Oct. 15, 1957 M. D. HARSH 2,810,091

ION TRAP

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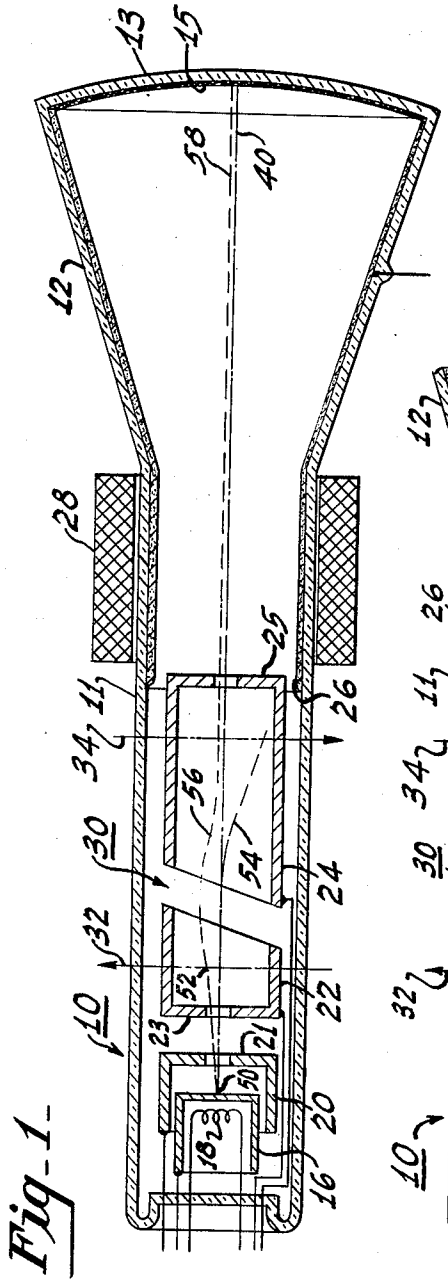


Fig. 1

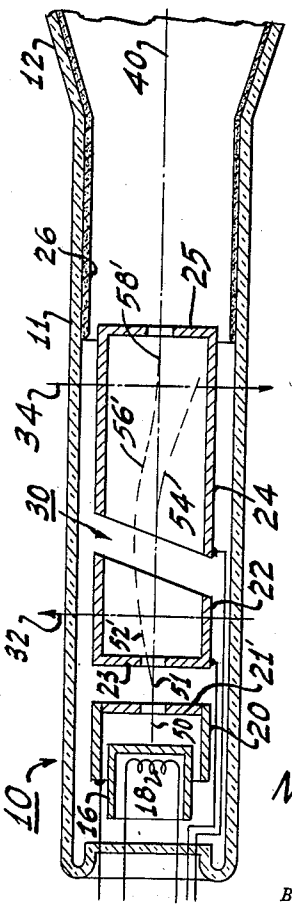


Fig. 2

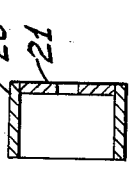


Fig. 3

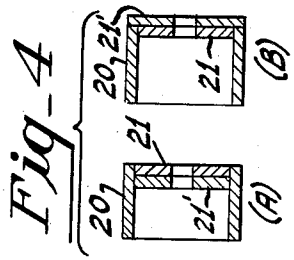


Fig. 4

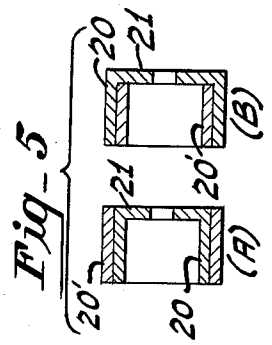


Fig. 5

INVENTOR.
MAURICE D. HARSH

BY Charles H. Brown

ATTORNEY

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ION TRAP

Maurice D. Harsh, Neffsville, Pa., assignor to Radio Corporation of America, a corporation of Delaware

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6 Claims. (Cl. 315—8)

This invention relates to a device for re-centering the electron beam in a cathode-ray tube after the entire beam has been deflected to trap the negative ions in the beam.

In cathode-ray tubes using electromagnetic deflection, the negative ions present in the beam are essentially unaffected by the magnetic deflection field. These negative ions maintain an unwavering bombardment of the fluorescent screen in one small area, thus causing a permanent darkening or discoloration on the screen called an ion spot. These ion spots may be eliminated by an ion trap which consists of an electrostatic lens field tilted to the longitudinal axis of the electron gun, and two magnetic fields that are transverse to the same longitudinal axis. The electrostatic lens field deflects the entire beam from the axis of the electron gun. One magnetic field deflects the electron portion of the beam back toward the axis of the cathode-ray tube. The second magnetic field, opposite in direction to the first magnetic field, bends the electron beam into approximate alignment with the axis of the cathode-ray tube. But since the negative ions are essentially unaffected by the magnetic fields, they continue their travel on the off-axis deflection path, and eventually strike an electrode that collects such ions.

Despite the two magnetic fields provided in the ion trap, it is still difficult to re-center accurately the deflected electron beam on the axis of the electron gun. This difficulty remains because it has not been possible to produce magnetic fields that are narrow and sharp enough to compensate exactly for the deflection of the electrons introduced by the tilted electrostatic lens. The two magnetic ion trap fields also tend to distort the electron beam.

An object of this invention is to improve the centering of the electrostatically deflected electron beam in a cathode-ray tube containing an ion trap.

Another object of this invention is to reduce the magnetic distortion of the electron beam in the region between the cathode and the tilted electrostatic lens in the cathode ray tube.

Another object of this invention is to provide narrow magnetic ion trap fields that produce more accurate compensation for the deflection of the electron beam caused by the tilted electrostatic lens in a cathode-ray tube ion trap arrangement.

Anther object of this invention is to provide accurate centering of the electrostatically deflected electron beam in a cathode-ray tube containing an ion trap, by means that are inexpensive and simple.

To provide a more accurate and sharply defined magnetic ion trap field in the cathode-ray tube ion trap, this invention shields the control grid of the electron gun from the magnetic ion trap field. This shielding may be accomplished by placing a ferro-magnetic material, such as iron, near the control grid, and between the control grid and the magnetic field. This shielding isolates a portion of the beam path enclosed by the control grid

from the magnetic ion trap field, thus effectively narrowing the magnetic field as shown in the following drawings, in which:

Fig. 1 is a longitudinal sectional view of a cathode ray tube showing the beam paths in an ion trap not utilizing this invention.

Fig. 2 is a longitudinal sectional view of a portion of a cathode-ray tube showing the beam paths in an ion trap utilizing one embodiment of this invention.

Figs. 3, 4, and 5 are longitudinal sectional views of other embodiments of the magnetic shield.

Referring first to Fig. 1, a typical cathode-ray tube is indicated by **10**. The tube **10** is evacuated and has a glass neck **11** closed at one end, and a diverging glass or metal bulb **12** attached to the opposite end of the neck **11**. The bulb **12** is closed by a glass face plate **13** that is coated on its inner surface with a fluorescent screen **15**. The neck **11** contains the electron-gun structure which, in its usual form, comprises an electron emitting cathode **16**, a heater filament **18** contained within said cathode, a cylindrical control grid **20** having a centrally apertured disk **21** at its end toward the glass plate **13**, a cylindrical first anode **22** having a centrally apertured disk **23** at its end next to the control grid **20**, a cylindrical second anode **24** having a centrally apertured disk **25** at its end toward the glass plate **13**, and a third anode **26** formed by coating the inner surface of a portion of the tube neck **11** and bulb **12** with an electrically conducting material such as aquadag. This third anode **26** may or may not be electrically connected to the second anode **24**, depending on the exact purpose and use of the cathode-ray tube. The control grid **20** and disk **21**, the first anode **22** and disk **23**, and the second anode **24** and disk **25** are all made of a nonmagnetic, metallic material such as stainless steel, and are physically spaced so that the longitudinal axis of each coincides with the longitudinal axis **40** of the electron gun. An electromagnetic deflecting yoke **28** encircles the neck **11**. In practice, this yoke **28** includes a pair of horizontal deflecting coils and a pair of vertical deflecting coils. However, since these coils form no essential part of this invention per se and yoke **28** is merely indicated.

The cathode-ray tube, as shown in Fig. 1 and as generally used, has the usual potentials applied to the various components of the electron-gun structure so as to project the electrons emitted from the cathode toward the screen **15**. The electrostatic lens **30**, formed between the first anode **22** and the second anode **24** has its axis of symmetry tilted about the axis **40** of the cathode-ray tube gun. The two magnetic ion trap fields, which are in the region surrounding the electrostatic lens **30**, and which transversely deflect the beam of electrons in opposite directions are not shown, but their resultant lines of force are represented by the lines **32** and **34** which are terminated by arrows indicating the directions of the forces.

In Fig. 1, the beam **50** formed by the electron gun contains both electrons and negative ions. The electrons of the composite beam are deflected in the direction indicated by the line of force **32** of one magnetic ion trap field so that they follow path **52**. The ions continue along their original path **50** until they enter the region of the electrostatic lens **30**. This lens deflects the negative ions so that they follow path **54** and strike the second anode **24** which collects them. This lens **30** also deflects the beam of electrons so that it follows path **56** back toward the electron-gun axis **40**. Under the resultant influence of the electrostatic lens **30** and the forces **32** and **34** of the magnetic ion trap fields, the electrons of the beam finally proceed along path **58**.

It is desirable that the last deflected path **58** of the

electron beam coincides as nearly as possible with the axis **40** of the cathode-ray tube. However, because of the unrestricted magnetic fields previously employed to redeflect the electron beam, it has been difficult to re-center accurately the electron beam so that it coincides with the axis of the cathode-ray tube. This invention improves that re-centering and reduces the magnetic distortion of the electron beam.

One embodiment of this invention is shown in Fig. 2, wherein the parts which are identical with those of Fig. 1 have been given like reference numerals. However, only that portion of the cathode-ray tube that is necessary for an understanding of the invention has been shown in Fig. 2. The control grid **20** in Fig. 2 includes a nonmagnetic metallic cylinder and an apertured disk **21'** in accordance with this invention made of a ferromagnetic material such as iron. Because of its high permeability, the ferromagnetic disk **21'** shields the space within control grid **20** from magnetic fields, thus narrowing and sharply defining the magnetic ion trap fields **32** and **34**. As a result of this narrowing action on the magnetic fields, the electron beam is not deflected by the magnetic fields **32** until it reaches a point **51** outside the shielding effect of the apertured disk **21'**. Under the resultant influence of the electrostatic lens **30** and the forces **32** and **34** of the magnetic ion trap fields, the electron beam follows paths **52'**, **56'** and finally **58'**. As before, the ions follow path **54** and are collected by the second anode **24**. Not only does the ferromagnetic disk **21'** cause path **58'** to coincide more closely with the cathode-ray tube axis **40**, but it reduces the distortion of the electron beam. These advantages are accomplished because the shielding action of the disk **21'** restricts the magnetic fields, thus allowing them to compensate more precisely for the electrostatic deflection without distorting the electron beam any more than necessary.

Another embodiment of this invention is shown in Fig. 3, wherein only the control grid portion of the electron-gun structure is shown. Instead of the control grid **20** and disk **21** both being made of a nonmagnetic metallic material, the cylinder **20'** is made of a ferromagnetic material such as iron. This magnetic material shields the control grid in the same manner as did the magnetic apertured disk **21'** in Fig. 2, thereby re-centering the electron beam more accurately and introducing less distortion to it.

Figs. 4A and 4B show different constructions of another embodiment of this invention. Instead of replacing the usual nonmagnetic, metallic, apertured disk **21** with the ferromagnetic apertured disk **21'** as shown in Fig. 2, this embodiment simply adds a ferromagnetic apertured disk **21'** to the usual disk **21**. This disk **21'** may be placed either within the control grid, as shown in Fig. 4A, or external of the control grid, as shown in Fig. 4B. In either case, it shields the control grid in the same way as did the ferromagnetic apertured disk **21'** shown in Fig. 2, to give the same advantages.

Figs. 5A and 5B show different forms of another embodiment of the invention. Instead of replacing the usual nonmagnetic metallic cylinder **20** with a ferromagnetic cylinder **20'** as shown in Fig. 3, a ferromagnetic collar **20'** is positioned adjacent to the cylindrical portion **20** of the control grid either outside the cylindrical portion, as shown in Fig. 5A, or within the cylindrical portion, as shown in Fig. 5B. The ferromagnetic collar **20'** also shields the control grid **20** from the magnetic fields as did the ferromagnetic cylindrical grid as shown in Fig. 3, thus restricting the magnetic field to give more accurate beam re-centering with less beam distortion.

What is claimed is:

1. An electron gun for a cathode ray tube adapted for use with an external magnetic field, said gun comprising an electron source and a plurality of electrodes spaced therefrom for forming an electron beam along a path, one of said electrodes including a wall portion for shielding said beam path from said magnetic field.

2. An electron gun for a cathode ray tube adapted for use with an external magnetic field, said gun comprising an electron source, a control electrode insulatingly spaced from said electron source, and an additional electrode insulatingly spaced from said control electrode to form electrons from said source into a beam, said control electrode including a ferromagnetic wall portion for shielding said electron source from said magnetic field.

3. The invention of claim 2, wherein said ferromagnetic wall portion includes an apertured member adjacent to said electron source.

4. The invention of claim 2, wherein said ferromagnetic wall portion includes a tubular wall portion enclosing said electron source.

5. An electron gun for a cathode ray tube adapted for use with an external magnetic field, said gun comprising an electron source, a control electrode insulatingly spaced from said electron source, and an additional electrode insulatingly spaced from said control electrode to form electrons from said source into a beam, and a ferromagnetic wall portion surrounding said electron source for magnetically shielding said source from said magnetic field.

6. An electron gun for a cathode ray tube adapted for use with an external magnetic field, said gun comprising an electron source, a control electrode insulatingly spaced from said electron source, and an additional electrode insulatingly spaced from said control electrode to form electrons from said source into a beam along a path, and an apertured ferromagnetic wall portion spaced from said electron source along said beam path for shielding said source from said magnetic field.

References Cited in the file of this patent

UNITED STATES PATENTS

2,522,872 Heppner ---------- Sept. 19, 1950