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FLEXIBLE AUXILIARY DEFLECTION COIL

This invention relates to the field of beam scan velocity modulation apparatus for cathode ray tube displays, and in particular to a flexible conductor auxiliary deflection coil.

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BACKGROUND OF THE INVENTION

Scan velocity modulation is known in beam deflection of cathode ray tubes, and is employed to enhance the perceived sharpness of the displayed picture. The basic concept of scan, velocity modulation is the modulation of the horizontal scanning velocity of the electron beam at a light to dark or dark to light image transitions. For example, when a scan crosses a bright vertical bar on a dark background, the objective is a display where the screen brightness rises instantly to a maximum as the horizontal scan crosses the bright vertical bar and then drops instantly to the minimum level after passing the bar. However, the rise and fall times of the electron beam current are not instantaneous. In a display without scan velocity modulation, there are shades of gray at the transitions which blur the edges and are perceived as a softening, or lack of sharpness.

With beam scan velocity modulation, circuitry is provided to anticipate a transition in the luminance signal, and to modify the horizontal scanning speed such that the beam is accelerated at the dark area adjacent the transition, i.e., scanned at a rate in excess of the average scan rate. The time gained by this acceleration of the beam is used on the bright side of the transition, where the beam is decelerated to below the average scanning rate, thus the total time taken to scan horizontal lines remains constant, with the acceleration and deceleration canceling one another. The effect of increasing the scanning beam velocity in the dark area prior to the bright transition results in less beam current hitting the phosphor and consequently less phosphor excitation which makes the dark area darker. The slowed scanning velocity in the bright area causes the beam to excite the phosphors for a slightly longer period and results in an additional brightening immediately after the transition. The overall effect of the velocity modulation at an



edge transition is to cause the transition to appear sharper than if scanned at a constant rate. At transitions from a light background to a dark area the process is reversed. The net effect is to increase the perceived sharpness of image edges, and thus the picture
5 appears to be sharper and of greater resolution.

The beam velocity modulation is applied using an additional coil operable to modify the horizontal deflection of the beam. The additional coil is driven with edge transition information extracted from the luminance video signal by a driver
10 circuit.

The SVM coil may be a flat wound laminated coil, which in some earlier SVM applications was mounted on the purity/static convergence magnet holder, to affect the electron beams after they exit the focus (G4) grid of the electron gun. Printed circuit coils are
15 also known and these may be positioned under the static convergence magnets or under the deflection yoke.

SVM coil placement in the immediate proximity of the electron guns reduces the SVM coil field strength applied to the electron beam. The electron guns normally include permeable
20 ferromagnetic material (e.g., steel) which tends to confine the SVM field to the permeable material. The electron guns also include non-ferromagnetic conductive material which dissipates the SVM field by eddy current induction. In short, the ferrous and
conductive material of the electron guns tend to partially dissipate
25 the SVM field and shield the electron beams from interaction therewith.

It is possible to combat adverse effects of shielding and dissipation inherent in a particular SVM coil mounting location by, for example, increasing the SVM drive current, however this may
30 require improved performance current drivers, with increased device dissipation. The number of coil turns may be increased to achieve the desired SVM deflection sensitivity, however, this increase in inductance may result in a reduction in the high frequency performance of the SVM coil to a frequency below that
35 required by the spectral composition of the displayed signal. SVM deflection sensitivity may be improved by positioning the



SVM coil as close as possible to the electron beam, since magnetic field strength decreases in proportional the inverse of the spacing distance raised to a power. However, positioning, for example, on the tube neck may result in mechanical mounting problems of the other neck components which may be placed to overlap such an SVM coil position. Thus any SVM coil positioned in contact with a tube surface should have a minimized cross sectional dimension for both the coil and the connections thereto.

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SUMMARY OF THE INVENTION

A cathode ray tube display with scanning beam velocity modulation comprises a cathode ray tube with a neck, and gun for generating an electron beam. A deflection yoke is mounted on cathode ray tube for electron beam deflection. A first flexible support having a side for conductor fabrication and a second flexible support having a side for conductor fabrication are superimposed and wrapped to conform to the neck circumference. A first coil pattern is formed as a conductor on the first support and a second coil pattern is formed as a conductor on the second support. A conductive connection couples the first coil pattern and the second coil pattern. A connector couples scanning velocity modulation current to energize the first coil pattern and the second coil pattern for scanning beam velocity modulation.

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BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1A shows an inventive embodiment of an SVM deflection coil and placement.
FIGURE 1B shows an alternative inventive SVM coil placement.
FIGURE 2A shows an exploded view of an inventive embodiment.
FIGURE 2B shows an alternative inventive SVM coil placement.
FIGURE 3A shows the conductor patterns of an inventive embodiment.
FIGURE 3B shows a support layer for conductor fabrication.
FIGURE 3C is a cross section of the tube neck of FIG. 2 at C/C showing circumferential placement of conductor patterns.
FIGURE 3D is a magnified view at section line H/H of FIGURE 3C.



FIGURE 4A shows a first conductor pattern and support layer of an alternative inventive embodiment.

FIGURE 4B shows a second conductor pattern and support layer of an alternative inventive embodiment.

5 FIGURE 4C shows a cross section view positioned as FIGURE 3D.

DETAILED DESCRIPTION

With reference to FIGURE 1A, a television picture tube is arranged with an electron gun 40 at a rear end 32, which emits a
10 stream of electrons that are accelerated toward a phosphor screen 34 at the opposite or front end. The electrons are moving charges and constitute a current, whereby the electrons are deflected by incident magnetic fields. The electron beam is deflected at a
15 horizontal scanning rate to trace successive lines, and at a vertical scanning rate to cause the successive lines to be vertically spaced from one another on the screen. The scanning defines a raster pattern which is repeated in interleaved fields or in progressive scans of each successive line in turn.

The television picture or cathode ray tube has a funnel
20 shaped or flaring portion 38 between the electron gun rear end 32 and the screen 34. Deflection coils for vertical deflection and horizontal deflection are mounted on a deflection yoke arrangement on a funnel portion 38 of the tube, typically being wound on a plastic yoke form or liner 72. The vertical and horizontal deflection
25 coils are elongated along the funnel in a direction parallel to the electron beam axis 42, and follow along the flaring surface 38 of the tube. The vertical deflection windings are wrapped toroidally on a magnetically permeable core and the saddle shaped horizontal deflection windings are adjacent funnel 38 of the tube.

30 A flexible printed circuit scan velocity modulation (or SVM) coil 50 is conformed to tube neck 30. In FIGURE 1A, scan velocity modulation coil 50 is positioned adjacent the tube neck with a static convergence magnet system 52 overlapping. For example, in a CRT which employs a PI 88 COTY M electron gun
35 assembly, the SVM coil is positioned over the main lens G5-G6 of the assembly. The SVM coil is radially positioned to place the coil



conductors which are parallel to the tube Z axis, symmetrically about the tube X axis. The scan velocity modulation coil 50 may alternatively be positioned tube neck 30 adjacent the funnel 38, with the horizontal deflection coils of yoke assembly 80 overlapping, as shown in FIGURE 1B. An energizing current is coupled to coil 50, via a conductive connector 88, which results in modulation of the horizontal deflection scanning velocity responsive to displayed video edge transitions. The principal of scanning beam velocity modulation and the derivation of the energizing current is well known and consequently will not be explained.

FIGURE 2A shows an exploded partial view of cathode ray tube funnel 38, neck 30 and gun structure 40. An inventive embodiment where flexible scan velocity modulation coil 50 is conformed to the tube neck surface at the same Z axis location as the static convergence magnet 52. The connector conductor surface 88, is positioned on the Y axis and may be oriented to extend towards the screen 34, or socket 32, as required by coupling to an SVM drive amplifier, not shown. Positioning on the +Y or -Y axis provides the correct angular placement of the coils which results in optimum sensitivity. The static convergence magnet 52 is positioned on the tube neck 30 at a Z axis position for achieving static convergence and as such overlaps the SVM coil 50. FIGURE 2B shows an alternative neck location of SVM coil 50, positioned adjacent the funnel 38, such as to be under the horizontal deflection coils of yoke 80, which to illustrate SVM coil positioning, have been omitted from FIGURE 2B.

FIGURE 3A shows track and coil patterns which are employed to fabricate electrical conductor layers L1 and L3. There are various techniques for fabricating an electrical conductor having a specific pattern. For example, it is possible to use a printing method where a conductive ink or fluid is deposited on a support layer to produce the required track and coil patterns. Conductive ink or fluid may be deposited by a spraying method similar to that used in an ink jet printing system. A contact printing technique may be used where a conductive ink or fluid depicting the desired track and coil pattern is transferred to a

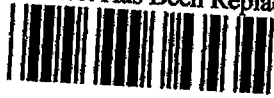


support layer. It is also well known to employ a conductor layer where the conductor is selectively removed with the remaining conductor describing the desired track pattern.

In FIGURE 3A the track and coil patterns shown for loop 1 and loop 3, and loop 2 and loop 4 are very similar, such that when formed as conductive layers L1 and L3 and positioned on a support layer L2, the conductors of pattern P1 overlay similar ones of pattern P3. For example, in FIGURE 3A, conductor A2, the center conductor of loop 1 overlays conductor A'2 of loop 3, similarly for loop 2, conductor B 2 with overlays B'2, and so forth for loops 2 and 4, C2 with C'2 and D2 with D'2.

FIGURE 3B shows the support layer L2. Electrical connection between layer L1 and layer L3 is provided by electrically conductive paths through the support layer L2 at H10 and H20. These conductive paths connect with layer L1 at points H1 and H2, and layer L3 at points H11 and H21. Thus, coil loop 1 is electrically connected in series with coil loop 3, and coil loop 2 is electrically connected in series with coil loop 4. In this inventive assembly, loop conductors of group A, namely A1-3 and A'1-3 are overlaid in a multiple layer configuration, the field generated by six conductors is advantageously produced in a circumferential area the same as that occupied by three conductors of a single layer configuration. Thus a required field strength for a given deflection sensitivity may be generated by multiple coil layers within a narrow chordal angle which advantageously optimizes the deflection sensitivity for this SVM coil configuration. This advantageous configuration also applies to the loop conductors of groups B, C, and D, as shown in FIGURE 3C.

In FIGURE 3A, dimension M is the spacing between the center conductors (suffixed 2 as shown), and is selected to be equal to approximately one third of the tube neck circumference. This approximate dimension must take into account the thickness of the conductor layer L1 or L 3, plus the thickness of the support layer L2. In this example of a coil pattern, the support layer L2 is flexible and is formed into a cylinder of diameter equal to that of the tube neck. When conformed with the tube surface this



selection of dimension M results, in the center conductors A2 and B2, at each side of loop 1, subtending an angle of 120° about the tube Z axis, as depicted in FIGURE 3C. The spacing between the loops, m, is chosen to position the loops symmetrically about the tube Z axis such that conductors A2 and D2 are spaced
5 circumferentially to be the same as conductors B2 and C2. Thus, with the track pattern shown in FIGURE 3A, and the radial positioning shown in FIGURE 3C, a magnetic dipole field is established on the tube Y axis, perpendicular to the both the X and
10 Z axes. This Y axis field results in horizontal or X axis deflection of the Z axis electron beam. The selection of 120° conductor spacing results in zero third harmonic field generation by the coil. Setting the third harmonic of the SVM coil field to zero, eliminates the possibility of SVM action producing deflection differentials between
15 the three electron beams, i.e. SVM operation will not result in miscolored edges.

FIGURE 3C is a radial section through the tube neck, and for simplicity of illustration the gun structures within the neck have been omitted and the thickness of the flexible coil system has
20 been exaggerated to provide additional clarity. Undelected electron beams are shown on the X axis of the tube symmetrically positioned about the tube Z axis. The section is positioned such as to cut through coil loop conductor groups A, B, C, and D. When the support is conformed to the tube neck, and the center conductors
25 (suffix 2) are spaced as described earlier. The suffix 2 conductors A2 and A'2, and B2 and B'2 subtend an angle of 120° about the Z axis as shown in FIGURE 3C. Similarly for conductors C2 and C'2, and D 2 and D'2 which also subtend an angle of 120° about the Z axis. The conformed support is positioned on the tube neck such
30 that the suffix 2 conductors are symmetrically positioned about the +Y and -Y axis. Furthermore, as a consequence of the dimensions and placement of the loops on the support L2, the suffix 2 conductors will be symmetrically positioned about the +X and -X axis. The physical placement of conductors 88 in the loop pattern is
35 used to provide a rotational reference for angular placement of the conformed coils on the tube neck, this results in the desired



symmetrical placement of the various conductor groups about the various tube axes.

FIGURE 3D is a magnified sectional view of FIGURE 3C at the section line H/H. For simplicity of illustration, this view
5 ignores the conformance of the flexible support L2 and coil conductor layers L1, L3 to the tube neck circumference. This magnified cross section which shows the registered alignment of conductors B1-3 and B'1-3. Electrical connection between layer L1 and layer L3 is provided by an electrically conductive path through
10 the support layer L2 which connects to layer 1 at pad H1, and layer 2 at pad H11. Deflection sensitivity of this inventive flexible SVM coil system is advantageously enhanced by wrapping the flexible SVM coil system around the circumference of the tube neck. Thus the coil system is in contact with the glass and as close as possible
15 to the electron beams.

Advantageously, deflection sensitivity is further enhanced by the 120° angular placement of the Z axis center conductors A2-A'2, B2-B'2, C2-C'2, D2-D'2. By locating the conductors at 120° , the field produced by the coil system has zero
20 third harmonic component. With zero third harmonic field, more useful SVM deflection of beams results, since SVM drive current does not generate third order fields which would produce unwanted differential deflection of the outer electron beams relative to the center.

Deflection sensitivity is further enhanced by the
25 positioning of the coil layers such that the Z axis conductors, A1-3 and A'1-3, B1-3 and B'1-3, C1-3 and C'1-3, D1-3 and D'1-3 overlap. FIGURE 3D shows the registered overlapping alignment of conductors B1-3 and B'1-3. This feature constrains the
30 circumferential field to approximately that of a single layer. Thus, the third order field remains at zero but since the coil loops are connected in series the inductance is increased in proportion to the number of turns squared.

Multiple layer coil systems may be constructed to
35 achieve a desired inductance value without compromising the desirable requirement for zero third harmonic field generation.

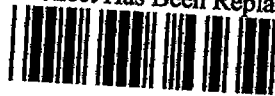


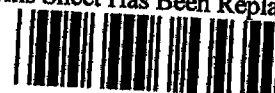
FIGURE 4A shows a coil pattern which is formed as a conductor as a first layer of multiple layer coil system. The dimensional parameters are as described earlier. The coil pattern P1 of FIGURE 4A is formed as conductive layer 1 on support layer L10.

5 Conductive connecting holes H10 and H20 extend through the support layer L10. FIGURE 4B shows a coil pattern P3 of a further layer of multiple layer coil system, where energizing current is coupled to coil loops 3 and 4 by conductors 88. Coil pattern P3 is formed as a conductive layer L3 on support layer L20. Support
10 layers L10 and L20 are superimposed such that H10 and H20 are aligned with pad contact areas H11 and H21. Following alignment the conductive holes and contact pads are conductively joined, the support layers may also be attached one to the other. The assembled multi layer coil is shown in magnified cross section in
15 FIGURE 4C, (section located as described for FIGURE 3C). FIGURE 4C shows the alignment of group B conductors, conductive holes and pads, which are superimposed such that conductor B 1 overlays conductor B'1 etc.

The inventive SVM coil assembly may be fabricated by
20 many methods however, photo lithographic techniques employing photo sensitive conductor layers on a flexible support layer offer savings in material costs and considerable savings in manufacturing tooling and assembly costs. For example, wound SVM coils require winding machines and coil support structures, and additionally the
25 wire must be terminated to provide connection. Other printed circuit coils exist having wire connections to the coils, these cross each coil loop to a central feed point. However, such wire connections are undesirable since they increase the cross sectional dimension of the coil, and represent a further operational
30 manufacturing step and additional cost.

The inventive SVM coil system was fabricated on a flexible support layer with a coil pattern layer formed on each side. The performance SVM coil system was evaluated under the following conditions:

35 Tube type 27 V.
Electron gun PI 88, COTY M.



EHT 30 KV.

Tube neck diameter 29mm

Yoke pull back 3 mm, (back of yoke 87 mm from base).

SVM coil front edge 84 mm from base.

5 The SVM coil system has the following specifications :

conductor width : 0.8 mm

conductor spacing : 0.5 mm

conductor thickness : 8-10 μ M

support thickness : 0.125 mm

10 turns per loop 3, two layers

inductance (at 1 KHz) : 3.8 μ H

resistance : 1.78 Ω

Deflection sensitivity:

DC deflection sensitivity in center : 2.75 mm /A

15 AC drive signal, 1 Amp pulse, 100 ns rise and fall times

AC deflection sensitivity in center : 0.73mm /A.



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What is claimed is:

1. A cathode ray tube display with scanning beam velocity modulation comprising:

5 a cathode ray tube having a neck (30) and gun (40) for generating an electron beam (42);

a deflection yoke (80) mounted on said cathode ray tube for electron beam (42) deflection;

10 Characterized by a flexible layer (L2) having a first side (L1) and a second side (L3) for conductor fabrication, being wrapped to conform to a circumference of said neck (30);

a first coil pattern (P1) formed as a conductor in contact with said first side (L1) and a second coil pattern (P3) formed as a conductor in contact with said second side (L3);

15 conductive holes (H10, H20) coupling via said layer (L2), pads (H1, H2) on said first coil pattern (P1) on said first side (L1) and pads (H11, H21) on said second coil pattern (P3) on said second side (L3); and

20 a connector (88) for coupling scanning velocity modulation current for energizing said first coil pattern (P1) and said second coil pattern (P3) for scanning beam velocity modulation.

2. The apparatus of claim 1, characterized in that said first coil pattern conductor (P1) and said second coil pattern conductor (P3) further comprise conductors formed in a plurality of concentric loops.

3. The apparatus of claim 1, characterized in that said first coil pattern conductor (P1) and said second coil pattern conductor (P3) are dimensionally similar such that when in superimposed said first coil pattern (P1) and said second coil pattern (P3) overlay.

4. The apparatus of claim 1, characterized in that said flexible layer (L2) is conformed and positioned on said tube neck (30) under a static electron beam convergence device (52).





5. The apparatus of claim 1, characterized in that said flexible layer (L2) is conformed and positioned on said tube neck (30) under a deflection yoke (80).

5 6. A cathode ray tube display with scanning beam velocity modulation comprising:

a cathode ray tube having a neck (30) and gun (40) for generating an electron beam (42);

10 a deflection yoke (80) mounted on said cathode ray tube for electron beam (42) deflection;

characterized by a first flexible layer (L10) having a side for conductor formation, and a second flexible layer (L20) having a side for a conductor formation, said first (L10) and second (20) flexible layer being superimposed and wrapped to coaxially
15 conform to a circumference of said neck (30);

a first coil pattern (P1) formed as a conductor (L1) in contact with said first flexible layer conductor formation side and a second coil pattern (P3) formed as a conductor (L3) on said second flexible layer conductor formation side;

20 conductive holes (H10, H20) couple pads (H1, H2) on said first coil pattern conductor (L1) and pads (H11, H21) on said second coil pattern conductor (L3) through said first flexible layer (L10); and

25 a connection (88) coupling scanning beam velocity modulation current to said first coil (L1) and said second coil (L3) for scanning beam velocity modulation.

7. The apparatus of claim 6, characterized in that said first coil pattern conductor (L1) and said second coil pattern conductor
30 (L3) further comprise conductors formed in a plurality of concentric loops.

8. The apparatus of claim 6, characterized in that said first coil pattern conductor (L1) and said second coil pattern conductor
35 (L3) are dimensionally similar such that when superimposed, said





first coil pattern conductor (L1) and said second coil pattern conductor (L3) overlay.

9. The apparatus of claim 6, characterized in that said
5 wrapped flexible layer is positioned on said tube neck (32) under a static electron beam convergence device (52).

10. The apparatus of claim 6, characterized in that said
10 wrapped flexible layer is positioned on said tube neck under a deflection yoke (80).

11. The apparatus of claim 7, characterized in that said neck
(30) and gun (40) define a Z axis of said cathode ray tube, said coil
pattern conductor loops on said layer conforming to said neck
15 circumference such that a part of said loops are parallel with said Z axis.

12. The apparatus of claim 11, characterized in that said
part of said loops that are parallel with said Z axis have dimensions
20 such to locate the parallel part at a circumferential angle of ± 120 degrees and symmetrical about a Y axis orthogonal to said Z axis.

13. The apparatus of claim 12, characterized in that the
parallel part of said loops is positioned circumferentially to be
25 symmetrical about an axis orthogonal to said Z axis and said Y axis.

14. The apparatus of claim 11, characterized in that said
conductor coil pattern loops are rectangular with a pair of sides of
said rectangle parallel with said Z axis.

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15. The apparatus of claim 14, characterized in that said
rectangular dimensions locate said pair of sides at a circumferential
angle of ± 120 degrees and symmetrical about said Y axis orthogonal
to said Z axis.

