Feb. 11, 1969 E. GOSTYN 3,427,497

MEANS FOR CONTROLLING DISTORTION IN A CATHODE RAY TUBE

Filed July 7, 1965 Sheet 1 of 2

FIG. 1

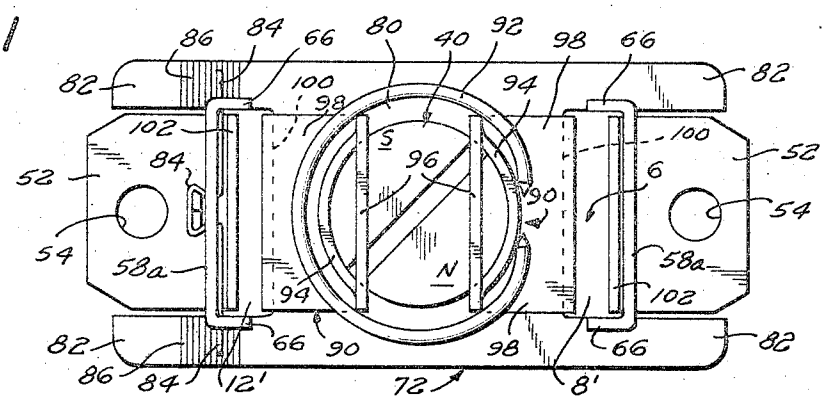


FIG. 2

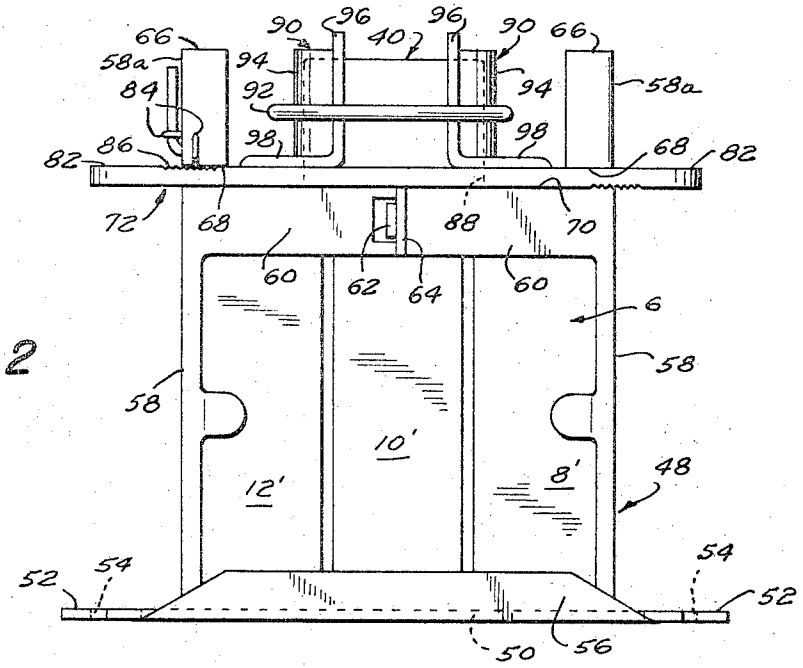
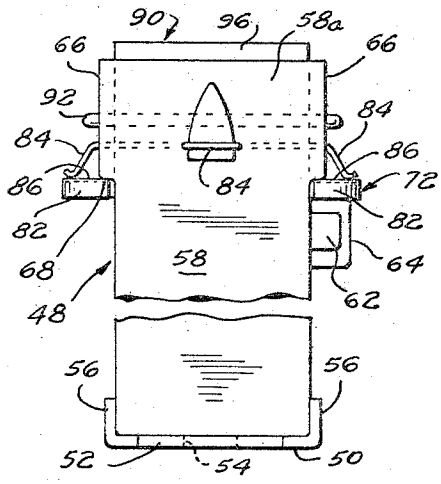


FIG. 3



INVENTOR
ERNEST GOSTYN
BY James and Franklin
ATTORNEY

MEANS FOR CONTROLLING DISTORTION IN A CATHODE RAY TUBE

Filed July 7, 1965 Sheet 2 of 2

FIG. 4

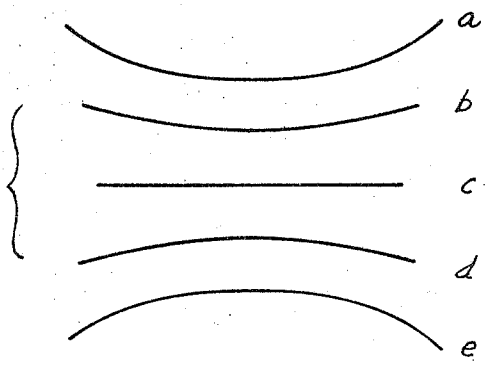


FIG. 5

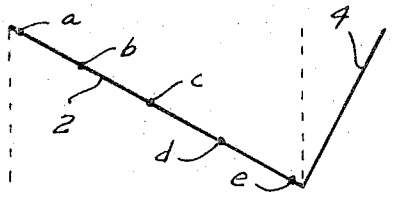


FIG. 6

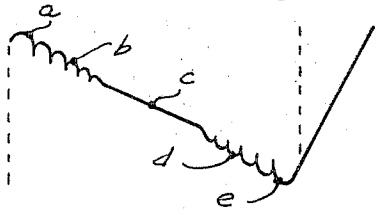
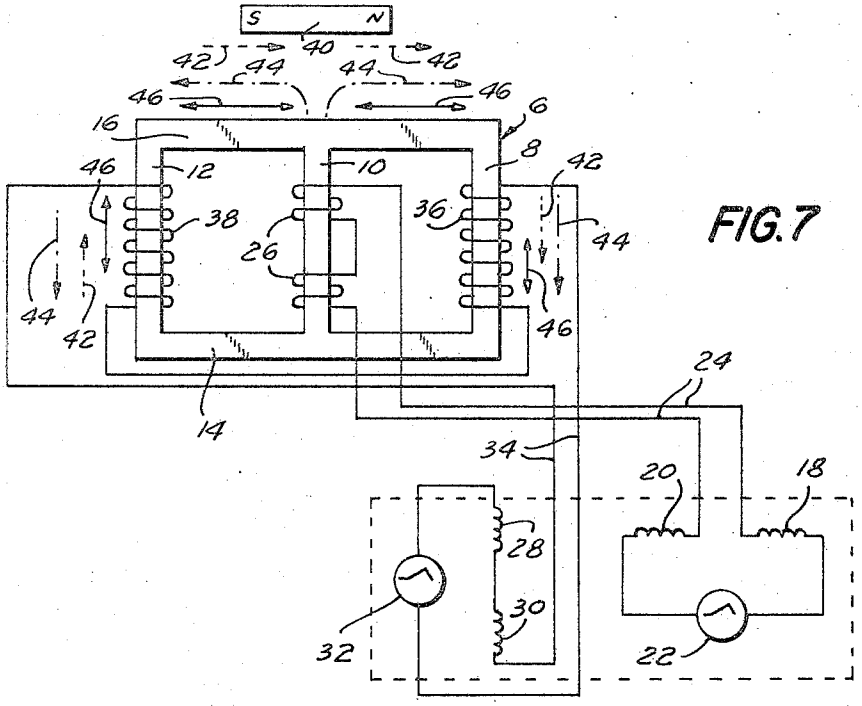


FIG. 7



INVENTOR
ERNEST GOSTYN
BY James and Franklin
ATTORNEY

United States Patent Office 3,427,497
Patented Feb. 11, 1969

3,427,497

MEANS FOR CONTROLLING DISTORTION IN A CATHODE RAY TUBE

Ernest Gostyn, Longmeadow, Mass., assignor to General Instrument Corporation, a corporation of Delaware

Filed July 7, 1965, Ser. No. 470,024
U.S. Cl. 315—27 17 Claims
Int. Cl. H01j 29/70; H01f 21/00

ABSTRACT OF THE DISCLOSURE

Magnetic apparatus for controlling distortion in a cathode ray tube and capable of having the magnitude and distribution of the correcting effect baried, a permanent magnet being rotatable relative to the fixed magnetic structure to vary the magnitude of the correcting effect and being shiftable along the magnetic structure for varying the distribution of the correcting effect.

The present invention relates to means for controlling or modifying distortion in cathode ray tube displays, particularly distortion of the "pincushion" type. It is particularly well adapted for use in conjunction with color display tubes.

The so-called "pincushion" type distortion of cathode ray tube displays has long been recognized. In black-and-white displays this type of distortion is to considerable extent corrected through the use of permanent magnets which are so shaped and so fixed in position relative to the cathode ray tube as to produce an appropriate magnetic biasing effect on the cathode ray beam. However, in the case of color display tubes which are based on use of the shadow mask or similar principles such fixed correcting magnets cannot be used.

One approach which has been adopted in connection with pincushion distortion correction in color displays involves the modulation or variation of one of the sweep currents in such a fashion as to produce the desired results. It has further been suggested in the prior art that this modulation be accomplished in an electromagnetic manner, using a combination of magnetic and electrical circuitry which works on the principle of magnetic saturability. In general, adequate nominal correction is produced by this means, but only for one particular design of display system, and it is difficult if not impossible for a given device to be readily adjustable or modifiable so as to compensate for the individual perculiarities of a series of display tubes as they come from a production line, or to make correction adjustments from time to time in order to compensate for changes in the operating characteristics of the cathode ray tube which occur with use. Thus it has been difficult, on a production line, to produce a large number of color displays all of which have the same degree of excellence insofar as absence of pincushion distortion is concerned, and it has been correspondingly difficult to prevent an increase in pincushion distortion in a color display tube as it is used.

The prime object of the present invention is to a highly effective modulation of the sweep current of a display tube in order to minimize or eliminate pincushion distortion, the magnitude of the compensating correction being readily variable, and the relative magnitudes of the corrections at the opposite extremes of the display likewise being variable. Thus a single system design can be used with display tubes of different characteristics, or with display tubes nominally having the same characteristics but in which individual such tubes depart somewhat from their nominal characteristics.

In accordance with the present invention the electromagnetic modulation of the sweep current is accomplished in electromagnetic fashion, as in the prior art, but the system is so constructed and arranged as to provide for adjustable variation in the modulating effect, thereby to produce the desired variations in magnitude or location of the distortion-correcting effects. More specifically, the modulating structure comprises a magnetic circuit having a plurality of legs with which coils are associated, the legs being connected by a magnetizable arm in such a fashion that a current through one winding will effect or modulate the current in another winding. A permanent magnet is associated with the magnetic circuit in order to provide a desired magnetic bias, the location and magnitude of the bias determining, at least in part, the modulation effect produced. The permanent biasing magnet is formed separately from the main magnetic circuit, and is mounted so as to be movable relative to a portion of the core with which it is magnetically associated, thereby to vary its biasing effect. In order to vary the maximum amplitude of the modulating effect produced, the biasing magnet is rotatably mounted relative to the main magnetic circuit so that the direction of magnetization of the permanent magnet may be shifted between positions parallel to and perpendicular to that arm of the magnetic circuit with which the biasing magnet is associated. In addition, the biasing magnet is mounted for translation along the arm of the magnetic circuit with which it is associated, so that the magnitude of its biasing effect can be varied as between different portions of the magnetic circuit. In this way the pincushion correction can be made greater at one end of the display than at the other end thereof, and the absolute magnitude of the correction produced can be independently adjusted and controlled.

It is preferred that the biasing magnet be mounted on a carriage which is itself movably mounted on the basic magnetic circuit, the carriage being shiftable in position in order to produce the desired distribution of magnetic biasing effect in the different portions thereof, and means are provided for reliably retaining the carriage in its adjusted position. The biasing magnet may itself be rotatably mounted on the carriage, thereby to permit variation of the absolute magnitude of the magnetic biasing force produced independently of the distribution thereof among the various parts of the basic magnetic circuit. Additional structural arrangements may be utilized to enhance and intensify the effect of the biasing magnet on the basic magnetic circuit and thus produce a desired degree of adjustment sensitivity.

To the accomplishment of the above, and to such other objects as may hereinafter appear, the present invention relates to a device for controlling distortion in a cathode ray tube, as defined in the following claims and as described in this specification, taken together with the accompanying drawings, in which:

FIG. 1 is a top plan view of one structural embodiment of the present invention;

FIG. 2 is a front elevational view thereof;

FIG. 3 is a side elevational view thereof;

FIG. 4 is a schematic representation illustrating the geometric requirements for correction of pincushion effect;

FIG. 5 is a graphical representation of a typical sweep current cycle without correction in accordance with the present invention;

FIG. 6 is a view similar to FIG. 5 but showing the sweep current with the correction applied; and

FIG. 7 is an electromagnetic circuit diagram showing the use of the device of FIGS. 1–3 for producing sweep current corrections of the type shown in FIG. 6.

Pincushion distortion is a type of distortion in which the outlines of a nominally rectangular display depart from rectangularity in a concave fashion, the resultant outline having the shape of a conventional pincushion in which the corners are spaced outwardly from the midpoint of

the sides. FIG. 4 discloses, in more or less schematic form, such a distortion. For simplicity of explanation, the entire display is represented by five horizontal lines, *a–e*, which represent horizontal sweeps which are repeated in order cyclically for each vertical scan or sweep. The central line *c* is straight, but is shorter than the other lines. The lines *b* and *d* are curved, and the lines *a* and *e* are curved still more, the length of the lines *b* and *d* being intermediate between that of the line *c* and those of the lines *a* and *e*. It will be seen from FIG. 4 that deviation from the rectangular pattern occurs at the top and bottom and at the left and right sides. Either type of deviation or distortion can be corrected in accordance with the present invention. In the description to follow correction will be applied to the top and bottom type of pincushion distortion.

From an examination of FIG. 4 it will be seen that the top and bottom type of pincushion distortion can be counteracted if the vertical sweep current is varied in accordance with the horizontal sweep, with that variation in vertical sweep current changing as the horizontal sweep moves from line *a* to line *b* and on to line *e*. Line a will be converted to a straight line (thus eliminating the top and bottom pincushion effect) if the vertical sweep current is reduced as the horizontal beam deflection approaches the left and right sides. The same is true of line *b*, except that the amount of reduction in the vertical sweep current will be less than that of line *a*. For line *c* the vertical sweep current should remain constant. The correction for line *d* is similar to that for line *b*, but in the opposite direction, and the correction for line *e* is similar to that for line *a*, but in the opposite direction.

A typical vertical deflection current wave, in idealized form, is illustrated graphically in FIG. 5. The graph portion **2** represents the change in vertical deflection current during a single display cycle, while the graph portion **4** indicates the more rapid change of the vertical sweep current as it resets to its initial condition, ready for the next cycle. It will be understood that during the time that the graph portion **2** goes from maximum to minimum the horizontal sweep occurs a multiplicity of times, thereby to form the horizontal sweep lines *a–e* (plus as many other horizontal sweep lines as are necessary to produce a display of desired quality. In a typical TV display the vertical sweep occurs at the rate of 60 c.p.s., while the horizontal rate occurs at 15,750 c.p.s.).

Typical points on the curve **2** corresponding to the horizontal sweeps *a–e* are identified in FIGS. 5 and 6 with corresponding letters. FIG. 6 represents the idealized graph of FIG. 5 with pincushion distortion correcting modulations applied thereto. As shown in FIG. 6, the correcting modulation applied at point *a* is of the same magnitude as, but in the opposite direction from, the modulation correction applied at point *e*, the modulation corrections at points *b* and *d* are similarly related to one another but have a magnitude less than that applied at points *a* and *e* respectively, and no modulation correction at all is applied at point *c*.

To produce the modulations shown in FIG. 6, the electromagnetic circuit shown in FIG. 7 is employed. It comprises a ferromagnetic core generally designated **6** and having legs **8**, **10** and **12** connected at their lower ends by arm **14** and at their upper ends by arm **16**. The cathode ray tube vertical deflection windings **18** and **20** are energized by a vertical sweep current source **22** having an output of the type shown. The ends of the deflection windings **18** and **20** are connected by wires **24** in series with a winding **26** on the intermediate leg **10** of the magnetic core **6**. The horizontal deflection windings **28** and **30** of the cathode ray tube are connected in series with a horizontal sweep current source **32**, having an output of the character shown, and they are further connected by wires **34** in series with one another and with windings **36** and **38** on the outer legs **8** and **12** respectively of the magnetic core **6**. A permanent magnet **40**, magnetically polarized as indicated, is magnetically operatively associated with the upper arm **16** of the magnetic core **6**. The biasing magnetic field produced by the magnet **40** is represented by the broken line arrows **42**. Those arrows, it will be noted, extend in opposite directions through the legs **8** and **12**, and with the magnet **40** centrally positioned along the arm, none of that biasing field passes through the leg **10**. The magnetic field produced in the leg **10** by the current in the winding **26** is represented by the dot-dash arrows **44**. These arrows **44**, it will be noted, extend in the same direction through the legs **8** and **12**. During the time that current is flowing in the winding **26** in a given direction the current through the windings **36** and **38** will alternate, because the horizontal scan is accomplished many times for each vertical scan. The magnetic field produced in the core **6** by reason of the horizontal deflection current in the windings **36** and **38** is represented by the solid line arrows **46**, which are double-headed to indicate that their direction alternates. The windings **26** correspond to the "gate" winding of a magnetic amplifier, while the windings **36** and **38** contitute the control windings. The horizontal deflection current variations produce variations in the magnetic fields indicated by the solid line arrows **46**. These, in conjunction with the biasing magnetic field **42** and the excitation status of the magnetic fields in the legs **8** and **12**, control the permeability of the leg **10** and thus affect the reactance of the winding **26**. That reactance will vary in step with the horizontal sweep current, and as the reactance varies, the magnitude of the current flowing therethrough, and hence the magnitude of the current flowing through the vertical deflection windings **18** and **20**, will also vary.

The modulation effect on the winding **26** will be determined not only by that portion of the field **46** which passes through the leg **10**, but also by the instantaneous current in the winding **26** itself. Thus with the vertical sweep current declining from its maximum value toward zero (represented by the point *c* on graph **2**) there will be a constantly declining inductive drop in the winding **26**, and the modulation thereof by the current in the windings **36** and **38** will therefore also decline. When the vertical deflection beam is half-way down (when the current in winding **26** is zero) there will be no modulation effect. As the vertical sweep current moves down below zero the current through the winding **26** will increase in the opposite direction, and hence the modulation effect thereon will increase, but in the opposite direction. Thus modulations of the types schematically indicated in FIG. 6 are produced.

Further analysis of the operation of the magnetic system of FIG. 7 reveals that the amplitude of the correcting modulation produced for any given value of vertical deflection current (other than zero) will vary in accordance with the magnitude of the biasing magnetic field represented by the arrows **42**. Analysis also reveals that with the vertical sweep current in one direction one leg **8** or **12** of the core **6** predominates over the other in effecting modulation control, and when the vertical deflection current is in the other direction it is the other of the legs **8** or **12** which predominates in modulation control. This may be demonstrated by assuming a direction of vertical deflection current which produces the magnetic field indicated by the arrows **44**. The biasing field **42** and the vertical-deflection-current-producing field **44** add in the leg **8** and subtract in the leg **12**. The addition of the fields **42** and **44** in the leg **8** tend to saturate that leg and thus disable its control function. The resultant magnetic field in the leg **12**, however, is capable of producing a magnetic operating level which permits modulation. When the vertical deflection current is in the opposite direction, the arrows **44** will be reversed in direction, and then the arrows **42** and **44** will add in the leg **12** and subtract in the leg **8**, thus shifting control from the former to the latter. The degree of modulation control will, of course, be determined primarily by the resultant magnetic field

in the leg or legs which are exercising control at any given moment, and that value of magnetic operating level will, for a given magnitude of vertical deflection current, be determined by the effective magnetic field produced by the biasing magnet **40**.

From this analysis it appears that the magnitude of modulation, and hence the magnitude of the resultant pincushion correction, can be achieved by varying the intensity of the magnetic biasing field **42**. Further, the pincushion correction at the top and bottom portions of the display (corresponding in FIGS 5–6 to positive and negative vertical deflection current respectively) can be varied, so that more correction is provided at the top than at the bottom or vice versa, by varying the distribution of the biasing field **42** between the legs **8** and **12**. This can be done by shifting the magnet **40** toward the leg **8** or the leg **12**, depending upon the variation desired, the biasing magnetic field then partially passing through the control leg **10**, so that the biasing fields in the legs **8** and **12** are no longer equal. This causes one leg **8** or **12** to produce a greater modulation control than the other. Since, as we have seen, one leg predominates for one direction of vertical deflection current and the other leg dominates for the other direction of that current, the resultant will be a variation in the amount of correction produced at the top half of the display as compared with that produced at the bottom half of the display.

FIGS. 1–3 illustrate a preferred structural embodiment of an electromagnetic modulator corresponding to that schematically shown in FIG. 7 and capable of effecting the adjustments in modulation effect described above. The magnetic core **6**, with the windings thereon, is received within a frame generally designated **48** and formed of some suitable non-magnetic material. It comprises a bottom wall **50** having outwardly extending ears **52** with apertures **54** therethrough, through which apertures screws may pass to secure the structure to any desired support. Lips **56** extend up from the side edges of the wall **50**, defining a channel within which the magnetic core assembly **6** is relatively snugly received and is constrained against lateral movement. Appropriately secured to the bottom wall **50** in any desired manner, and extending up therefrom between the lips **56**, are end walls **58** which substantially engage and confine the magnetic core assembly **6** against longitudinal movement, the walls **58** at each end of the core assembly **6** having straps **60** which extend toward one another and are adapted to be secured together in any appropriate fashion, as by having the tab **62** on the right hand strap **60** pass through an aperture in the ear **64** on the left hand strap **60** and then be bent up so as to prevent disengagement of the straps **60**. The magnetic core assembly **6** is constructed as shown in FIG. 7, but the individual legs and arms, and the coils carried thereby, are encapsulated or otherwise surrounded by insulating material, the portions **8'**, **10'** and **12'** shown in FIG. 2 representing the core legs **8**, **10** and **12** of the schematic embodiment of FIG. 7 with windings **36**, **26** and **38** respectively secured thereto and surrounded by encapsulating material.

The end walls **58** of the frame are provided with upward extensions **58***a* which project well above the top of the magnetic core **6**, and which are provided with wings **66** which are bent therefrom so as to extend toward the center line of the core assembly **6**. The bottom edges **68** of the wings **66** are spaced a short distance above the upper edges **70** of the straps **60**, the edges **70** more or less corresponding to the upper edges of the core assembly **6**. A carriage generally designated **72** is provided, that carriage being generally of H-shape and having a crosspiece **80** from which right and left hand pairs of arms **82** extend, the crosspiece **80** resting on the edges **70** and being received between the frame extensions **58***a* with sufficient clearance in the direction from one extension **58***a* to the other so that the crosspiece may be shifted in that direction. The arms **82** lie outside the frame extensions **58***a* and are received under the wings **66**. In this way the wings **66** keep the carriage **72** in vertical position substantially against the upper edge **70** of the frame straps **60**, and consequently substantially against the upper arm **16** of the core frame **6**, while permitting the carriage **72** to be shifted from right to left as viewed in FIGS. 1 and 2. In order to retain the carriage **72** in a given adjusted position, a wire spring element **84** is carried by one of the frame extensions **58***a*, and is adapted to resiliently engage a serrated portion **86** on the upper surface of the carriage arms **82**.

The carriage **72** carries, in any appropriate fashion, the biasing permanent magnet **40**. As here specifically disclosed the magnet **40** is cylindrical in shape and is magnetically polarized as indicated by the letters N and S in FIG. 1. It is mounted on the carriage **72** so as to move with the carriage as the latter is moved from right to left in FIGS. 1 and 2, and it is also preferably mounted in the carriage **72** so as to be pivotal about a vertical axis, thereby to move its axis of magnetization between positions parallel to and at right angles to the lengthwise dimension of the core arm **16**.

As here specifically disclosed, the magnet **40** is received within an aperture **88** in the crosspiece portion **80** of the carriage **72**. Partially surrounding the magnet **40** are a pair of magnetizable elements generally designated **90**, each located between the magnet **40** and one of the frame extensions **58***a*. They are held in position by means of the C-spring **92**, have upstanding arcuate shaped portions **94** which partially surround the periphery of the magnet **40**, have top bars **96** which overlie the magnet **40** and thereby retain it in position, and have outwardly extending pole piece portions **98** oriented toward the respective frame extensions **58***a*, the portions **98** being bent down around the left and right hand edges **100** of the crosspiece portion **80** of the carriage **72**. These elements **90** assist in retaining the magnet **40** in position on the carriage **72**, help to constitute a bearing for the magnet **40**, permitting it to be adjustably rotated in order to vary the effective magnetic biasing force, and by reason of the action of the spring washer **92** they frictionally grasp the magnet **40** and retain it in its rotatably adjusted position. Moreover, the magnetizable portions **98** make a more efficient magnetic circuit for the biasing magnetic flux, thus intensifying the degree to which the biasing magnet **40** can be effective in giving rise to the current modulations previously described. If desired, special magnetizable pole piece extensions **102** can be provided which extend up vertically inside the frame extensions **58***a* from the core legs **8** and **12** respectively to points substantially on a level with the pole piece portions **98**, thus further improving the efficiency of the magnetic circuit for the biasing flux.

From the above it will be seen that by rotating the magnet **40** relative to the carriage **72** the magnitude of the effective biasing magnetic flux reaching the legs **8** and **12** will be varied, and by shifting the carriage **82** to the right or the left, the magnet **40** moving along therewith, the relative distribution of the biasing magnetic force in the legs **8** and **12** will be varied, thus providing respectively the adjustment in the magnitude of the sweep current modulation and in the relative magnitudes of that modulation at the upper and lower portions of the scan respectively.

The structure involved is simple, inexpensive, and need not be made to any high degree of precision, yet through its use a device is produced which will not only give rise to such modulation of the sweep current as will minimize the pincushion effect in a given direction, but will also permit the degree of correction to be adjusted and modified at will. Consequently, a device of a single design can be used with many different cathode ray tube systems and, when used with tubes of a given system, can be adjusted to provide corrections appropriate for the departure of individual tubes from nominal geometric or electrical characteristics. It is, in addition, possible to employ the

relative magnitude correction in applications in which viewing angle problems make an unequal pincushion correction of opposing sides advantageous.

While but a single embodiment of the present invention has been here specifically disclosed, it will be apparent that many variations may be made therein, all within the scope of the instant invention as defined in the following claims.

I claim;

1. A device for controlling distortion in a cathode ray tube comprising a magnetic core having first and second legs connected by an arm, a biasing magnet, and means operatively connected to said magnet for mounting it adjacent said arm for movement in the direction of the length of said arm between said legs, and windings on said legs, said mounting means comprising a frame on which said core is mounted and a carriage mounted on said frame adjacent said core arm and movable in the direction of the length of said arm, said magnet being mounted on said carriage between magnetizable pole pieces which extend from said magnet toward said core legs and are movable with said carriage and magnet.

2. The device of claim **1**, in which said core legs have magnetizable pole piece extensions operatively extending therefrom, said magnet and said magnetizable pole pieces being received between said pole extensions.

3. In the device of claim **2**, resilient means engaging said magnetizable pole pieces and urging them into engagement with said magnet.

4. In the device of claim **1**, resilient means engaging said magnetizable pole pieces and urging them into engagement with said magnet.

5. A device for controlling distortion in a cathode ray tube comprising a magnetic core having first and second outer legs and an intermediate leg all connected by an arm, a biasing magnet, means operatively connected to said magnet for mounting it adjacent said arm generally in registration with said intermediate leg, said magnet being magnetically polarized substantially in a plane parallel to said arm and being rotatably mounted in said mounting means to vary the effective magnetic strength in the direction of the length of said arm, windings on said outer legs and a winding on said intermediate leg, said windings on said outer legs constituting a control winding, said winding on said intermediate leg being connected to deflection means in a cathode ray tube assembly.

6. The device of claim **5**, in which said mounting means comprises a frame on which said core is mounted and a carriage mounted on said frame adjacent said core arm, said magnet being rotatably mounted on said carriage.

7. A device for controlling distortion in a cathode ray tube comprising a magnetic core having first and second legs connected by an arm, a biasing magnet, means operatively connected to said magnet for mounting it adjacent said arm for movement in the direction of the length of said arm between said legs, said magnet being magnetically polarized substantially in a plane parallel to said arm and being rotatably mounted in said mounting means to vary the effective magnetic strength in the direction of the length of said arm, and windings on said legs, at least one of said windings being connected to deflection means in a cathode ray tube assembly.

8. The device of claim **7**, in which said mounting means comprises a frame on which said core is mounted and a carriage mounted on said frame adjacent said core arm and movable in the direction of the length of said arm, said magnet being mounted on said carriage.

9. The device of claim **8**, in which said magnet is mounted on said carriage between magnetizable pole pieces which extend from said magnet toward said outer core legs and are movable with said carriage and magnet.

10. The device of claim **8**, in which said magnet is mounted on said carriage between magnetizable pole pieces which extend from said magnet toward said outer core legs and are movable with said carriage and magnet, said outer core legs having magnetizable pole piece extensions operatively extending therefrom, said magnet and said magnetizable pole pieces being received between said pole extensions.

11. The device of claim **7**, in which said mounting means comprises a frame on which said core is mounted and a carriage mounted on said frame adjacent said core arm, said magnet being rotatably mounted on said carriage.

12. The device of claim **7**, in which said mounting means comprises a frame on which said core is mounted and a carriage mounted on said frame adjacent said core arm and movable in the direction of the length of said arm, said magnet being rotatably mounted on said carriage.

13. The device of claim **12**, in which said magnet is mounted on said carriage between magnetizable pole pieces which extend from said magnet toward said outer core legs and are movable with said carriage and magnet.

14. The device of claim **12**, in which said magnet is mounted on said carriage between magnetizable pole pieces which extend from said magnet toward said outer core legs and are movable with said carriage and magnet, said outer core legs having magnetizable pole piece extensions operatively extending therefrom, said magnet and said magnetizable pole pieces being received between said pole extensions.

15. The device of claim **7**, in which said mounting means comprises af rame on which said core is mounted and a carriage mounted on said frame adjacent said core arm and movable in the direction of the length of said arm, said magnet being rotatably mounted on said carriage, and means on said frame operatively engaging said carriage to hold it in an adjusted position along said core arm.

16. A magnetic modulator comprising a magnetic core having first and second outer legs and an intermediate leg all connected by an arm, a biasing magnet, means operatively connected to said magnet for mounting it adjacent said arm generally in registration with said intermediate leg for movement in the direction of the length of said arm between said outer legs, said magnet being magnetically polarized substantially in a plane parallel to said arm and being rotatably mounted in said mounting means to vary the effective magnetic strength in the direction of the length of said arm, and windings on said outer legs and a winding on said intermediate leg.

17. The magnetic modulator of claim **16**, in which said mounting means comprises a frame on which said core is mounted and a carriage mounted on said frame adjacent said core arm and movable in a direction of the length of said arm, said magnet being rotatably mounted on said carriage, magnetizable pole pieces on said carriage between which said magnet is mounted and from which magnet said pole pieces extend toward said outer core legs, said outer core legs having magnetizable pole piece extensions operatively extending therefrom, said magnet and said magnetizable pole pieces being received between said pole piece extensions, and means on said frame operatively engaging said carriage to hold it in an adjusted position along said core arm.

References Cited

UNITED STATES PATENTS

2,702,874	2/1955	Adler	323—92 X
2,802,140	8/1957	Mattingly	336—110 X
3,283,279	11/1966	Garlotte	336—110
3,346,765	10/1967	Barkow	315—27

RODNEY D. BENNETT, *Primary Examiner.*

R. E. BERGER, *Assistant Examiner.*

U.S. Cl. X.R.

336—110