

Dec. 14, 1948.

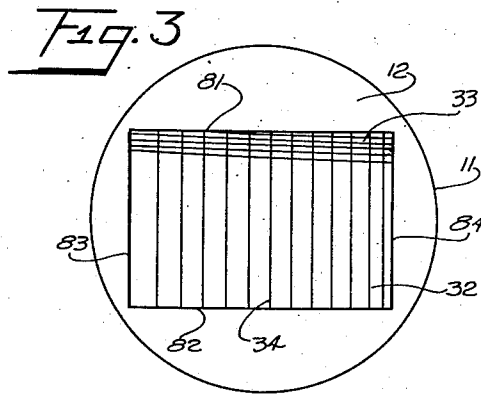
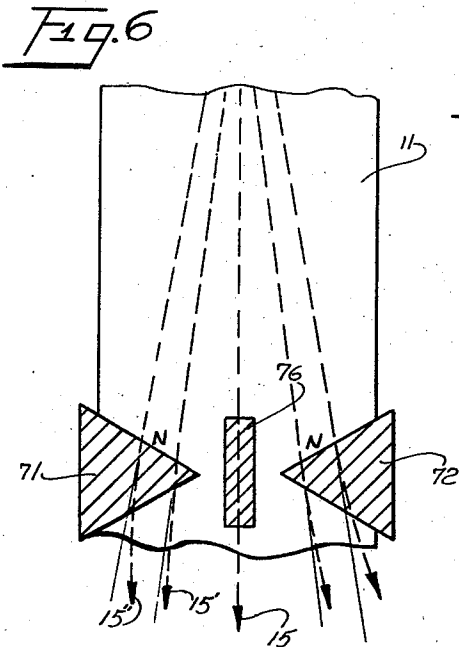
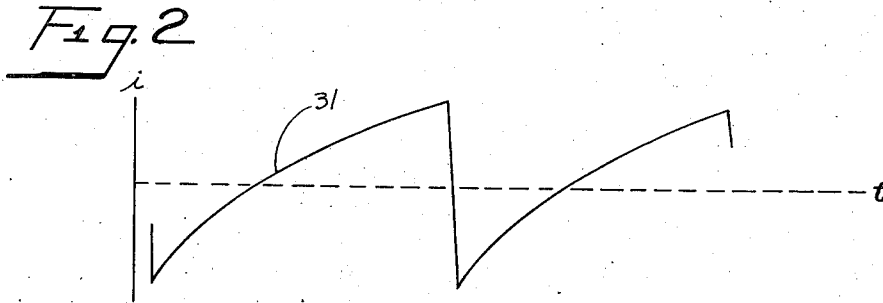
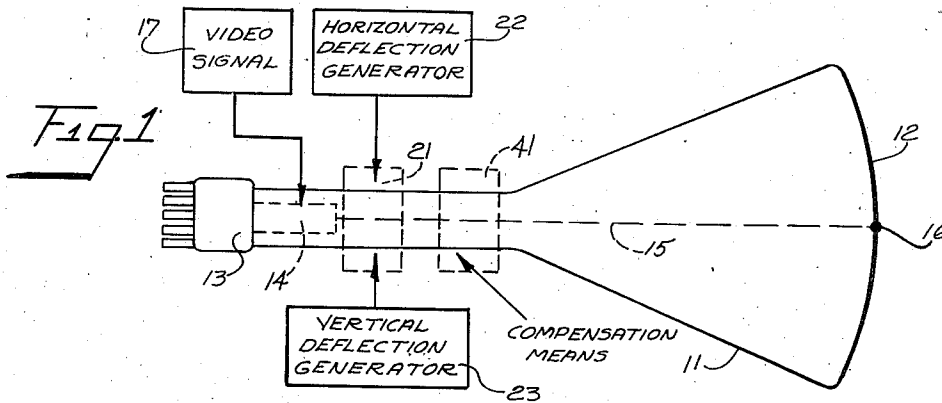
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2,455,977

MAGNETIC LENS FOR CORRECTING SCANNING DEFECTS

Filed Dec. 31, 1946

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 4

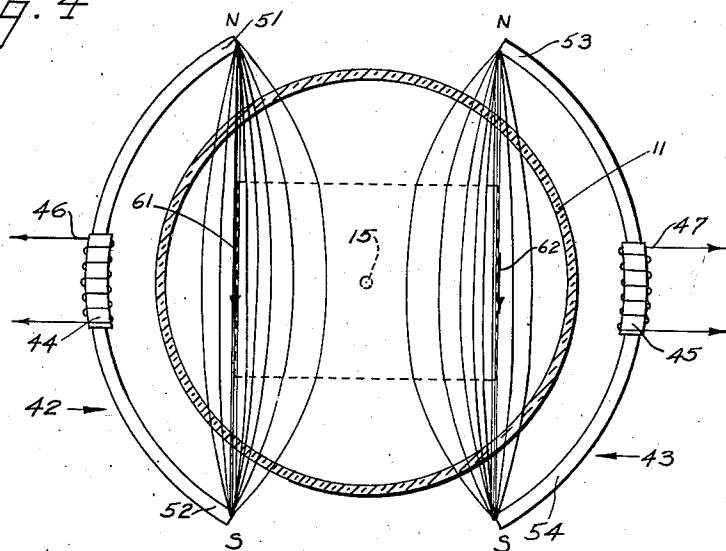
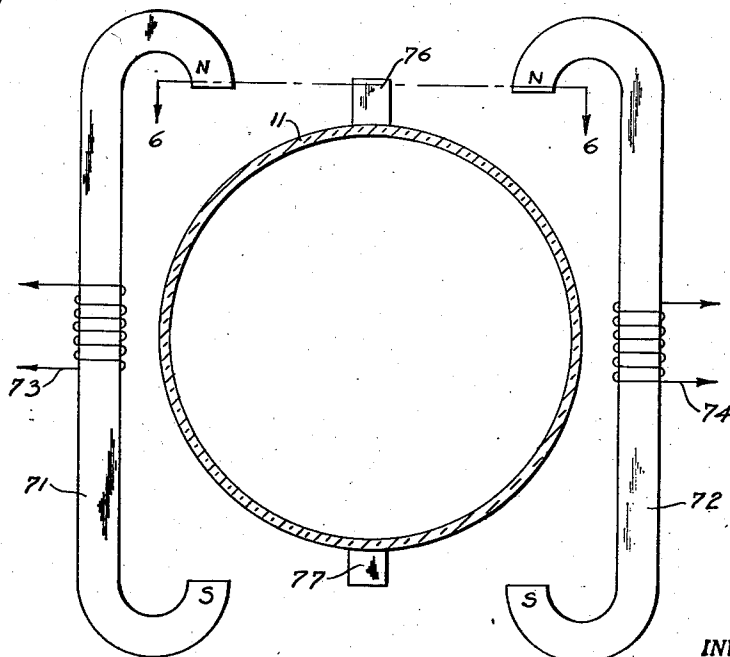


Fig. 5



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MAGNETIC LENS FOR CORRECTING
SCANNING DEFECTSCarlo V. Bocciarelli, Oxford, Pa., assignor to
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This invention relates in general to cathode ray tube image systems, and more particularly to novel means for decreasing television picture distortion while substantially simplifying associated circuit design problems.

In electronic television transmission and reception, as is well known, a cathode ray tube is used for image presentation. The cathode ray tube includes, within an envelope, an electron gun for generating and impinging an electron beam upon a fluorescent screen to provide a luminous point. Deflection means associated with the cathode ray tube are utilized to sweep the electron beam so that the luminous point on the screen traces a substantially rectangular raster of horizontal lines. Simultaneously, the electron beam is intensity modulated with a video signal representing the instantaneous lights and shades of the transmitted picture, whereby the combined sweep and intensity modulation provide the final image upon the fluorescent screen.

Electrostatic and electromagnetic deflection systems for cathode ray tubes are both in wide use in television receivers, and each has its advantages and problems. As the present invention has particular advantage when associated with magnetic receiver deflection means, a brief discussion of the general features thereof is given in the following.

For magnetic deflection, a yoke having two sets of orthogonally disposed coils is positioned around the neck of the cathode ray tube between the electron gun and the fluorescent screen. In order to obtain a uniform rectangular raster, it is required that these coils provide two magnetic fields which vary in a "saw-tooth" manner with respect to time and which are related in frequency.

In present day commercial practice the horizontal and vertical sweep frequencies are 15,750 and 60 cycles per second respectively, for interlaced scanning of 30 frames per second. In color television, and high definition black-and-white television still higher frequencies may be employed.

In order to obtain a magnetic field which has a saw-tooth time variation, it is required that the deflection coil be energized with a saw-tooth of current. As a deflection coil includes resistive and inductive components, the voltage wave-form which must be applied is complex in nature and particular care must be taken in deflection generator design.

The power requirements of a magnetic deflection generator are a function of the deflection circuit resistance and the magnitude of the cur-

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rent required to provide the desired sweep length. In general, the power capacity of a deflection generator must be fairly high while the waveform of the output must be held to close tolerances.

A deviation from linearity in the saw-tooth of current ordinarily results in a corresponding deviation in the linearity of the image reproduced. As a representative example, consider a television receiver wherein the horizontal sweep generator provides an output current which increases exponentially with time; that is, the time rate of change of current decreases throughout the trace period from an initial maximum. This is representative of the usual case. When energized by a non-linear saw-tooth signal of this type, the cathode ray tube image exhibits a distortion characterized by initial expansion and final compression, i. e., by an expansion at one side thereof and a compression at the other side thereof; hence equal time intervals are not represented by equal distances across the fluorescent screen.

In practical television systems, it is often difficult to obtain a linear saw-tooth current variation of sufficient magnitude and power to provide a sweep for a large cathode ray tube, particularly in the case of the high frequency horizontal sweep, without excessive circuit complication. Thus, a high quality sweep circuit may only be obtained at considerable expense, and as a consequence, many systems have image distortion of the type outlined above.

Linearization of the sweep current to obtain a satisfactory image within commercial tolerances may be obtained by electronic means associated with the sweep circuit and the deflection yoke.

If a low impedance deflection yoke is used, however, linearization by a special tube circuit shunting the deflection coils is substantially impossible because of the low yoke reactance in relation to the tube plate resistance. A high impedance yoke may be employed but the cost of a construction of this type is very high.

The present invention contemplates, and has as a primary object, the provision of means for compensating an image system whereby a uniform, linear image is obtained in a cathode ray tube utilizing non-linear deflection means.

Another object of this invention is to provide a cathode ray image system with fixed magnetic means for minimizing image distortion resulting from a non-linear sweep.

A further object of this invention is to provide means for establishing a corrective magnetic field

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through a cathode ray tube between the associated deflection means and fluorescent screen.

A still further object of this invention is to compensate for image distortion in cathode ray picture systems through the use of permanent magnets suitably disposed about the tube.

Another object of the present invention is to provide means for eliminating television picture distortion so that the image meets commercial standards without the requirement of complex and expensive circuits.

These and other objects of the present invention will now become apparent from the following specification taken in connection with the accompanying drawings in which:

Figure 1 is a top view of a cathode ray tube showing various components thereof as used in an image system;

Figure 2 is a graphical representation of a non-linear saw-tooth wave-form which may be applied to the horizontal deflection circuit of the cathode ray tube shown in Figure 1;

Figure 3 is a front view of the fluorescent screen of the cathode ray tube of Figure 1 and illustrates a distorted image thereon;

Figure 4 is a front view of one embodiment of a magnetic compensation system;

Figure 5 is a front view of another embodiment of a magnetic compensation system; and

Figure 6 is a top cross-sectional view of the magnetic system shown in Figure 5.

With reference now to the drawings, and more particularly Figure 1, there is shown the essential components of a television or like image system utilizing a cathode ray tube 11. Cathode ray tube 11 comprises a glass envelope having a face 12, the inside of which is coated with a phosphor capable of generating light upon the impact of an electron beam.

Within the neck of cathode ray tube 11, and above tube base 13, is an electron gun 14 which when suitably energized from a conventional power source (not shown) provides an electron beam 15 focused to a sharply defined point 16 on fluorescent screen 12.

The luminous intensity of the point of impact 16 upon fluorescent screen 12 is controlled by intensity modulating electron beam 15 from a video signal source 17 suitably connected to electron gun 14. The particular nature of the video signal is not important to an understanding of the present invention.

A magnetic deflection yoke, schematically represented at 21 in Figure 1, is disposed about the neck of the cathode ray tube 11 between the electron gun 14 and fluorescent screen 12. This deflection yoke comprises a pair of coils having orthogonally oriented axes, which coils are energized from horizontal and vertical deflection generators 22 and 23 respectively. When thus energized, the electron beam 15 is swept horizontally and vertically to produce a rectangular raster of light on screen 12 of cathode ray tube.

In Figure 2 there is illustrated a current-time wave-form 31 which is generally saw-tooth in shape and if of suitable frequency may be applied to the horizontal deflection coil of yoke 21 (Figure 1). The saw-tooth of current 31 of Figure 2 illustrates a common distortion encountered in television horizontal deflection generators. Here the current rise is exponential so that the time rate of current rise diminishes with time, progressively flattening the curve as shown.

If a horizontal sweep current wave-form as shown in Figure 2 is applied by deflection genera-

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tor 22 to cathode ray tube 11 (Figure 1), the luminous raster produced upon fluorescent screen 12 will be characterized by a distortion which is illustrated in Figure 3. With reference to Figure 3, there is shown the fluorescent face 12 of cathode ray tube 11 and a representative image raster 32 of substantially rectangular form as is conventional in commercial television practice. The raster 32 is composed of a plurality of horizontal luminous lines, such as line 33, which are formed by deflection of electron beam 15 under the influence of sweep current 31. In Figure 3 the raster 32 has been divided by a plurality of vertical lines 34 which represent equal sweep time intervals by the spacing therebetween. A grid of vertical lines 34 may be formed upon screen 12 if the video signal source 17 of Figure 1 provides a succession of sharp pulses equally spaced in time, the number of pulses occurring during each horizontal sweep cycle being a fixed, predetermined number.

If the sweep current 31 (Figure 2) were uniformly linear for the entire sweep cycle, then the individual lines 34 produced by the modulating pulses would be equally spaced across the face of the fluorescent screen. However, for a current wave-form 31, as shown, as the time rate of change of current falls off, the time rate of change of displacement correspondingly falls off, so that a series of pulses as mentioned above produce a grid of vertical lines 34 as shown in Figure 3, wherein the lines are progressively crowded toward the right. If instead of a pulsed video signal, conventional television picture signals were employed, the picture on screen 12 would exhibit a progressive compression from left to right as viewed in Figure 3.

In accordance with the principles of the present invention, linearization of the image is obtained without change in the deflection generators, and without adjustment of the sweep current wave-form 31. As is schematically indicated in Figure 1, compensation means 41 are provided between the deflection yoke 21 and the fluorescent screen, which means are capable of introducing a predetermined deflection to the electron beam 16 at each point in its sweep pattern, whereby the combined effect of the non-linear sweep and the compensating means produce an over-all raster which is well within commercial tolerances when considered from the standpoint of distortion.

Although the compensating means 41 are shown positioned about the neck of tube 11, it will become apparent that these means may be positioned at any point between the electron gun and the fluorescent screen.

Before considering specific embodiments of sweep compensating means, the general requirements thereof will be discussed. In order to correct the distortion of the raster indicated in Figure 3, it is necessary to contract the image horizontally at the left and correspondingly expand the image at the right. In Figure 4 there is illustrated means for accomplishing a correction of this general nature through the use of a fixed magnetic field, which may for simplicity of construction throughout be established by permanent magnets. As shown in Figure 4, a pair of magnets 42 and 43 are disposed about the neck of cathode ray tube 11 described in connection with Figure 1. The electron beam of the tube is schematically shown by broken line 15 directed toward the tube fluorescent screen. Magnets 42 and 43 comprise rectangular magnetic cores 44 and 45 respectively about which are wound field coils 46 and 47, energized from suitable direct current

sources to establish the polarities shown on arcuate soft iron pole pieces 51, 52, 53 and 54, extending from the magnets as shown. Pole pieces 51-54, inclusive, may be attached to their respective magnetic cores 44 and 45 in any suitable manner. The supports for magnetic structures 42 and 43 have not been shown, but may comprise suitable non-magnetic elements.

In Figure 4, arrowheads 61 and 62 illustrate the direction of the magnetic field established when coils 46 and 47 are energized. The field strength is adjusted by altering the currents in coils 46 and 47 while field distribution is varied by altering the position of the magnetic structures 42 and 43. The field distribution should be so adjusted as to be a maximum at the outer edges of the picture, diminishing to zero, or to a minimum, near the center of the picture. The deviation of electron beam 15 as it is swept through this field varies continuously, being a maximum at the right and left-hand edges of the picture and minimum near the center, so that linearization of the spacing between vertical lines 34 as shown in the raster 32 of Figure 3 is obtained.

The magnetic field is normal to the axis of tube 11 and varies in intensity in a horizontal line normal to the electron beam 15. A sufficient degree of linearization, for certain commercial purposes, may sometimes be accomplished through the use of only one of the magnets 42-43 shown in Figure 4.

By suitably altering the strength of the currents in coils 46 and 47, any degree of compensation may be obtained and if desired for any reason the distortion shown in Figure 3 may be reversed; that is, the lines 34 may be crowded at the left and expanded at the right. In picture systems, this of course is of no utility. Magnet cores 44 and 45 may be replaced by permanent magnets having the required strength, in which case the required compensation may be obtained wholly without the expenditure of power.

In Figures 5 and 6 is shown another possible embodiment of a compensating means for eliminating distortion in the final image ordinarily introduced by a non-linear sweep. Thus disposed about the neck of cathode ray tube are a pair of C-shaped magnetic members 71 and 72 each having a uniform triangular cross-section. The center sections of members 71 and 72 are wound with coils 73 and 74 respectively, which are energized from suitable power sources (not shown) for establishing the magnetic polarities shown.

The magnetic field established by magnets 71 and 72 extends between the triangular pole pieces through the neck of cathode ray tube 11 and substantially normal to the axis thereof. In a horizontal plane (Figure 6) the flux density is essentially uniform in a triangular area corresponding to the pole piece cross-section.

As the electron beam 15 is swept through the triangular area of the magnetic field by the tube deflection yoke (21 in Figure 1) a deviation is imparted to the beam from its original path, which deviation is a function of how long a path the beam traces through the field. In Figure 6 it is evident that when the beam 15 is deflected to position 15', the influence of the field and the resultant beam deviation is less than when in position 15''. In this manner, by a variation of the strength of the fields of magnets 71 and 72, compensation for many forms of sweep distortion may be realized.

Soft iron pieces 76 and 77 are preferably disposed as shown in Figures 5 and 6, to shunt the horizontal components of the field above the tube

so that distortion in the vertical direction of the sweep is precluded. The means for supporting soft iron pieces 76 and 77 and magnets 71 and 72 in the positions shown have been omitted to clarity.

For simplicity of design and to reduce the system power requirements, coils 73 and 74 may be dispensed with and permanent magnets and pole pieces of suitable form employed. In this manner an inexpensive non-linear sweep may be used to obtain a distortionless image. As mentioned in connection with the embodiment of Figure 4, the magnetic fields of magnets 71 and 72 of Figures 5 and 6 may be adjusted so that the distortion shown in Figure 3 is overcompensated and the compression and expansion are on sides opposite those shown. This indicates that a wide range of distortion may be compensated, although overcompensation itself is of no utility in television, unless certain effects are desired.

The magnetic systems of Figures 4 through 6 inclusive have been shown disposed about the tube neck. From the standpoint of equipment size, this is advantageous. However, construction of the compensating means need not be limited to those shown, and may be disposed wherever convenient between the electron gun and the fluorescent screen.

As a result of linearization by the magnetic means shown in Figures 4, 5 and 6, the raster appearing on the tube face may become otherwise distorted. One such distortion, known as shear, results in the upper and lower boundaries of the raster 81 and 82 respectively, in Figure 3, shifting so that they are no longer parallel to each other. Such shear may be compensated by suitably designed deflection yokes, but ordinarily this shear is negligible and need not be compensated.

In distortion of another form, the sides of the raster, 83 and 84 in Figure 3, exhibit considerable curvature. Such curvature when significant may be compensated in various ways, for example by feeding a suitable sinusoidally or parabolically varying voltage, readily obtained in a television circuit, to the cathode ray tube centering coils (not shown in the drawings) in proper phase.

In summary, the foregoing disclosure teaches an image system construction wherein the time rate of displacement of a fluorescent spot in a cathode ray tube may be altered from the time rate of change of a deflection current. A linear sweep may be produced by utilizing a non-linear sweep current and a fixed compensating magnetic field.

It will be understood that compensation of the type described above may be utilized in connection with cathode ray tubes other than those in television systems, and with other than magnetic deflection.

Thus, since various modifications and extensions of the principles of the present invention may become evident to those skilled in the art, it is preferred that the spirit and scope of this invention be defined solely by the appended claims.

I claim:

1. In an image system, a cathode ray tube having means for generating a luminous spot, means for applying a sweep signal to said cathode ray tube for deflecting said luminous spot, said sweep signal having a substantially non-linear time variation, and an adjustable magnetic means for establishing a constant magnetic field through said cathode ray tube, the orientation and configuration of said magnetic field being arranged whereby in combination with said sweep signal

said field provides substantially linear deflection of said luminous spot.

2. In an image system, a cathode ray tube, said tube including means for generating an electron beam, a fluorescent screen, means for impinging said electron beam upon said screen for providing a luminous spot, means for deflecting said electron beam, said last mentioned means being energized from a non-linear deflecting signal source, and means for linearizing the deflection of said luminous spot comprising magnetic means for establishing a constant magnetic field through said cathode ray tube between said deflecting means and said fluorescent screen.

3. In an image system, a cathode ray tube, said tube including means for generating an electron beam, a fluorescent screen, means for impinging said electron beam upon said screen for providing a luminous spot, means for deflecting said electron beam, said last mentioned means being energized from a non-linear deflecting signal source, and means for linearizing the deflection of said luminous spot comprising magnetic means for establishing a constant magnetic field through said cathode ray tube between said deflecting means and said fluorescent screen, said magnetic field being substantially normal to the axis of said cathode ray tube and of variable intensity in a direction normal thereto, said magnetic field being of a configuration to act on said electron beam in combination with said deflecting means to provide substantially linear deflection of said beam.

4. In an image system, a cathode ray tube, said tube including means for generating an electron beam, a fluorescent screen, means for impinging said electron beam upon said screen for providing a luminous spot, means for deflecting said electron beam, said last mentioned means being energized from a non-linear deflecting signal source, and means for linearizing the deflection of said luminous spot comprising magnetic means for establishing a constant magnetic field through said cathode ray tube between said deflecting means and said fluorescent screen, said magnetic field being substantially normal to the axis of said cathode ray tube and to the direction of deflection of said luminous spot.

5. In an image system, a cathode ray tube, said tube including means for generating an electron beam, a fluorescent screen, means for impinging said electron beam upon said screen for providing a luminous spot, means for deflecting said electron beam, said last mentioned means being energized from a non-linear deflecting signal source, and means for linearizing the deflection of said luminous spot comprising magnetic means for establishing a magnetic field through said cathode ray tube between said deflecting means and said fluorescent screen, said magnetic field being substantially normal to the axis of said cathode ray tube and to the direction of deflection of said luminous spot, said magnetic field being of substantially uniform density and of variable extent axially of said tube.

6. A picture system comprising a cathode ray tube having means for generating and deflecting a luminous spot, said deflecting means being energized from a deflection signal source, said signal source having an output non-linear with respect to time, and a constant compensation means between said deflecting means and said luminous spot, whereby the deflection of said luminous spot under the influence of said deflecting means and said compensation means is substantially linear with respect to time.

7. A cathode ray tube sweep system comprising in combination a sweep signal generator, the output signal of said generator being saw-tooth in form and having a non-linear time variation, deflection means associated with said cathode ray tube and energized by said non-linear saw-tooth signal, and magnetic means for establishing a fixed magnetic field of predetermined configuration adjustable to vary the field distribution through said cathode ray tube whereby said sweep system is substantially linearized.

8. A cathode ray tube deflection system comprising in combination a deflection yoke positioned about said cathode ray tube, a deflection signal source energizing said deflection yoke, said source providing a saw-tooth deflection signal of non-linear time variation, means for substantially compensating said non-linear deflection signal including an adjustable magnetic member for establishing a constant magnetic field through said cathode ray tube, said field being normal to the axis of said tube and varying in intensity along an axis normal to said field and extending through said tube axis.

9. A cathode ray tube deflection system comprising in combination a deflection yoke positioned about said cathode ray tube, a deflection signal source energizing said deflection yoke, said source providing a saw-tooth deflection signal of non-linear time variation, means for substantially compensating said non-linear deflection signal including a magnetic member for establishing a magnetic field through said cathode ray tube, said field being normal to the axis of said tube and varying in intensity along an axis normal to said field and extending through said tube axis, said magnetic member including arcuate pole pieces disposed about said cathode ray tube and means for magnetizing said pole pieces.

10. A cathode ray tube deflection system comprising in combination a deflection yoke positioned about said cathode ray tube, a deflection signal source energizing said deflection yoke for sweeping the electron beam of said cathode ray tube, said source providing a saw-tooth sweep signal of non-linear time variation, the sweep of said tube electron beam under the influence of said sweep signal being correspondingly non-linear, compensating means associated with said cathode ray tube for substantially linearizing said electron beam sweep, said compensating means including a magnetic member disposed about said cathode ray tube, said magnetic member having pole pieces extending therefrom and embracing said cathode ray tube, said magnetic member and pole pieces providing a magnetic field extending through said cathode ray tube normal to the axis thereof and normal to the direction of sweep of said electron beam under the influence of said sweep signal, said magnetic field having an intensity variation parallel to said direction of sweep of said electron beam, said electron beam being directed through said magnetic field whereby the deviation of said electron beam in transit through said magnetic field is varied in accordance with said intensity variation, said intensity variation being arranged to substantially linearize said electron beam sweep.

11. A cathode ray tube deflection system comprising in combination a deflection yoke positioned about said cathode ray tube, a deflection signal source energizing said deflection yoke for sweeping the electron beam of said cathode ray

tube, said source providing a saw-tooth sweep signal of non-linear time variation, the sweep of said tube electron beam under the influence of said sweep signal being correspondingly non-linear, compensating means associated with said cathode ray tube for substantially linearizing said electron beam sweep, said compensating means including a magnetic member disposed about said cathode ray tube, said magnetic member having pole pieces extending therefrom and embracing said cathode ray tube, said magnetic field extending through said cathode ray tube normal to the axis thereof and normal to the direction of sweep of said electron beam under the influence of said sweep signal, said magnetic field being of substantially uniform density in a plane through the axis of said tube and parallel to said direction of said sweep, said field extending through an area of said plane of substantially triangular configuration, said electron beam being swept through the area of said field, said electron beam being deviated in traversing said field, the extent of said deviation being a function of the extent of said electron beam path through said area of said field, said triangular field area being disposed and arranged whereby said electron beam sweep is substantially linearized in transit therethrough.

12. A cathode ray tube deflection system comprising in combination a deflection yoke positioned about said cathode ray tube, a deflection signal source energizing said deflection yoke for sweeping the electron beam of said cathode ray tube, said source providing a saw-tooth sweep signal of non-linear time variation, the sweep of said tube electron beam under the influence of said sweep signal being correspondingly non-linear, compensating means associated with said cathode ray tube for substantially linearizing said electron beam sweep, said compensating means including a magnetic member disposed about said cathode ray tube, said magnetic member having pole pieces extending therefrom and embracing said cathode ray tube, said magnetic member and pole pieces providing a magnetic field extending through said cathode ray tube

normal to the axis thereof and normal to the direction of sweep of said electron beam under the influence of said sweep signal, said magnetic field being of substantially uniform density in a plane through the axis of said tube and parallel to said direction of said sweep, said field extending through an area of said plane of substantially triangular configuration, said electron beam being swept through the area of said field, said electron beam being deviated in traversing said field, the extent of said deviation being a function of the extent of said electron beam path through said area of said field, said triangular field area being disposed and arranged whereby said electron beam sweep is substantially linearized in transit therethrough, said pole pieces of said magnetic member being of substantially triangular cross-sectional area, and means for substantially eliminating magnetic field components within said cathode ray tube parallel to said direction of said sweep.

13. In an image system, a cathode ray tube having means for generating a luminous spot, sweep means having a predetermined time variation for causing motion of said luminous spot, said motion normally being non-linear with respect to time and a correction magnetic means acting directly in said deflected spot to effect linearity of motion thereto, said magnetic means being adjustable to vary the field distribution and to vary the field strength.

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