindrical ring, means for mounting said ring in coaxial relationship with, and upon, the neck of a cathode-ray tube, an endless plate of ferro-magnetic material rotatably mounted upon said ring, said plate being provided with a substantially circular aperture for seating the plate upon the ring, said plate having a substantially oval periphery and the face of said plate being in slidable contact with opposite ends of the magnets whereby rotation of said plate displaces the axis of the magnetic field established between said opposed magnet ends.

5. A device for magnetically deflecting an electron beam in a cathode-ray tube, comprising a substantially circular cylindrical ring constructed of non-magnetic rigid material, a pair of bar magnets carried upon diametrically opposite sides of said ring with the poles of one magnet disposed opposite unlike poles of the other magnet and with the lengths of said bar magnets disposed substantially parallel to the axis of said cylindrical ring, means for mounting said ring in coaxial relationship with, and upon, the neck of a cathode-ray tube, an endless relatively flat plate of ferro-magnetic material rotatably mounted upon said ring, said plate being provided with a substantially circular aperture for seating the

plate upon the ring with its flat surfaces disposed transversely with respect to the ring surface, said plate having a substantially oval periphery and the face of said plate being in slidable contact with opposite ends of the magnets whereby rotation of said plate displaces the axis of the magnetic field established between said opposed magnet ends.

6. A device for magnetically deflecting an electron beam in a cathode-ray tube, which comprises in combination, a pair of bar magnets, means for holding said magnets in substantially parallel spaced relationship with opposite poles opposed to establish two spaced magnetic fields between the opposed magnet ends, a ferro-magnetic endless ring of non-uniform cross section rotatably carried upon said means and in movable contact with one pair of opposite ends of said magnets, and means for mounting said magnets and holding means upon the neck of a cathode-ray tube.

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