

[54] **METHOD OF MAKING AND ADJUSTING  
DEFLECTION YOKE**

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**Related U.S. Application Data**

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[52] U.S. Cl. .... **29/25.13**, 178/7.8, 335/212,  
324/158 R

[51] Int. Cl. .... **H01j 9/18**

[58] Field of Search ..... 29/25.11, 25.13; 178/7.8,  
178/7.81; 335/210, 212, 213; 324/158 R

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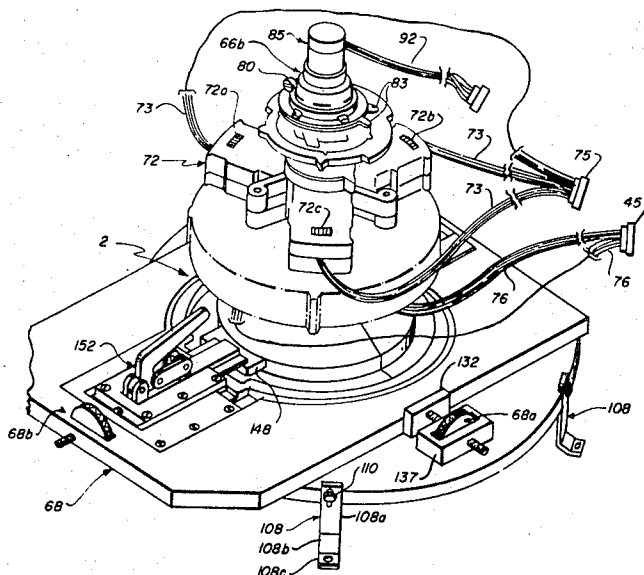
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Hattis & Strampel

[57]

**ABSTRACT**

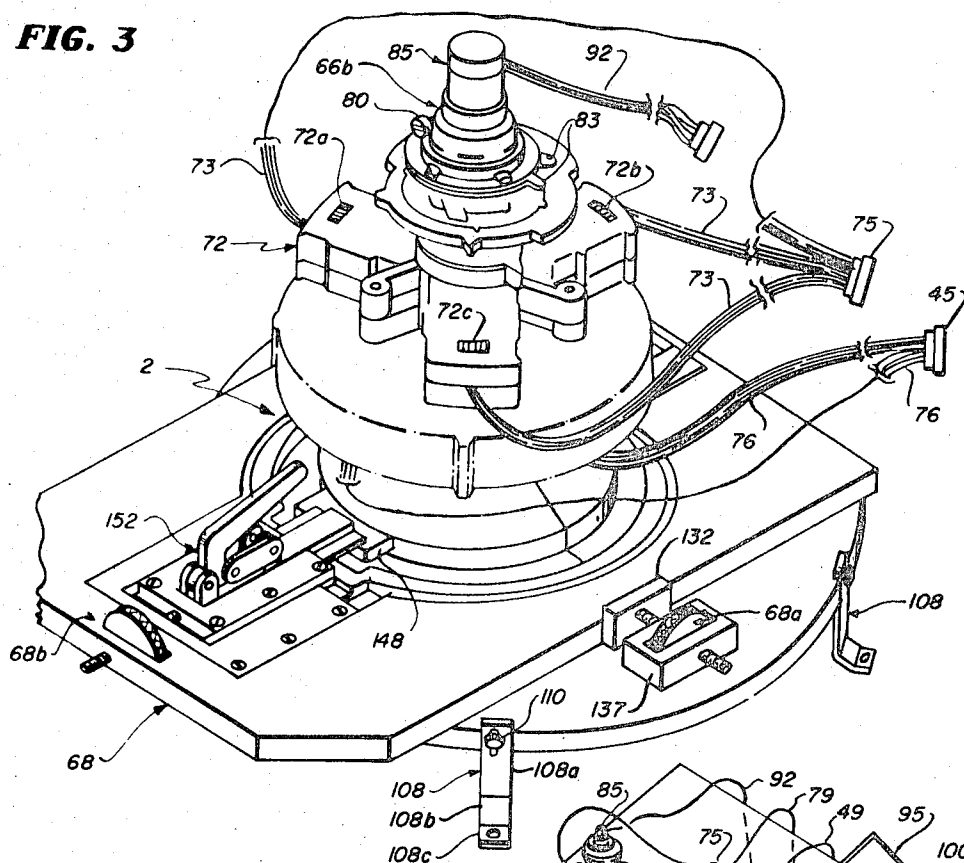
The core and deflection coils of a deflection yoke assembly for a color television cathode tube are initially assembled and mounted to provide for the relative fine adjustment of the core and deflection coils along at least the vertical axis and most desirably also along the horizontal axis. Separate screw adjusting means or the like, either permanently or temporarily affixed to the deflection yoke assembly, relatively adjusts the relative positions of the deflection coils and the core. The adjustment along the vertical axis is used to vary the red-green trace crossover of a cross-hatch video pattern at the 3 and 9 o'clock positions of the cathode ray tube face to zero or a finite value. The adjustment along the horizontal axis is used to equalize or reduce to zero the red trace height of a cross-hatch video pattern at the 12 and 6 o'clock positions of the cathode ray tube face.

**15 Claims, 13 Drawing Figures**

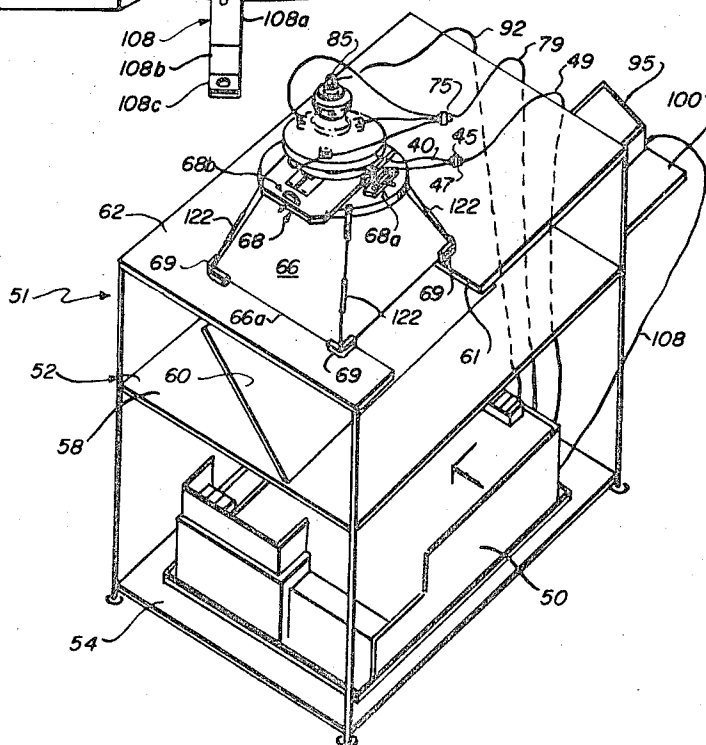


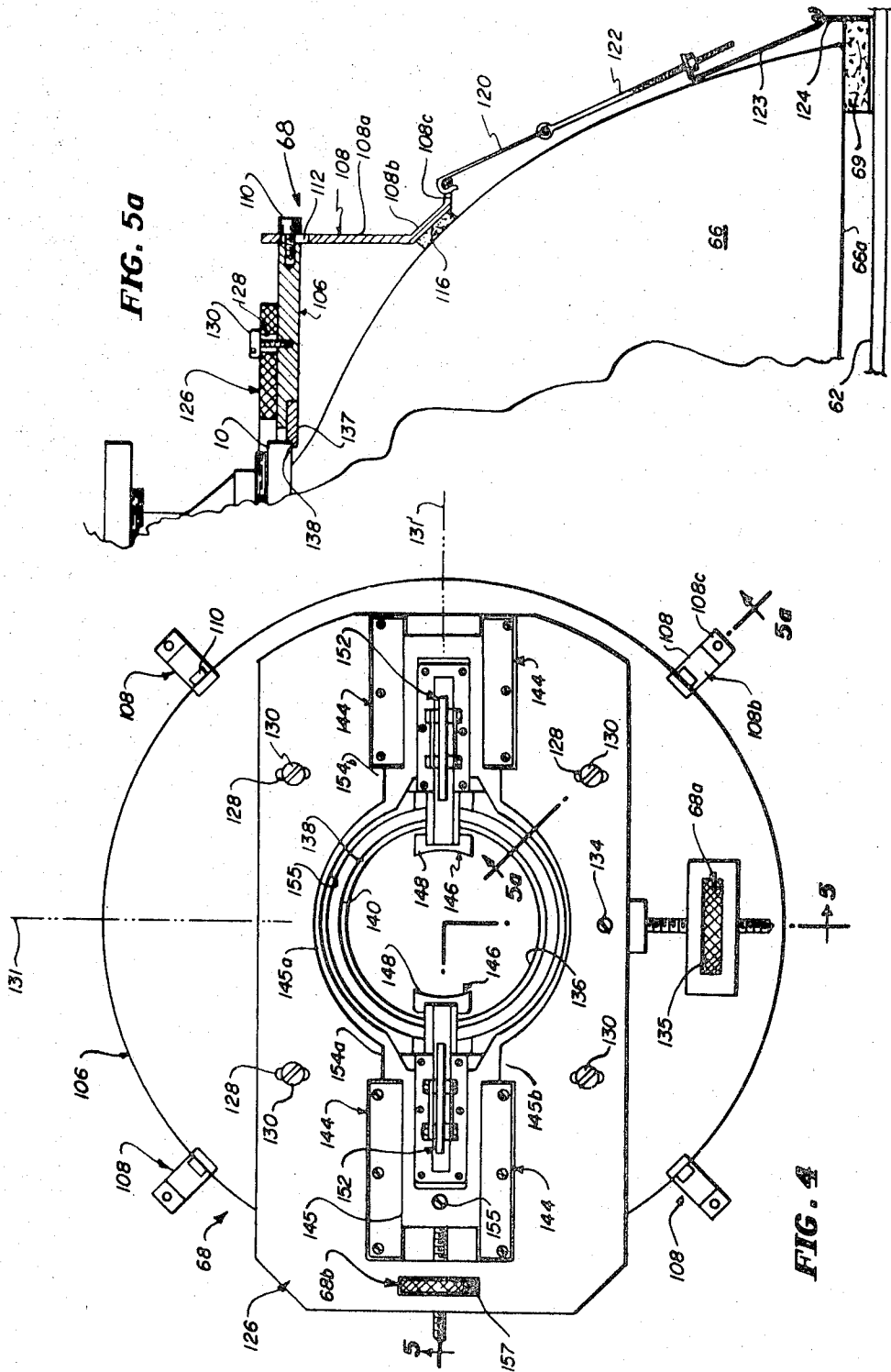


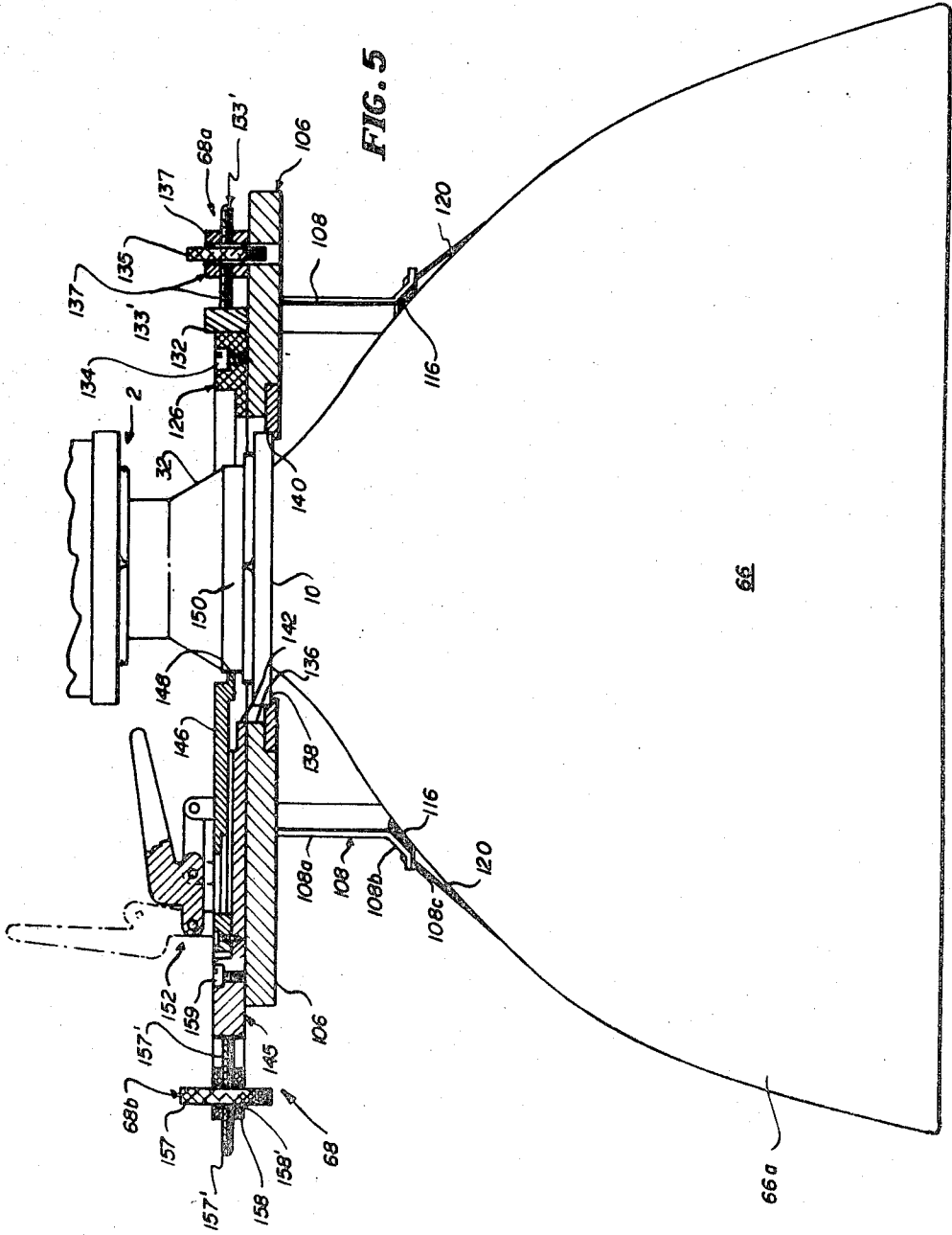
**FIG. 3**



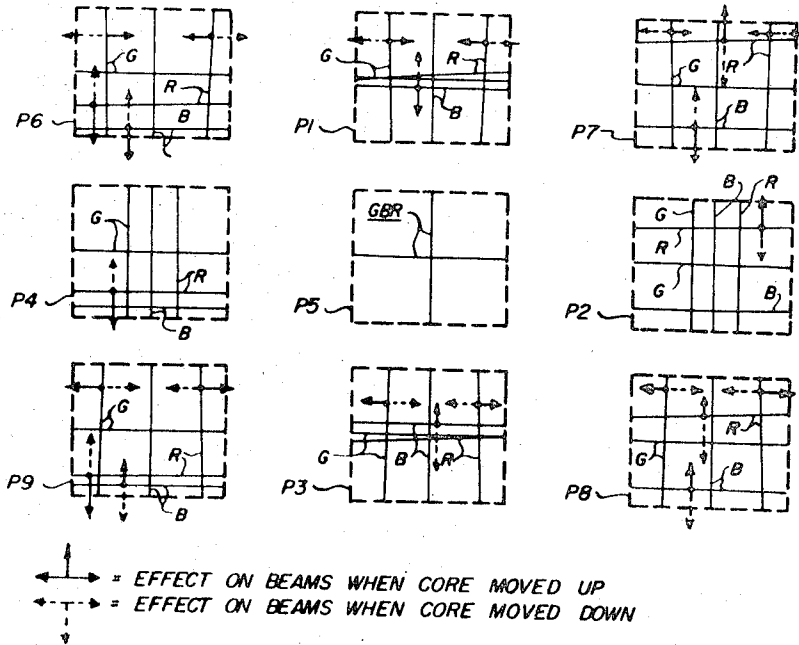
**FIG. 2**



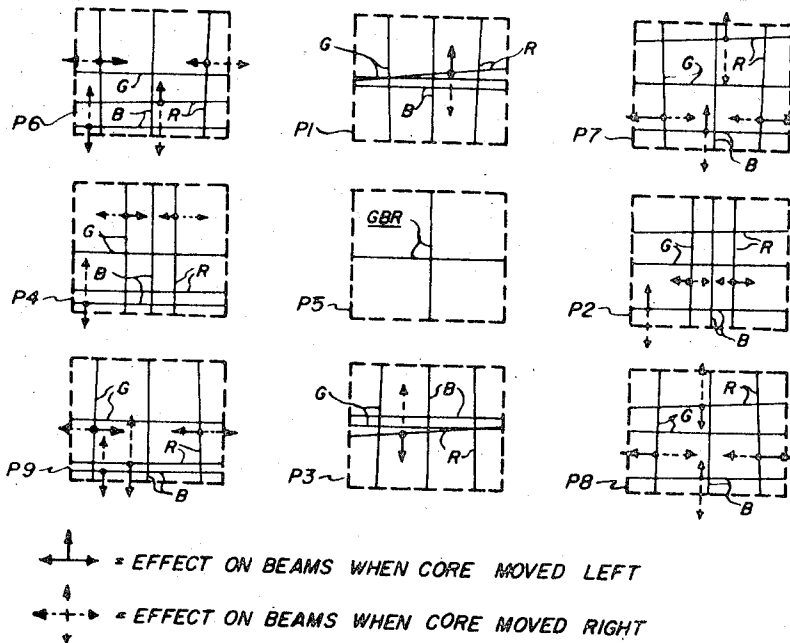




EFFECT ON BEAM TRACES  
WHEN CORE MOVED VERT. RELATIVE TO WINDINGS



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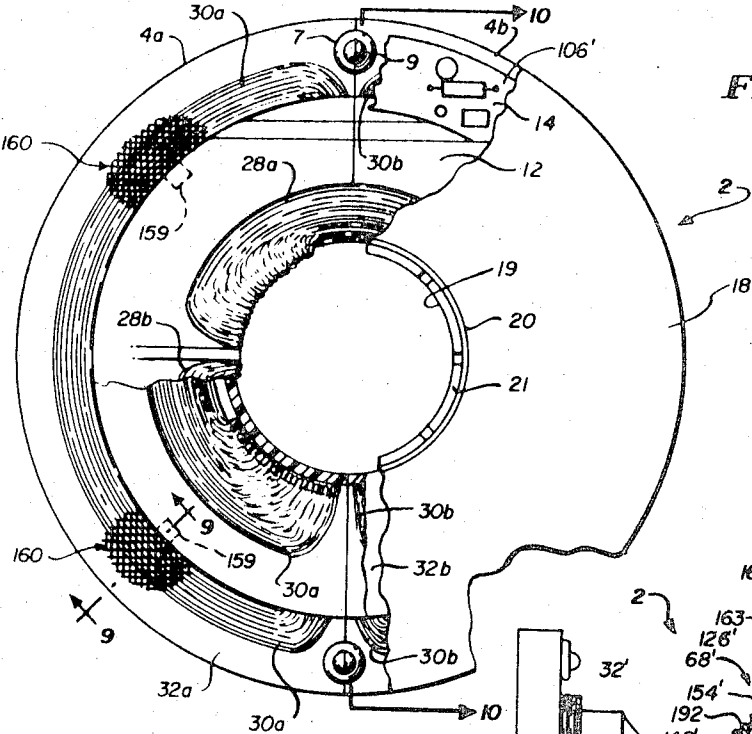


FIG. 8

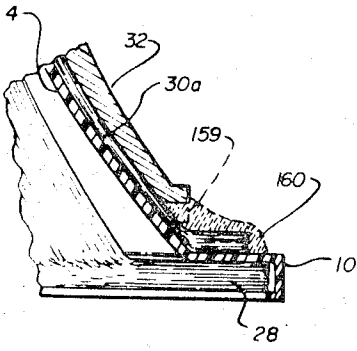


FIG. 9

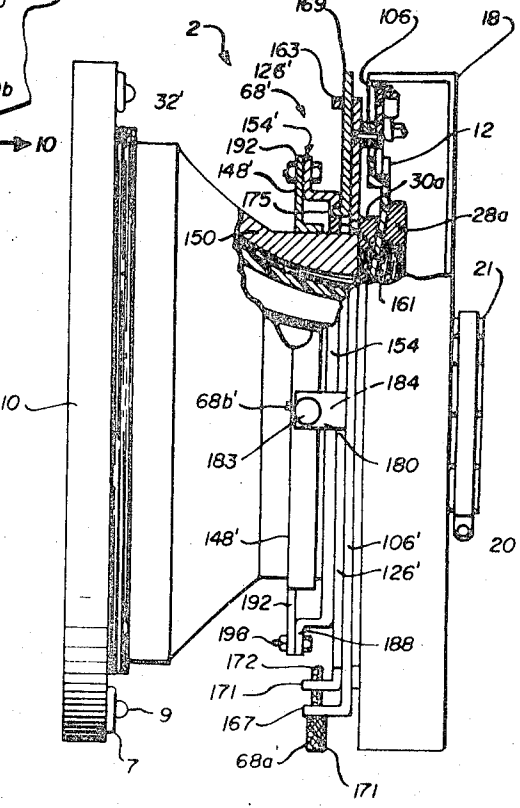
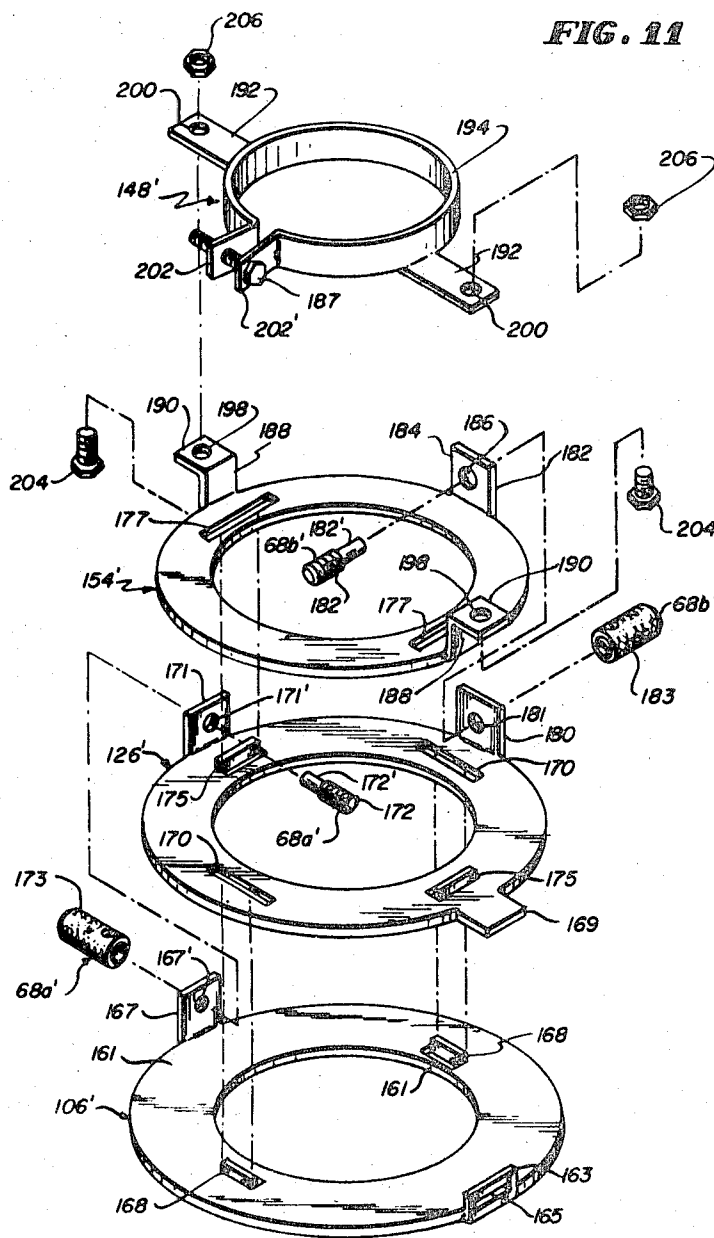


FIG. 10

FIG. 11



## METHOD OF MAKING AND ADJUSTING DEFLECTION YOKE

This application is a division of application Ser. No. 284,370 filed Aug. 28, 1972, now U.S. Pat. No. 3,810,053.

### BACKGROUND OF THE INVENTION

This invention relates to deflection yoke assemblies for color television cathode ray tubes and a method of marking and adjusting the same.

Color television cathode ray tubes are commonly provided with three juxtaposed electron guns positioned either triangularly or in-line at the base of the narrow neck of the cathode ray tube, so the cathode beams generated by these electron guns assume substantially different positions within the various transverse cross sectional planes of the cathode ray tube until they reach a point at or near the phosphor coated front face of the cathode ray tube. The phosphor coatings on the front face of the cathode ray tube are deposited as triads of phosphor dots, each dot of a triad responding to impingement thereon of a beam intended to produce a different one of the three characteristic colors of red, blue or green. A perforated screen or mask spaced behind the phosphor coated face forms beam screening areas for the various beams approaching the same at different angles so that each beam, which generally encompasses a number of groups of triad dots, passing through the same screen apertures as the other beams will only strike the triad dot which produces the color assigned to the beam involved.

To produce deflection of the beams, a deflection yoke assembly is mounted around the neck of the cathode ray tube. The deflection yoke assembly conventionally used today has deflection coils carrying time varying signals producing electron beam deflecting, vertically and horizontally extending, magnetic fields within the portion of the cathode ray tube transversed by the said electron beams. In one form of deflection yoke assembly, vertically spaced coils on the top and bottom of the tube neck produce a vertically extending magnetic field which effects horizontal deflection of the beams, and horizontally spaced coils on opposite sides of the tube neck produce a horizontally extending magnetic field which effects vertical deflection of the beam. A core snugly envelopes the outermost of these coils to provide a low reluctance path for the magnetic fields outside of the cathode ray tube.

To cause convergence or registration of the beams at or adjacent to the front face of the cathode ray tube, there is commonly provided both electromechanical and electronic means for effecting this result. Thus, a convergence yoke assembly is generally mounted around the neck of the cathode ray tube behind the deflection yoke assembly which convergence yoke assembly is provided with individual manual adjustments which commonly move permanent magnets for varying static magnetic field components respectively in the paths of the red, green and blue producing electron beams, so that the three beams converge into registration at the center of the cathode ray tube. Other magnetic field adjusting units are also mounted on the neck of the cathode ray tube referred to as purity and lateral blue adjusting units, further to insure that each beam strikes its proper phosphor dot.

Contemporary deflection yoke assemblies do not produce linear magnetic fields, that is, the flux lines

(and equi-potential lines at right angles thereto) are curved in order to produce pictures without undesirable distortions which would otherwise occur because the front face of the cathode ray tubes is relatively flat and hence not equi-distant at all points from the electron guns referred to. As the electron beams are deflected from the center of the front face of a cathode ray tube, the intensity of the magnetic fields produced by the current flowing through the horizontal or vertical coils of the deflection yoke assembly become greater. In both the possible triangularly and in-line related positioning of the electron guns as manufactured today, the electron guns which generate the red and green producing electron beams occupy the same vertical position but different horizontal positions in the neck of the cathode ray tube. The beams produced by these cathode ray guns will, therefore, occupy different positions horizontally within the curved vertically extending magnetic field of the horizontal deflection coils and are accordingly deflected to different extents thereby both horizontally and vertically because of the curved equi-potential lines referred to, and in degree proportional to the intensity of the magnetic fields involved.

The curved horizontally extending equi-potential lines of the horizontal deflection coils, in the absence of dynamic convergence signals derived from the horizontal deflection current generator circuits and fed to windings forming part of the convergence yoke assembly, produce a progressively greater deflection of the red producing electron beam upwardly with respect to the green producing electron beam as the distance of the beam to the right of center of the face of the cathode ray tube increases, and a progressively greater deflection of the red producing electron beam downwardly with respect to the green producing electron beam as the distance of the beam to the left of the center of the face of the cathode ray tube increases. Thus, assuming the green trace as a reference trace which is approximately horizontal across the face of the cathode ray tube, the red trace crosses over the green trace so it occupies a position rotated counterclockwise of the green trace. A divergence of the green and red traces of only one-thirty-two inches is readily noticeable. Such crossing divergence between the horizontal red and green traces occurring at the horizontal center line of the cathode ray tube face is referred to as "crossover" and the degree thereof is measured at the 3 and 9 o'clock positions thereon. A similar crossing divergence of the horizontal red and green traces occurs above and below the horizontal center line of the cathode ray tube face for reasons including those responsible for crossover at the horizontal center line of the cathode ray tube face.

Divergence between the traces also occurs at all points spaced from the center point of the cathode ray tube face, among other reasons, because the focal or convergence points of the different beams occurs at points spaced progressively increasing distances from this face proceeding away from the center point due to the aforesaid varying distances of the electron guns to various points on the cathode ray tube face.

These various divergences between the traces are ultimately reduced to zero or to finite tolerable limits so that an acceptable color picture is achieved. Where the deflection yoke assembly meets certain specifications, this can generally be achieved by the feeding to the

aforesaid windings of the convergence yoke assembly signals referred to as horizontal and vertical dynamic convergence signals produced by wave shaping circuits fed with the progressively increasing horizontal and vertical deflection signals of the horizontal and vertical deflection coils to vary the magnetic fields affecting the electron beams as a function of beam deflection, to converge or register the electron beams which would otherwise be out of registration progressively increasing degrees as the beams are deflected further from the right or left of or up and down from the center of the cathode ray tube face. To obtain the properly shaped dynamic convergence signals a large number of manual adjustments of different circuit variables are required to provide proper dynamic convergence of the horizontal and red traces over the entire face of the cathode ray tube.

In testing the acceptability of a deflection yoke assembly, it has been heretofore common for the deflection yoke manufacturers to apply a cross-hatch video pattern to a standard test cathode ray tube used with a standard test receiver (both supplied by the television receiver manufacturer involved) to which tube the deflection yoke assembly to be tested is applied. The cross-hatch video pattern comprises groups of horizontal and vertical red, green and blue traces in a grid-like pattern distributed over the face of the cathode ray tube. In the absence of any dynamic convergence signals, a convergence unit also mounted on the cathode ray tube is first adjusted to produce crossing white traces at the center of the cathode ray tube face. Then, in accordance with the practice prior to the present invention, the vertical separation of the horizontal red and blue traces from the horizontal green trace at the 12, 6, 3 and 9 o'clock positions on the cathode ray tube face are measured along with the horizontal separation of the vertical red and blue traces from the vertical green traces thereat. To ensure to the television receiver manufacturer's satisfaction that the dynamic convergence circuit adjustments in the television receivers with which the deflection yoke assemblies are to be ultimately used will be operative to effect a proper final convergence (indicated by crossing white traces at each of the trace crossover points involved), all of these measurements must fall within certain tolerances specified by the television receiver manufacturer involved. If the deflection yoke assembly being tested produces trace divergencies falling within these tolerances, then the vertical separation of the horizontal red traces from the green horizontal traces are often measured in each of the four corners of the cathode ray tube face to determine if they fall within specified tolerances. A deflection yoke assembly which does not produce trace deflections within the limited trace divergencies specified has heretofore been rejected. Although, if a deflection yoke assembly passes the static tests referred to, it will normally pass a test where the traces are finally dynamically converged to produce the crossing white traces at the various tests points involved, it is common for the deflection yoke manufacturer to make spot checks of the deflection yoke assemblies which passed the aforesaid static tests to determine whether the dynamic convergence circuit adjustments on the standard test receiver can achieve the proper crossing white traces at these points on the cathode ray tube face and other intermediate points.

Because of the practical limits on the tolerances of the parts making up the deflection yoke assemblies, a significant percentage of the deflection yoke assemblies have often failed to meet specifications resulting in a substantial loss of materials, time and labor. If an assembled deflection yoke assembly was found to be deficient, it was discarded or dis-assembled and the parts thereof combined with other parts in the hope that the new combination would meet specifications.

Tolerances in the manufacture of the cathode ray tube also introduce displacements of the beam traces due, for example, to a slight rotation of the cathode ray guns in the cathode ray tubes from their desired orientations. Thus, strict tolerances are also imposed on the cathode ray tube manufacturers so that with a standard test deflection yoke assembly supplied by the television receiver manufacturers for the purposes of testing the cathode ray tubes, the displacements of the beam traces thereon must fall within prescribed limits to ensure the receiver manufacturers that proper convergence of such traces can be achieved by the dynamic convergence adjustments referred to.

Even with the strict tolerances presently imposed, the accepted degree of variation in the beam trace displacements due to the tolerances in the manufacture of deflection yoke assemblies and cathode ray tubes is such that the person making the large number of adjustments of the dynamic convergence wave shaping circuits at the plant of the television receiver manufacturer can spend a considerable time in making the different adjustments. This adjustment procedure can be simplified and the reject ratio of the deflection yoke assembly and cathode ray tube manufacturers significantly reduced if the deflection yoke assemblies could be made to produce identical or closely similar amounts of beam trace displacements on the standard test cathode ray tube face. This would also make possible the increase of the tolerances permitted in the manufacture of the cathode ray tubes and the parts of the horizontal dynamic convergence wave shaping circuits or a simplification of the latter circuits.

It is one of the objects of the present invention to provide a method of manufacturing deflection yoke assemblies for color television cathode ray tubes which greatly reduces and in many cases eliminates any rejects thereof. A related object of the invention is to provide a method of adjusting a deflection yoke assembly for a color television cathode ray tube so it can be quickly and easily placed in a condition where the beam traces deflected thereby with cross-hatch producing signals applied thereto and the cathode ray tube can be readily dynamically converged. A further related object of the invention is to provide a method of adjusting a deflection yoke assembly for a color television cathode ray tube wherein the assembly can be quickly and easily placed in a condition where the beam traces deflected thereby with cross-hatch producing signals supplied thereto and the cathode ray tube are readily positioned to provide a desired degree of crossover at the 3 and 9 o'clock positions of the cathode ray tube face and/or red trace height (i.e. spacing of the horizontal red trace from the horizontal green trace) at the 12 and 6 o'clock positions of the cathode ray tube face.

#### SUMMARY OF THE INVENTION

The various aspects of the present invention results

from an unexpected discovery that the relative positions of the beam traces of color cathode ray tubes, particularly the horizontal red and green trace crossover at the 3 and 9 o'clock positions and/or the horizontal red trace height at the 12 and 6 o'clock positions of the cathode ray tube face, can be readily accurately varied between zero and a small finite value in one direction or the other by designing the core and/or the vertical and/or horizontal deflection coils so that the relative vertical and/or horizontal positions thereof are adjustable, and varying the relative vertical and/or horizontal positions thereof to provide the desired trace positions at these points. (Such adjustments are not possible on conventional deflection yoke assemblies since the cores thereof are designed to be unadjustable with respect to both the horizontal and vertical deflection coils.) It has also been discovered that all of the various aforesaid previously taken divergence measurements need not be made to determine whether the deflection yoke assembly being tested has its optimum deflection producing parameters to ensure that the cross-hatch video pattern can be properly dynamically converged. Thus, it was determined that if the 3 and 9 o'clock red-green trace crossover was adjusted to a correct value (which is generally, but not necessarily in all cases, zero), the downward displacement of the horizontal blue traces from the horizontal green trace at the 3 and 9 o'clock positions and the horizontal spacing between the vertical red and green traces at the 3 and 9 o'clock positions would generally automatically be optimized (i.e., in their best positions to ensure a proper final dynamic convergence), making unnecessary the additional measurement referred to.

This adjustment of the red-green trace crossover at the 3 and 9 o'clock positions of the cathode ray tube is achieved by varying the relative vertical position between the core and the deflection coils, and in most cases could be the only adjustment needed to ensure that a cross-hatch pattern could be properly dynamically converged. However, for best results, another adjustment to be described is preferably carried out to optimize all of the beam deflecting parameters of the deflection yoke assembly. Thus, in accordance with another aspect of the invention, as a secondary, though important, factor in optimizing the deflection producing parameters of the deflection yoke assembly, it was determined that if the spacing of the horizontal red trace from the horizontal green trace (i.e., red trace height) at the 12 and 6 o'clock positions were made ideally zero or at least equal, the horizontal displacement of vertical red traces from the vertical green traces and the vertical displacement of blue horizontal traces from the green horizontal traces at the 12 and 6 o'clock positions are minimized. This red trace height adjustment is achieved by varying the relative horizontal position between the core and deflection coils. The two deflection yoke assembly adjustments are most desirably made by providing the assembly with separate manual controls which respectively move the core relative to the deflection coils along the vertical and horizontal axes thereof.

When the deflection yoke assembly need not be adjusted by the television receiver manufacturer or by the serviceman, (this may be preferred since the adjustment made by the deflection yoke manufacturers can then be permanently fixed by cementing the core and deflection coils together where vibrations and handling

cannot disturb the adjustment), the means for adjusting the relative positioning of the core and horizontal deflection coils need not be a permanent attachment to the deflection yoke assembly to reduce the cost thereof. In such case, it is a means which may be temporarily removably mounted upon each deflection yoke assembly and then removed for further use on another yoke after the relative positions of the core and deflection coils have been fixed as by cementing the same in their relative adjusted positions.

The adjustment of the horizontal spacing of the vertical blue traces from the vertical green traces at the 3 and 9 o'clock positions (referred to as "blue width") has heretofore been effected by adjusting the vertical position of the entire deflection yoke assembly on the neck of a cathode ray tube. However, such vertical adjustment does not perceptibly vary the red-green trace crossover. What was not heretofore appreciated is that a variation in the relative position between the core and deflection coils of the deflection yoke assembly produces any useful result, such as a variation in red-green trace crossover. Since the core of a deflection yoke does not itself produce magnetic lines of force but merely effects the magnetic reluctance of a magnetic path outside of the cathode ray tube, the moving of a core relative to the deflection coils would not necessarily be expected to change the relative positions of the red and green traces as above described.

Not only does the aforesaid adjustment of the deflection yoke assembly eliminate the rejection of deflection yoke assemblies by the deflection yoke manufacturers because of excessive trace divergences on the test cross-hatch pattern, but, unlike previous manufacturing techniques where there was a significant but acceptable variation in the red-green trace crossover, it makes possible the manufacture of all deflection yoke assemblies producing near identical trace divergences so that greater tolerances in the angles of the electrode guns of the cathode ray tubes and the parts making up the dynamic convergence circuits can be specified, if desired, and the effort needed to make the final adjustments of the dynamic convergence circuits is significantly reduced.

The above and other features, objects and advantages of the invention will become more apparent upon making reference to the specification to follow, the claims and the drawings, wherein:

#### DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial sectional and partial elevational view of a deflection yoke assembly used in the method of the present invention;

FIG. 2 is a perspective view of a deflection yoke assembly adjusting station where the deflection yoke assembly of FIG. 1 is adjusted to optimize its beam deflection producing parameters in accordance with the present invention;

FIG. 3 is a perspective view of the cathode ray tube and deflection yoke assembly portion of the adjusting station of FIG. 2;

FIG. 4 is a plan view of the deflection yoke assembly adjusting fixture forming one of the elements of the adjusting station shown in FIG. 2;

FIG. 5 is a sectional view through the deflection yoke assembly adjusting fixture shown in FIG. 4, taken along section lines 5—5 thereof, when the adjusting fixture is applied over the neck of a cathode ray tube and tempo-

rarily receives a deflection yoke assembly at the adjusting station as shown in FIG. 2;

FIG. 5A is a sectional view through the deflection yoke assembly adjusting fixture shown in FIG. 4, taken along section line 5A—5A thereof, when the adjusting fixture is applied over the neck of a cathode ray tube and temporarily receives a deflection yoke assembly at the adjusting station as shown in FIG. 2;

FIG. 6 is a view of a cross-hatch video pattern provided on the face of the cathode ray tube at the adjusting station of FIG. 2 during the deflection yoke assembly adjusting operation performed thereat;

FIG. 7A is a greatly enlarged view of those portions of the cathode ray tube face enclosed by dashed lines in FIG. 6, and includes arrows which illustrates the effect on the beam traces of a variation in the position of the core relative to the deflection coils along the vertical axis of the deflection yoke assembly;

FIG. 7B is a view corresponding to FIG. 7A but including arrows which illustrate the effect on the beam traces of a variation in the position of the core relative to the deflection coils along the horizontal axis of the deflection yoke assembly;

FIG. 8 is a fragmentary sectional view through the deflection yoke assembly of FIG. 1 at the adjusting station shown in FIG. 2 after the adjustment thereof has been fixed by adhesively securing the core in its final adjusted position;

FIG. 9 is a fragmentary enlarged sectional view through the deflection yoke assembly of FIG. 8, taken along section line 9—9 thereof;

FIG. 10 is a side elevational view, partly in section, illustrating a modified form of deflection yoke assembly where the core adjusting means is permanently affixed thereto; and

FIG. 11 is an exploded view of the core adjusting means forming a permanent attachment to the deflection yoke assembly shown in FIG. 10.

FIG. 1 illustrates a deflection yoke assembly 2 of the saddle deflection coil type presently used in most color television sets. As thereshown, the assembly includes a frame generally indicated by reference numeral 4 made of a suitable synthetic plastic material. The frame 4, as illustrated, is made of two confronting mirror-image parts 4a and 4b (FIG. 8) each including a generally forwardly flaring main body portion 6 terminating in its front end in a radially outwardly extending front annular wall or flange 8 joining an outer forwardly projecting annular rim 10. The frame parts 4a—4b are secured together in any suitable way, such as by securing rings 7—7 made of a flexible resilient material each force-fitted over the enlarged heads of confronting pairs of pin-forming projections 9—9 respectively extending from the confronting marginal portions of the frame parts 4a—4b. The main body portion 6 of each frame part 4a or 4b terminates at the rear thereof in a radially extending rear semi-annular wall 12. The rear walls 12—12 of the confronting frame parts 4a—4b form a mounting panel upon which various circuit-forming elements like 16 associated with deflection coil circuits are soldered to terminal strips like 14 anchored to the coplanar faces of the walls 12—12. A rear cover member 18 (preferably made of a synthetic plastic material) is suitably releasably secured to the walls 12—12 in any well known manner. The cover member 18 has a central opening 19 defined by an inwardly flexible cathode ray tube engaging neck portion 21 which, as illustrated,

is anchored to the neck portion of a cathode ray tube by a clamp 20 enveloping the flexible neck portion 21 and having a tightening screw 23.

The frame 4 has securely anchored to thinner surface 29 of the forwardly flaring main body portion thereof a pair of vertically spaced horizontal deflection coils 28a—28b. A pair of horizontally spaced vertically spaced deflection coils 30a—30b are closely but rotatably adjustably mounted around the outer surface 31 of the forwardly flaring main body portion 6 of the frame 4. As is well known, current flow through vertically spaced horizontal deflection coils 28a—28b generates a vertically extending magnetic field within the space enveloped thereby which effects horizontal displacement of electron beams, and current flow through the horizontally spaced vertical deflection coils 30a—30b generates a horizontally extending magnetic field within the spaced envelope thereby which effects vertical displacement of electron beams.

To provide a sufficiently high magnetic field strength for a given current flow in the deflection coils, a low magnetic reluctance path is provided for the magnetic field by a hollow core 32 made of a low magnetic reluctance material, which is generally an iron based material. The core 32, which is generally made of two adhesively secured together mirror image parts 32a—32b to permit it conveniently to be mounted in place on the deflection yoke assembly, defines an open-ended cavity 34 therein having a generally forwardly flaring configuration like the main body portion 6 of the frame 4 and the outermost deflection coils 30a—30b which the core envelopes. Unlike the cores used in deflection yoke assemblies heretofore produced wherein the core snugly fit around the outermost deflection coils as previously indicated, the core 32 fits loosely around the latter coils so that it is adjustable relative thereto along at least one axis, most especially the vertical axis, of the deflection yoke assembly, and most advantageously also along the horizontal axis of the deflection yoke assembly. For example, it was found that in most cases sufficient clearance is provided to usefully adjust or optimize the beam deflection parameters of the deflection yoke assembly when the permitted movement of the core 32 relative to the outer deflection coils 30a—30b is from about 0.020 to 0.040 inches.

In the particular deflection coil assembly 2 illustrated in FIG. 1, the adjustment of the core position is effected by a core adjusting fixture to be described into which the deflection yoke assembly 2 is temporarily placed for adjustment. Following such adjustment, the position of the core is fixed by application of a suitable adhesive or the like. (In accordance with another aspect of the invention to be described, the means for adjusting the core is a permanent attachment to the deflection yoke assembly so that the television manufacturer or repairman may make an adjustment thereof, if desired. Also, the feature of making the core adjustable with respect to the deflection coils and providing a means for effecting fine adjustment of the position thereof is applicable to all types of deflection yoke assemblies, such as toroidal core deflection yoke assemblies.)

Conductors 40 extend from the various deflection coils and the circuit-forming elements mounted on the terminal strips 14 to a connector 45 adapted to be connected to a complementary connector such as 47 shown in FIG. 2, in turn, connected to a long cable 49

of conductors extending to the various terminals of a standard test television receiver 50 supplied by the television receiver manufacturer to which the deflection coil assembly is to be sold. FIG. 2 illustrates an exemplary adjusting station 51 used at the plant of the deflection yoke assembly manufacturer. (It should be understood that the construction and arrangement of the various components forming part of the adjusting station 51 may vary widely.) As there shown, an equipment support rack 52 is provided having a bottom shelf 54 upon which rests the standard test receiver 50. Supported on an intermediate shelf 58 of the rack is a mirror 60 inclining upwardly and rearwardly at approximately a 45° angle. The mirror 60 is visible easily by a person sitting in front of the rack 52 viewing the same through an opening 61 extending to the front margin of an upper shelf 62. The opening 61 extends a substantial distance across the width of the shelf 62, and supported above the rear portion of this opening is the color cathode ray tube 66 used with the standard test receiver. The cathode ray tube 66 is mounted with its front side screen-forming end 66a facing downwardly so that the beam traces appearing on the cathode ray tube screen will be reflected forwardly by the mirror 60 on the shelf below, so the person making the adjustments to be described can see the beam traces through the front portion of the opening 61 as he glances downwardly and rearwardly upon the mirror 60. The cathode ray tube 66 may be confined in this downwardly facing position in any suitable way. For example, the margins of the front face of the cathode ray tube may be supported upon the defining margins of the shelf opening 61 and confined in a given position thereover by suitable positioning means, which may include cushion elements 69.

There is supported upon the wide front end 66a of the cathode ray tube adjacent the neck portion 66b thereof an adjusting fixture 68 (which will be described later on in the specification) in which is supported the deflection yoke assembly 2. As will be described in more detail, the adjusting fixture 68 has an adjusting member 68a for adjusting the position of the core 32 relative to the deflection coils 28a-28b and 30a-30b along the normal vertical axis of the deflection yoke assembly, (the normal horizontal or vertical axis being related to the usual horizontally oriented position of the deflection yoke assembly upon the neck of a cathode ray tube), and an adjusting member 68b for adjusting the position of the core 32 along the normal horizontal axis thereof. Positioned behind the deflection yoke assembly 2 around the neck 66b of the cathode ray tube 66 is a convergence assembly 72 having the usual static convergence adjusting control members 72a, 72b and 72c (FIG. 3). The convergence assembly 72 may have windings (not shown) which receive the dynamic convergence signals previously referred to. These windings are connected through various insulated conductors 73 to a connector 75 which connects with a complimentary connector 77 connected by a cable 79 of conductors to the standard test receiver 50 in a conventional way. Suitable magnet-containing lateral blue width and purity adjusting controls 80 and 83 are also supported around the neck 66a of the cathode ray tube behind the convergence assembly 72 in the usual manner. Since these controls are not associated directly with any electrical circuitry, there are no electrical conductors associated therewith. The plug termi-

nals at the end of the neck of the cathode ray tube are connected through a socket connector 85 and conductors in a cable 92 to the standard test receiver 50 in a conventional way.

The adjusting station further includes what is sometimes referred to as a color generator 95 shown mounted on a support shelf 100 extending from one side of the rack 52. The color generator 95 has a cable 104 extending to the standard test receiver 50. The color generator 95 is a well known unit which generates selected voltages fed to the input terminals of the standard test receiver 50 to effect one of a selected number of video patterns on the screen of a color television cathode ray tube. These voltages provide synchronization and intensity control voltages in the usual manner to provide the desired pattern on the screen of the cathode ray tube, such as the cross-hatch pattern shown in FIG. 6 to which reference will be made later on in the specification.

Refer now more particularly to FIGS. 4 and 5 and 5A which shows the constructional details of an exemplary deflection coil assembly adjusting fixture 68. As there shown, the fixture includes a base plate 106 provided with suitable means for supporting the same upon the downwardly facing cathode ray tube 66. As illustrated, this means comprises spaced supporting legs 108 each having a vertically extending shank portion 108a secured by a screw 110 passing through a vertically elongated slot 112 in the shank portion 108a and threading into the threaded opening in the base plate 106. The position of the base plate 106 with regard to the neck portion of the cathode ray tube 66 can thereby be adjusted over certain limits. The shank portion 108a of each leg 108 terminates in an outwardly and downwardly inclining intermediate portion 108b which bears upon a cushion pad 116 directly bearing on the outer surface of the forwardly flaring front end 66a of the cathode ray tube 66. The intermediate portion 108b of each leg terminates in an outwardly extending eyelet-forming portion 108c through which extends a securing wire 120 connected to one end of a turnbuckle 122, or the like whose opposite end is connected by a wire 123 to an eyelet 124 secured to one of the corners of a cushion 69.

Adjustably mounted upon the top of the base plate 106 is a slide plate 126 having parallel elongated guide slots 128 into which pass the unthreaded shank portion of guidepins 130 having ends threading into the base plate 106. The guidepins 130 guide the slide plate 126 for movement parallel to a reference axis 131. The slide plate 126 has a block 132 to which the threaded shank portion 133' of a threaded rod 133 is anchored. The adjusting member 68a may include a knurled knob 135 projecting through a narrow slot 137' in a block 137 secured to the base plate 106 and threaded around the shank of the threaded rod 133 passing through unthreaded holes in the block 137. Rotation of the knob 135 in one direction or the other brings the knob against one of the defining walls of the slot 137 and moves the slide plate 126 in one direction or the other parallel to the axis 131. A screw 134 threaded into the slide plate 126 bears on the surface of the base plate 106 to fix the adjusted position thereof.

The base plate 106 has a relatively large opening 136 whose defining walls are in substantial spaced relationship to the adjacent portion of the cathode ray tube. The defining walls of the opening 136 are provided

with a stepped deflection yoke assembly positioning recess defined by an upwardly facing annular support surface 138 upon which the front edge portion of the annular skirt 10 of the frame of the deflection yoke assembly rests, and a radially inwardly extending surface 140 against which the side of the annular skirt 10 is snugly positioned. The deflection yoke assembly is positioned within this recess of the base plate 106 so the normal vertical axis of the deflection yoke assembly, which in the illustrated embodiment of the invention is the separation line between the frame parts 4a and 4b as best shown in FIG. 8, is co-extensive with the axis 131 of the adjusting fixture 68. The deflection yoke assembly positioning recess thus fixes the position of the frame and the deflection coils mounted thereon relative to the cathode ray tube 66.

The slide plate 126 has a central opening 142 of much greater size than the opening 136 in the base plate 106. Supported on diametrically opposite sides of the opening 142 of the slide plate 126 in a direction transverse to the aforementioned axis 131 are a pair of guide-forming means 144—144 supporting a slide member 145 carrying core-engaging jaw members 146—146 for movement parallel to an axis 131' transverse to the aforementioned axis 131. The jaw members 146—146, as illustrated, have confronting surfaces 148—148 sized and shaped snugly to engage opposite sides of the core 32 of the deflection yoke assembly. The core 32, as illustrated, has a front cylindrical outer surface portion 150 which is engaged by the correspondingly sized and shaped surfaces 148—148 of the jaw members 146—146.

The jaw members 146—146 are supported for movement by respective pivot-forming means 152—152 so that the jaw members can be withdrawn out of the way where the deflection yoke assembly 2 can be freely inserted within the aforementioned positioning recess of the base plate 106. Such means may take a variety of forms and, as illustrated, is a toggle type linkage carrying the jaw members 146—146 on the ends thereof. This linkage is anchored to and carried by the slide member 145 fitting into an opening in the slide plate 126. The slide member 145 has a ring-shaped center portion 145a with a large center opening 155. The ring-shaped center portion 145a terminates in opposite end portions 145b—145b which are slidably mounted within guideways of the guide-forming means 144—144. The slide member 145 is adjustable along the aforementioned axis 131' by the aforementioned adjusting member 68b which, as illustrated, is similar to adjusting member 68a by including a knurled knob 157 projecting through a narrow slot 158' in a block 158 on the base plate and threaded around the shank 157' of a threaded rod 157 passing through unthreaded holes in the block 158 and anchored to the slide member 145. Thus, rotation of the knurled knob 157 in one direction or the other advances the slide member 145 in one direction or the other parallel to the axis 131'. A screw 159 threaded into the slide member 145 and bearing on the surface of the base plate 106 locks the slide member into its adjusted position. It should be apparent that with the adjusting fixture 68 above described, the core 32 is independently adjustable along two orthogonal axes.

Either after or before the deflection yoke assembly 2 is positioned within the adjusting fixture 68, the outermost deflection coils 30a—30b are adjusted so the

cross-coupling therebetween (commonly referred to as "cross talk") is reduced substantially to zero using conventional voltage measuring techniques, and the zero "cross talk" position of the outermost deflection coils is fixed by applying a suitable adhesive between the outermost deflection coils and adjacent exposed portions of the frame 4 in the conventional manner. If it is believed necessary to make a subsequent "cross talk" adjustment after other parameters of the deflection yoke assembly are adjusted in the manner to be described, the adhesive is applied in a manner or is one which remains fairly soft over the period involved, so that the adhesive can be easily removed or broken to make a further adjustment of the outermost deflection coils following which additional adhesive is added to permanently affix the position of the outermost deflection coils.

In accordance with the invention the deflection yoke assembly is positioned in the adjusting fixture 68 in the manner previously described so that rotation of the adjusting member 68a thereof will move the core 32 relative to the deflection coils along the normal vertical axis of the deflection yoke assembly and the rotation of the adjusting member 68b will move the core 32 relative to the deflection coils along the normal horizontal axis of the deflection yoke assembly. Before this adjustment is made, the usual purity and static convergence adjustments are made by the controls 72a, 72b, 72c, 80 and 83 (FIG. 3) with the proper signals applied to and by the standard test receiver 50 in a well known manner (which will not be here described), with no dynamic convergence signals applied to the convergence assembly 72. (This can be accomplished by using a convergence assembly without the dynamic convergence signal-receiving windings or by eliminating the conductors normally connecting with such windings from the cable 79.)

In accordance with the most preferred procedure for utilizing the adjustable core feature of the present invention, after the above referred to "cross talk," purity and static convergence adjustments are made, the color generator 95 is set (if not previously so set) so that it produces a conventional cross-hatch pattern as shown in FIGS. 6, 7A and 7B. In such a pattern, all of the colored beams are energized to produce a cross grid pattern of adjacent red, green and blue traces respectively identified by the reference characters R, G and B. FIGS. 7A and 7B show in magnified form the various color traces at the 12, 3, 6 and 9 o'clock positions P1, P2, P3 and P4 on the face of the screen of the cathode ray tube, and also at the center and four corner positions P5, P6, P7, P8 and P9 thereof. In FIG. 7A, the solid arrows illustrate the direction of movement of the red, green and blue traces when the adjusting member 68a is adjusted in a direction which moves the core 32 in a normal upward direction along the normal vertical axis of the deflection yoke assembly and the dashed arrows therein indicate the direction of movement of the various traces when the adjusting member 68a is moved in a direction to move the core 32 in a normal downward direction along the normal vertical axis of the deflection yoke assembly. In FIG. 7B, the solid arrows illustrate the direction of movement of the red, green and blue traces R, G and B when the adjusting member 68b is adjusted in a direction which moves the core 32 left along the normal horizontal axis of the deflection yoke assembly and the dashed arrows therein

indicate the opposite direction of movement of the various beam traces affected thereby when the adjusting member 68b is moved to the right along the normal horizontal axis of the deflection yoke assembly.

It should be noted that in the 3 and 9 o'clock positions P2 and P4 before adjustment, the left hand end of the horizontally extending red trace R is below the horizontally extending green trace G, and the right hand end of the horizontally extending red trace R is above the horizontally extending green trace G. As illustrated, the horizontally extending red trace crosses over the horizontally extending green trace so it is rotated a substantial degree with respect thereto in a counterclockwise direction as seen in the drawings. As previously indicated, in accordance with the invention, the deflection parameters of the deflection coil assembly are optimized to a substantial degree by moving the adjusting member 68a in a direction which will rotate the horizontally extending red trace closer to, and in most cases preferably in alignment with, the horizontally extending green trace, thereby producing a horizontal yellow line across the center of the screen of the cathode ray tube. The television receiver manufacturer will commonly specify the maximum permissible degree of red trace crossover at the 3 and 9 o'clock positions of the cross-hatch pattern.

While this adjustment in presently manufactured deflection yoke assemblies may be sufficient in most instances to optimize the deflection producing parameters of the deflection yoke assembly, in the most advantageous form of the present invention another adjustment is made with the adjusting member 68b which affects the horizontally extending red and green traces R and G at the 12 and 6 o'clock positions P1 and P3 of the cross-hatch pattern. It will be noted in FIGS. 7A and 7B that at the 12 o'clock position P1, the horizontally extending red trace R crosses the horizontally extending green trace G at a point to the left of the point where the centered vertical blue trace B passes through the green trace G, so the red trace is above the green trace at the centered vertical blue trace B. In contrast to this, at the 6 o'clock position P3, the horizontally extending red trace R crosses the horizontally extending green trace G at a point far to the right of the point where the centered vertical blue trace B passes through the green trace G, so the red trace is below the green trace at the centered vertical blue trace B by an amount greater than the spacing of the horizontally extending red trace R from the horizontal green trace G along the vertical blue trace B passing through the green trace G at the 12 o'clock position P1. There is present what is referred to as an unequal "red raster height." In accordance with another aspect of the invention, the beam deflection parameters of the deflection yoke assembly are further optimized by rotating the adjusting member 68b so as to move the core along the normal horizontal axis of the deflection yoke assembly to equalize "the red raster height" at the 12 and 6 o'clock positions P1 and P3 of the cross-hatch pattern. This adjustment moves the horizontally extending red traces R at the 12 and 6 o'clock positions in opposite directions relative to horizontally extending green traces G at these points. It is preferable that this equalized position be one wherein the raster height at the point where the horizontally extending red and green traces cross the centered vertical blue traces B at the 12 and 6 o'clock positions to produce a zero "red raster height," but this

is frequently not possible. However, an equalization of this red raster height is what is important to effect the best adjustment of the deflection coil assembly.

The core 32 is most advantageously provided with a number of widely spaced apertures 159 (see FIGS. 8 and 9) at points overlying the outermost deflection coils 30a and 30b, and these apertures are filled with a hot-melted adhesive 160 so as to fix the adjusted position of the core 32 with regard to the deflection coils. As the hot melt cools, which may take from about 30 seconds to 1 minute, the effect of the various adjustments at the 12, 3, 6 and 9 o'clock positions P1, P2, P3 and P4 of the cross-hatch pattern are checked to be sure that these adjustments are maintained.

Following the aforementioned adjustment, measurements are made of the horizontal separation of the vertical blue traces B from the vertical green traces G at the 3 and 9 o'clock positions P2 and P4 (referred to as "blue width") to see if they meet specifications and, if not, the deflection yoke assembly is sent to the repair section for a coil change. Similarly, what is referred to as the "reverse trap" (dealing with the relative overall height of the vertical red and green traces R and G at the left and right sides of the cross-hatch pattern) is checked along with the spacing of the colored beams at the corners P6, P7, P8 and P9 of the cross-hatch pattern to determine whether the various beam spacing specifications set by the television receiver manufacturer are met and, if not, the deflection yoke assembly is similarly sent to the repair section for coil replacement.

Refer now to FIGS. 10 and 11 which illustrate a modified form of deflection yoke assembly 2' wherein the deflection yoke assembly includes as a permanent attachment thereof a deflection yoke assembly adjusting structure 68' permitting adjustment by the television receiver manufacturer or television repairman. (Many of the parts of the structure 68' correspond in function to portions of the deflection coil assembly adjusting fixture 68 previously described, and the corresponding elements therein have been similarly numbered, with a prime (') used on the parts of the structure 68'. The structure 68' includes an inner stationary annular plate 106' secured in any suitable way to the wall 12' of the insulating frame 4' of the deflection coil assembly 2'. The inner annular plate 106' has a central opening 161 which fits loosely around the narrow cylindrical inner end 150' of the core 32' so the position of the core is radially adjustable with respect to the annular plate 106'. The inner annular plate 106' has an outwardly axially extending ear 163 having a slot 165 extending therethrough. At a point on the periphery of the inner annular plate 106' diametrically opposite the ear 163 there is provided an outwardly axially extending lug 167 having a circular hole 167' therein. Projecting axially outwardly from the inner annular plate 106' at diametrically opposite points on the annular inner plate 106' and transversely to the spacing of the ear 163 and lug 167 are a pair of guide tongues 168—168.

Supported adjacent the outer face of the inner annular plate 106' is an annular slide plate 126' which is slidably mounted with respect to the inner annular plate 106' along an axis extending between the aforementioned ear 163 and the lug 167. To this end, the annular slide plate 126' has a tongue 169 extending radially therefrom which is slidably disposed within the slot 165 in the ear 163 on the inner annular plate 106'. The

annular slide plate 126' is also provided with a pair of diametrically oppositely disposed elongated guide slots 170—170 which slidably receive the aforementioned guide tongues 168—168. The guide tongues 168—168 guide the annular slide plate 126' for movement in the direction of the length of the slots. The annular slide plate 126' has an ear 171 positioned adjacent to the inner side of the aforementioned lug 167, the ear 171 having a hole 171' in alignment with the aforesaid lug hole 167'. An adjusting member 68a' is provided including a hollow hub portion 173 forming a knurled knob in which is anchored the reduced unthreaded portion 172' of a screw 172 threading within the hole 171'. The unthreaded portion 172' of the adjusting member 68a' is rotatable within the hole 167' of the lug 167, the defining walls of which form a bearing for the screw 172. When the screw is rotated in one direction or the other the annular slide plate 126' is moved along the face of the annular inner plate 106' which it confronts in a direction parallel to the elongated guide slots 170—170 in the annular slide plate 126'.

Adjustably mounted upon the slide plate 126' is a core mounted annular plate 154' which has a pair of diametrically oppositely disposed elongated guide slots 177—177 which fit over relatively narrow guide tongues 175—175 projecting axially outwardly from the outer face of the slide plate 126'. The guide tongues 175—175 have a thickness approximately equal to the width of the slots 177—177 and a length much less than the length thereof, so that the guide tongues 175—175 guide the core connected annular plate 154' for movement in the direction of the length of the slots 177—177, which is transverse to the direction in which the slide plate 126' is slidable relative to the inner annular plate 106'.

The slide plate 126' is provided with an outwardly axially extending lug 180 which has a hole 181 for rotatably supporting the reduced unthreaded portion 182' of a screw 182 forming part of an adjusting means 68b'. The screw 182 extends into and is anchored to a hollow hub 183 forming a knurled knob. The core connected annular plate 154' has an outwardly axially extending lug 186 positioned in confronting spaced relationship to the inner side of the lug 180 on the slide plate 126'. The lug 184 has a threaded opening 186 in which the screw 182 is threaded. It is thus apparent that upon rotation of the knurled hub 183 from which the screw 182 extends, the core connected annular plate 154' will move along the slide plate 126' which it confronts in a direction parallel to the length of the guide slots 177—177 therein.

The core connected annular plate 154' anchored to the core 32' of the deflection coil assembly 2' by means of a clamping member 148' which is a split sleeve-like structure firmly secured around the cylindrical inner end 150' of the core by a clamping screw 187.

The clamping member 148' is secured to the core connected annular member 154' by means including axially extending legs 188—188 terminating in radially outwardly extending flanges 190—190 abutting a pair of radial wings 192—192 extending from the clamping member 148'. The flanges 190—190 have holes 198—198 aligned with holes 200—200 on the wings 192—192. Bolts 204—204 passing through the aligned pairs of holes 198—200 and nuts 206—206 threading around the bolts 204—204 interconnect the flanges 190—190 and the wings 192—192.

It is apparent that the modified deflection coil assembly 2' with the integral adjusting structure 68' may be adjusted in the same manner previously described in connection with the adjustment of the deflection coil assembly 2, to provide the proper relationship between the beam deflecting parameters of the deflection coil assembly 2'. An adjusting station similar to that shown in FIG. 2 may be provided for this purpose and the identical procedure carried out as previously described.

It should be understood that numerous modifications may be made in the procedures for adjusting the deflection coil assembly described above without deviating from the broader aspects of the invention.

I claim:

1. A method of manufacturing a deflection yoke assembly with optimized beam deflecting parameters permitting the beams of a color television cathode ray tube to be properly dynamically converged over the face of the cathode ray tube, said method comprising: fabricating the deflection yoke assembly so it includes a frame mountable around the neck of a color television cathode ray tube, the frame supporting vertical and horizontal deflection coils and a core related to said vertical and horizontal deflection coils to form a low reluctance path for the magnetic field outside the neck of the cathode ray tube, one of said core and deflection coils being mounted for fine adjustment with respect to the other of same parallel to at least one of the horizontal and vertical axes of the deflection yoke assembly, mounting the deflection yoke assembly on the neck of a standard test color television cathode ray tube including beam intensity control terminals for controlling the intensity of the electron beams thereof striking the cathode ray tube screen, mounting purity and static convergence apparatus mounted around the neck of said cathode ray tube, making the usual purity and static convergence adjustments with said apparatus and, while applying signals to said cathode ray tube control terminals and to one of said horizontal and vertical deflection coils of said deflection yoke assembly to produce colored horizontal beam traces to be converged at least at two points spaced on opposite sides of the center point of the screen, adjusting the relative position between the core and at least one of said horizontal and vertical deflection coils to produce the desired convergence of said horizontal beam traces at said points.

2. The method of claim 1 wherein the horizontal and vertical deflection coils are immovably mounted relative to said frame, and said adjusting operation is performed by moving the core.

3. The method of claim 1 wherein said deflection yoke assembly frame is held in a fixed position and said core is clamped to a finely adjustable support structure which supports the core for movement along said axis.

4. The method of claim 3 wherein said adjustable structure includes means for holding said deflection yoke assembly frame in a fixed position, said frame and holding means forms a re-usable assembly which is only temporarily attached to the deflection yoke assembly, the core being adhesively secured in place on the deflection yoke assembly frame after said adjustment thereof is made.

5. A method of manufacturing a deflection yoke assembly with optimized beam deflecting parameters per-

mitting the beams of a color television cathode ray tube to be properly dynamically converged over the face of the cathode ray tube, said method comprising: fabricating the deflection yoke assembly so it includes a frame mountable around the neck of a color television cathode ray tube, the frame supporting vertical and horizontal deflection coils and a core related to said vertical and horizontal deflection coils to form a low reluctance path for the magnetic fields outside the neck of the cathode ray tube, one of said core and horizontal deflection coils being mounted for fine adjustment with respect to the other of same parallel to the vertical axis of the deflection yoke assembly, mounting the deflection yoke assembly on the neck of the standard test color television cathode ray tube including beam intensity control terminals for controlling the intensity of the electron beams thereof striking the cathode ray tube screen, mounting purity and static convergence apparatus around the neck of said cathode ray tube, making the usual purity and static convergence adjustments with said apparatus and, while applying signals to said cathode ray tube control terminals and at least to said horizontal deflection coils of said deflection yoke assembly to produce at least across the horizontal center band of the screen of the cathode ray tube colored horizontal beam traces, adjusting the relative vertical position between said core and horizontal deflection coils to produce a desired degree of convergence between at least two of the horizontal traces along said center band of said cathode ray tube screen at the 3 and 9 o'clock positions thereof.

6. The method of claim 5 wherein said adjusting operation is made to produce a zero or near zero convergence between the horizontal red and green traces at the 3 and 9 o'clock positions of the cathode ray tube screen.

7. The method of claim 5 wherein the horizontal and vertical deflection coils are immovably mounted relative to said frame, and said adjusting operation is performed by moving the core.

8. The method of claim 5 wherein said deflection yoke assembly frame is held in fixed position and said core is clamped to a finely adjustable support structure which supports the core for movement along said axis.

9. The method of claim 8 wherein said adjustable structure includes means for holding said deflection yoke assembly frame in a fixed position, said frame and holding means forms a re-usable assembly which is only temporarily attached to the deflection yoke assembly, the core being adhesively secured in place on the deflection yoke assembly frame after said adjustment thereof is made.

10. A method of manufacturing a deflection yoke assembly with optimized beam deflecting parameters permitting the beams of a color television cathode ray tube to be properly dynamically converged over the face of the cathode ray tube, said method comprising: fabricating the deflection yoke assembly so it includes a frame mountable around the neck of a color television cathode ray tube, the frame supporting vertical and horizontal

deflection coils and a core related to said vertical and horizontal deflection coils to form a low reluctance path for the magnetic fields outside the neck of the cathode ray tube, one of said core and vertical deflection coils being mounted for fine adjustment with respect to the other of same parallel to the horizontal axis of the deflection yoke assembly, mounting the deflection yoke assembly on the neck of a standard test color television cathode ray tube including beam intensity control terminals for controlling the intensity of the electron beams thereof striking the cathode ray tube screen, mounting purity and static convergence apparatus around the neck of said cathode ray tube, making the usual purity and static convergence adjustments with said apparatus and, while applying signals to said cathode ray tube control terminals and to said horizontal and vertical deflection coils of said deflection yoke assembly to produce at least across the uppermost and lowermost portions of said screen of the cathode ray tube colored horizontal beam traces, adjusting the relative horizontal position between said core and vertical deflection coils to produce a desired degree of convergence between at least two of the horizontal traces at the 12 and 6 o'clock positions of the cathode ray tube screen.

11. The method of claim 5 wherein said adjusting operation is made to produce a substantially equal spacing between the horizontal red and green traces at the 3 and 9 o'clock positions of the cathode ray tube screen.

12. The method of claim 11 wherein said signals produce also across the horizontal center band of the cathode ray tube screen colored horizontal traces, the adjustable one of said core and deflection coils is mounted for independent adjustment respectively along the horizontal and vertical axes of the deflection yoke assembly, and the adjustable one of said core and horizontal deflection coils is also adjusted along said vertical axis to produce zero or near zero convergence between the horizontal red and green traces at the 3 and 9 o'clock positions of the cathode ray tube screen.

13. The method of claim 10 wherein the horizontal and vertical deflection coils are immovably mounted relative to said frame, the said adjusting operation is performed by moving the core.

14. The method of claim 13 wherein said deflection yoke assembly frame is held in a fixed position and said core is clamped to a finely adjustable support structure which supports the core for movement along said axis.

15. The method of claim 14 wherein said adjustable structure includes means for holding said deflection yoke assembly frame in a fixed position, said frame and holding means forms a re-usable assembly which is only temporarily attached to the deflection yoke assembly, the core being adhesively secured in place on the deflection yoke assembly frame after said adjustment thereof is made.

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