GEODESIC ELECTROMAGNETIC DEFLECTION YOKE

Filed April 6, 1966 2 Sheets-Sheet 1

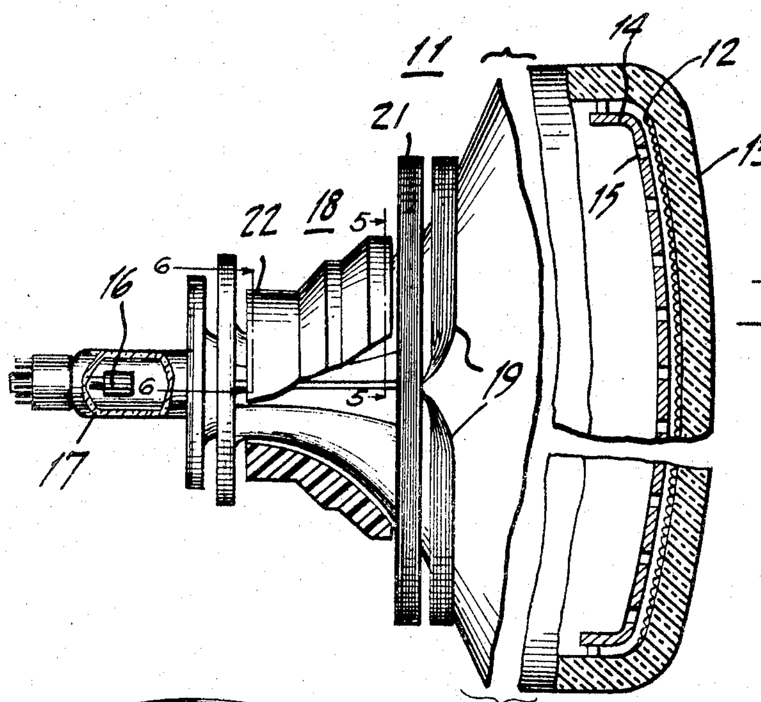

Fig. 1.

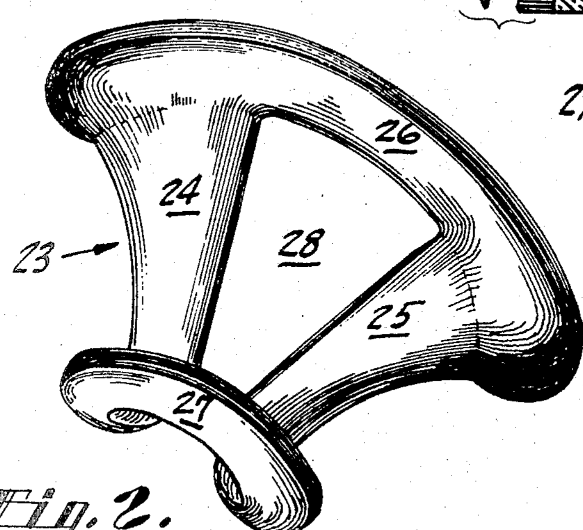

Fig. 2.

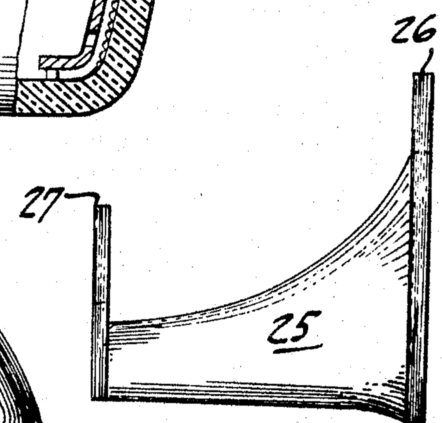

Fig. 3.

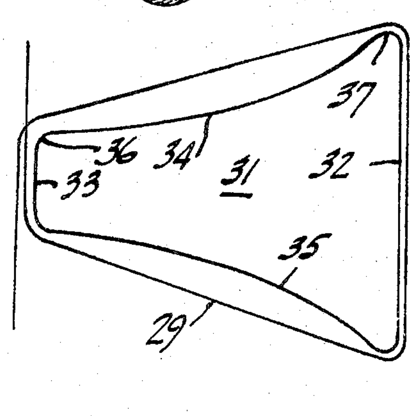

Fig. 4.

INVENTOR.
ROBERT L. BARBIN
BY
W. H. Sprague
Attorney

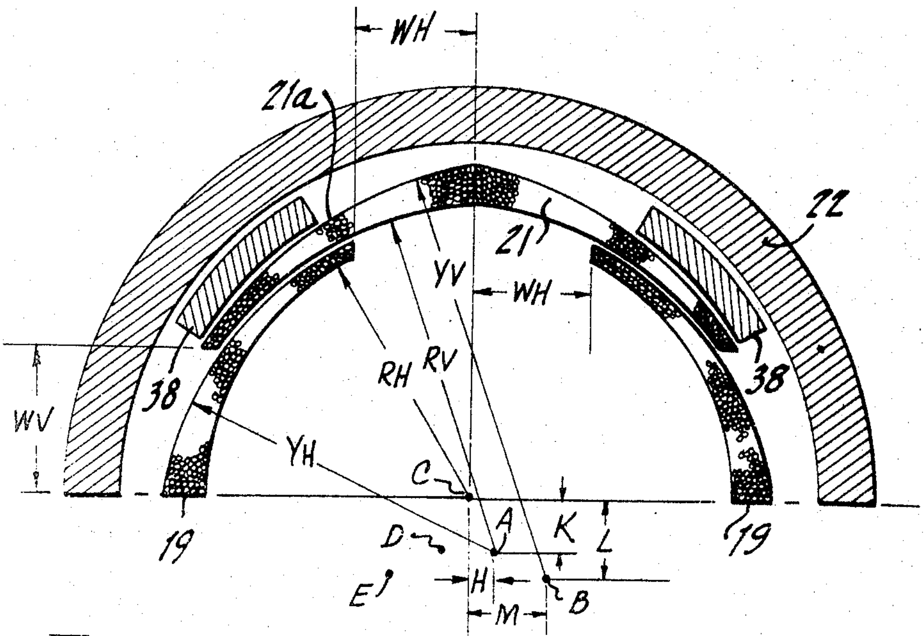

Fig. 5.

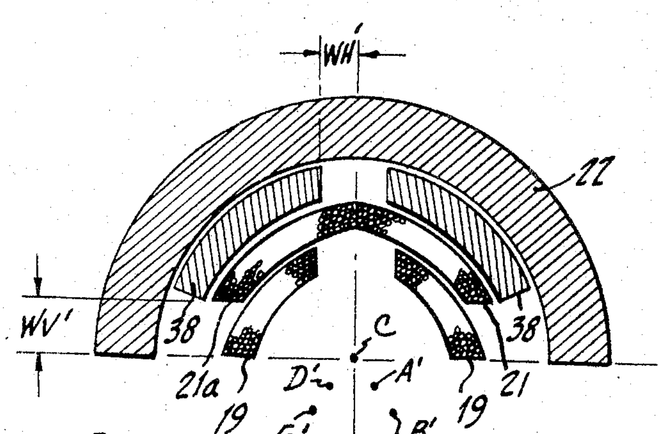

Fig. 6.

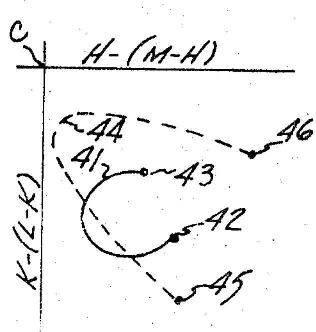

Fig. 7.

INVENTOR.
ROBERT L. BARBIN
BY
W. H. Sprouagle
Attorney

United States Patent Office 3,488,541
Patented Jan. 6, 1970

1

3,488,541

GEODESIC ELECTROMAGNETIC DEFLECTION YOKE

Robert Lloyd Barbin, Indianapolis, Ind., assignor to RCA Corporation, a corporation of Delaware

Filed Apr. 6, 1966, Ser. No. 540,616
Int. Cl. H01j 29/70
U.S. Cl. 313—76 3 Claims

ABSTRACT OF THE DISCLOSURE

The conductor distribution between the inside window and the outside of each coil is approximately uniform at the back of the yoke and changes progressively toward the front, ending with more conductors remote from the window than adjacent it. The coil configuration is such that the conductors lie along geodesic lines following the picture tube flare curvature.

This invention relates to electron beam deflection yokes and particularly to deflection yokes for relatively wide angle deflection of the three beams of a shadow mask type of color television picture tube.

Deflection yokes employed with such picture tubes comprise a pair of horizontal and a pair of vertical saddle-type coils. Each coil has two spaced groups of active side conductors extending generally along the longitudinal axis of the tube and spaced from one another circumferentially of the tube. The side conductors are joined at their ends by end conductors extending transversely of the tube. The side conductors follow the contour of the picture tube which flares from the neck section to the bulb section. The opening defined by the two spaced groups of side conductors and their associated front and rear end turns is generally termed a "window."

Wide angle beam deflection yokes of the character described not only must deflect the electron beams through the required angles to cover the entire screen area, but must do so with a minimum of raster distortion, astigmatism and coma. The capability of a yoke to accomplish such ends is determined by the location of the side coil conductors in their respective groups. In order to satisfy all of the enumerated requirements of a yoke with a single saddle-type coil, the optimum distribution of side conductors would be one in which the greater number of them is located in the portion remote from the window at the front and rear ends of the coil and in the portion adjacent to the window in the intermediate section of the coil. Such a distribution of the side conductors of the saddle-type yoke coils is not feasible with presently known winding techniques and tools.

It, therefore, is an object of this invention to provide an improved deflection yoke having such configuration and conductor distribution as to effect wide angle beam deflection with a minimum of raster distortion and coma, and selected astigmatism.

The deflection yoke embodying the invention has a varied distribution of the active coil conductors such that the distribution is approximately uniform at the rear of the yoke and is progressively changed toward the front of the yoke where a greater number of conductors are located remote from the coil windows than are disposed adjacent the windows. Additionally, each of the side coil conductors extending from the rear to the front of the yoke lies substantially along a geodesic line following the curvature of the flared bulb section of the picture tube. The term "geodesic line," as used in the following description and in the claims, is intended to have its usually accepted meaning, viz., the shortest line lying on a given surface and connecting two given points on that surface.

2

For a more complete disclosure of the invention, reference may be had to the following description which is given in conjunction with the accompanying drawings of which:

FIGURE 1 is a view, partly broken away and partly in section, of a shadow mask color picture tube and a deflection yoke embodying the invention;

FIGURE 2 is a perspective view of one of the coils of the yoke embodying the invention;

FIGURE 3 is a side view of the deflection yoke coil of FIGURE 2;

FIGURE 4 is a diagram illustrating a difficulty encountered in winding saddle-type deflection yoke coils;

FIGURE 5 is a diagrammatic partial cross-sectional view of the deflection yoke taken adjacent to the front end thereof;

FIGURE 6 is a diagrammatic partial cross-sectional view of the deflection yoke taken adjacent the rear end thereof; and

FIGURE 7 is a plot showing the general variation of some of the dimensions by which the desired coil configuration is achieved.

In FIGURE 1, a shadow mask type color picture tube **11** has a screen **12** comprising an array of phosphor elements capable, respectively, of emitting light of different colors when impinged by an electron beam. The screen **12** is formed on the inside surface of the curved end faceplate **14** of the tube. An array of electron guns **16** is mounted at the rear of the neck **17** of the tube **11** and is effective to direct three electron beams toward the phosphor screen **12** and the shadow mask **15**. The electron beams are deflected by a deflection yoke **18** to scan a rectangular raster at the screen **12**.

The subject matter of this invention is the deflection yoke **18**, which has the usual components including a pair of horizontal coils **19**, a pair of vertical coils **21** and a ferromagnetic core **22**. The general configuration of both pairs of horizontal and vertical deflecting coils **19** and **21** is similar. Accordingly, only one such coil will be described for the purpose of disclosing the present invention.

FIGURE 2 shows one of the deflecting yoke coils as having two groups of side conductors **24** and **25** which extend generally longitudinally of the yoke and picture tube. These two groups of side conductors are connected at the front by a group of end conductors **26** and the rear by a group of end conductors **27**. The conductors **24**, **25**, **26** and **27**, together define a window **28**.

The conductors of each of the side conductor groups **24** and **25**, follow the curvature of that portion of the picture tube **11** of FIGURE 1 in which the neck section **17** merges with the flared bulb section. This curvature is better illustrated in FIGURE 3.

FIGURE 4 illustrates the reason that, in the past, the optimum side conductor distribution in yoke coils has not been realizable. A coil is formed by winding a wire **29** around a window defining block **31** on an arbor. The wire is under some tension during the winding operation and, hence, is effectively stretched between the corners of the window block. It follows the contour of the block **31** only at the forward and rear ends **32** and **33** respectively. It does not follow the block contour along the concave sides **34** and **35**, which it must do in order to achieve the desired coil configuration.

In accordance with this invention, however, it has been determined that, by properly designing the curved sides **34** and **35** of the window block **31**, the intersection of this block and the curved surface of the arbor cavity on which the block is mounted is a geodesic line along the surface of the arbor contour. The wire, then, will follow the curved sides **34** and **35** of the block. Furthermore, the location of the wire along the longitudinal parts of the conductor groups 24 and 25 will produce as nearly optimum conductor distribution as possible with present winding techniques. Successive convolutions of the wire 29 around the block 31 follow similar paths; each path, however, being longer than its predecessors. The number of convolutions that are made in the region at the start of the coil adjacent the window block 31 as compared to the number of convolutions at the finish of the coil remote from the window block is controlled by the configuration of the cavity formed between the male and female halves of the arbor corresponding respectively to the cylindrical body and the mating cap of the commonly used coil winding machine of the type disclosed in U.S. Patent 2,448,672 of H. V. Knauf, Jr.

FIGURES 5 and 6 illustrate the manner in which the side conductor distribution varies from the rear to the front of the yoke. In both of these figures, the two groups of side conductors of one of the horizontal coils 19 and one group of side conductors of each of the vertical coils 21 and 21A are shown. It is to be understood that the other half of the yoke (not shown) is similar to that shown in these figures. Because of the symmetrical construction of the yoke coils, a description of the vertical and horizontal coil side conductor groups located in a given quadrant should be taken as a description of the conductor group in the other quadrants.

In FIGURE 5, the horizontal coils 19 are located on the inside of the yoke next to the picture tube. The vertical coils 21 are placed outside of the horizontal coils 19 with a space therebetween for insulating material (not shown). The coil structure is encircled by the ferromagnetic core 22 with sponge rubber pads 38 placed between the core and the vertical coils 21. The arrangement described to this point is generally the same as that used heretofore in yoke construction.

In accordance with the present invention, however, in a forward section of the yoke shown in FIGURE 5, the inner surface of the left-hand side conductor groups of the horizontal coil 19 is defined by an arc struck from the center C of the yoke with a radius RH. The outer surface of this horizontal side conductor group and the inner surface of the side conductor group of the vertical coil 21A are defined by arcs struck from a point A in the opposite quadrant with respective radii YH and RV. The outer surface of this vertical side conductor group is defined by an arc struck from a point B in the opposite quadrant with a radius YV. One half of the width of the window of the horizontal coil 19 is designated WH and a corresponding dimension of the vertical coils 21 and 21A is designated WV. The location of the opposite quadrant point A is defined by the coordinate dimensions H and K and the point B is defined by the coordinate dimensions L and M. The points D and E, which are the centers of curvature for the two side conductor groups of the coils 19 and 21 shown in the other quadrant, correspond respectively to the points A and B.

In a rear section of the yoke shown in FIGURE 6, the various surfaces of the coils 19 and 21 are defined by respective arcs struck from the points C, A′, B′, D′ and E′ corresponding respectively to points C, A, B, D and E of FIGURE 5. The associated radii of these arcs are not shown in order to avoid unnecessary complication of the drawing.

In accordance with the invention, the spacing from the center C of the points A and B varies from the locations shown in FIGURE 5 to the indicated locations of points A′ and B′ of FIGURE 6 as generally indicated by the graphs of FIGURE 7. In FIGURE 7, the solid line 41 is plotted with dimensions H and K as coordinates. The point 42 on the curve 41 represents the spacing of the point A of FIGURE 5 relative the center point C at the front transverse cross-section of the yoke. Similarly, the point 43 on the curve 41 represents the spacing between points A′ and C at the rear cross-section of the yoke shown in FIGURE 6. The changing location of points B and B′ respectively of FIGURES 5 and 6 is represented by the broken line curve 44 of FIGURE 7. In this case, however, it is more significant to indicate these locations in terms of dimensions representing the differences (M—H) and (L—K). Accordingly, the coordinates for the curve 44 are (M—H) and (L—K) as shown. The point 45 on the curve 44 represents the dimension differences (M—H) and (L—K) of the point B at the front yoke cross-section of FIGURE 5; and the point 46 represents similar dimension differences relative to the point B′ at the rear yoke cross-section of FIGURE 6. It will be understood that the locations of points D and E are similar to their corresponding points A and B.

The radius RH increases from the rear to the front cross-sections of the yoke to produce such an inside dimension of the yoke as to make it conform generally to the flared section of the picture tube. Also, the window dimensions WH and WV increase from the rear to the front cross-sections of the yoke. Because each transverse cross-section of each yoke coil necessarily has the same number of conductors, each cross-section must have sufficient area to accommodate the conductors, taking into account the fact that the conductors are not always perpendicular to the cross-section. Accordingly, the other radii YH, RV and YV have such variations from the rear to the front cross-sections of the yoke as to produce the desired conductor distribution in conjunction with the described variations of the dimensions RH, WH, WV and the locations of points A and B.

As a result of the described dimensional aspects of the yoke, the cross-sectional configuration of the yoke coils gradually changes from the generally uniform conductors distribution at the rear end, as shown in FIGURE 6, to one in which a relatively small number of conductors is located adjacent the window areas of the coils and a relatively large number of conductors is located remote from the windows at the front end, as shown in FIGURE 5.

Such a distribution of a greater number of conductors in the coils remote from the windows minimizes any pincushion distortion of the raster. Because such an arrangement is made in both horizontal and vertical yoke coils, the use of a yoke embodying this invention produces less top and bottom as well as side pincushion raster distortion. Also, by means of a conductor distribution achieved in a yoke made in accordance with the foregoing disclosure, including particularly the dimensions in FIGURES 5 and 6 and the information represented by the curves of FIGURE 7, the horizontal coils have a negative astigmatic effect upon the electron beams. The design of the horizontal coils in accordance with this invention is such, however, that these coils have substantially no coma, which obviates the need for dynamic waveforms and the like to correct the lateral position of the blue raster relative to the red and green rasters as in some prior art apparatus. In the present case, the conductor distribution in the vertical coils is such as to result in substantially no astigmatism.

A yoke designed in the manner described to minimize pincushion raster distortion and to have no coma does, however, have the described horizontal astigmatism. A beneficial use may be made of such astigmatism in the following manner. In a shadow mask color picture tube, the electron guns are arranged at the apices of an equilateral triangle so that two of the beams emanate at the some horizontal level and the third beam is vertically dispaced relative to them. Thus, as a consequence of the described negative astigmatic effect produced by the horizontal coils of this yoke, the reflection of the three beams away from the center of the viewing screen produces a displacement of the one beam relative to the other two such that, when the beams are dynamically converged, a raster distortion is produced which may be objectionable. It has been found, however, that such a feature is helpful in conjunction with other arrangements, including the positioning of the picture tube so that the one electron gun is displaced vertically from the other two in a direction opposite to that from which the screen is viewed, to compensate for any optical distortion of the raster produced by an off-axis viewing of the screen through the curved faceplate of the tube.

What is claimed is:

1. In an electromagnetic beam deflection yoke for a television picture tube, said tube having a generally cylindrical neck emerging into a flared bulb section, the combination comprising:

a pair of horizontal and a pair of vertical deflection coils disposed around the central longitudinal axis of said tube and encircling adjoining portions of said neck and bulb sections of said tube;

each of said coils including two spaced groups of side conductors extending generally longitudinally of said tube, joined by front and rear groups of end conductors extending generally transversely of said tube and defining a window area;

the distribution of side conductors is approximately uniform between said inner and outer edges of each group of side conductors in a transverse coil cross-section at the rear end of said yoke; and

said distribution of side conductors varies from a minimum at said inner edge to a maximum at said outer edge of each group of side conductors in a transverse coil cross-section at the front end of said yoke; and

each of said side conductors of each of said coils lying substantially along a geodesic line following the curvature of said flared bulb section of said picture tube.

2. In an electromagnetic beam deflection yoke for a television picture tube, said tube having a generally cylindrical neck section merging into a flared bulb section, the combination comprising:

a pair of horizontal and a pair of vertical deflection coils disposed around the central longitudinal axis of said tube and encircling adjoining portions of said neck and bulb section of said tube;

each of said coils including two spaced groups of side conductors extending generally longitudinally of said tube, joined at the front and rear groups of end conductors extending generally transversely of said tube and defining a window area;

the distribution of the side conductors in each of said groups of side conductors between the inner edge adjacent said window and the outer edge spaced from said window being varied substantially continuously in longitudinally successive transverse cross-sections of said coils;

said distribution of side conductors being approximately uniform between said inner and outer edges of each

group of side conductors in a transverse coil cross-section at the rear end of said yoke;

said distribution of side conductors varying from a minimum at said inner edge to a maximum at said outer edge of each group of side conductors in a transverse coil cross-section at the front end of said yoke;

said pair of horizontal coils being disposed adjacent to said merging neck and bulb sections with said four conductor groups thereof located respectively in the four quadrants of any of said transverse coil cross-sections;

said pair of vertical coils being disposed outside of said horizontal coils with said four conductor groups thereof located respectively in the four quadrants of any of said transverse coil cross-sections;

said distribution of side conductors in any given transverse coil cross-section being determined by the configuration of said coils as defined by their arcuate dimensions in said given transverse cross-section;

the center of curvature for the inner surfaces of all four conductor groups of said horizontal coils coinciding with the longitudinal axis of said picture tube;

the respective centers of curvature for the outer surfaces of all four conductor groups of said horizontal coils and of the inner and outer surfaces of all four conductor groups of said vertical coils being located in quadrants of said given transverse cross-section opposite to the quadrants in which the associated conductor group is located; and

each of said side conductors of each of said coils lying substantially along a geodesic line following the curvature of said flared bulb section of said picture tube.

3. In a deflection yoke, the combination as defined in claim 2 wherein:

the outer surfaces of the horizontal coil conductor groups and the inner surfaces of the vertical coil conductor groups in their respective quadrants have the same center of curvature.

References Cited

UNITED STATES PATENTS

2,570,425	10/1951	Bocciarelli	313—76
2,824,267	2/1958	Barkow	313—76 X
3,165,677	1/1965	Gostyn et al.	313—76 X

JAMES W. LAWRENCE, Primary Examiner

V. LAFRANCHI, Assistant Examiner

U.S. Cl. X.R.

335—213

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,488,541 Dated January 6, 1970

Inventor(s) Robert Lloyd Barbin

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 5, line 10, following "neck", "emerging" should read -- section merging --.

Column 5, line 43, delete "at the" and substitute -- by -- therefor.

SIGNED AND
SEALED
JUL 21 1970

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents