

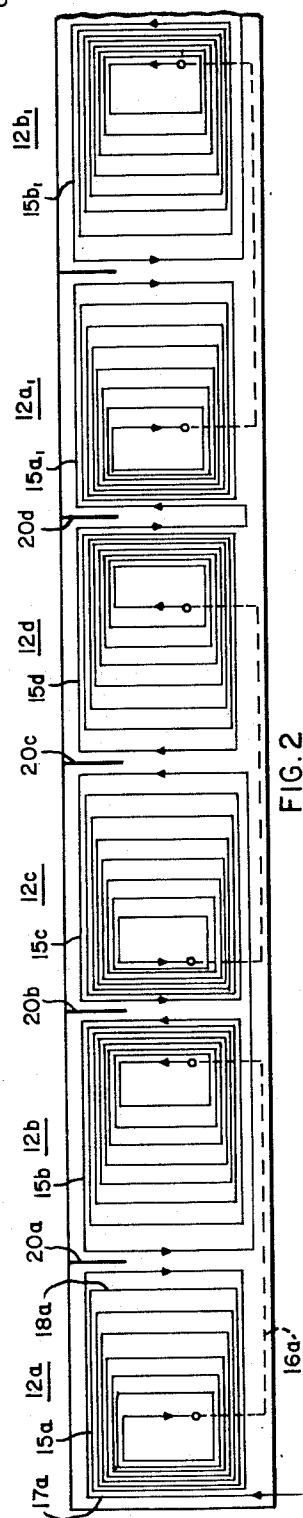
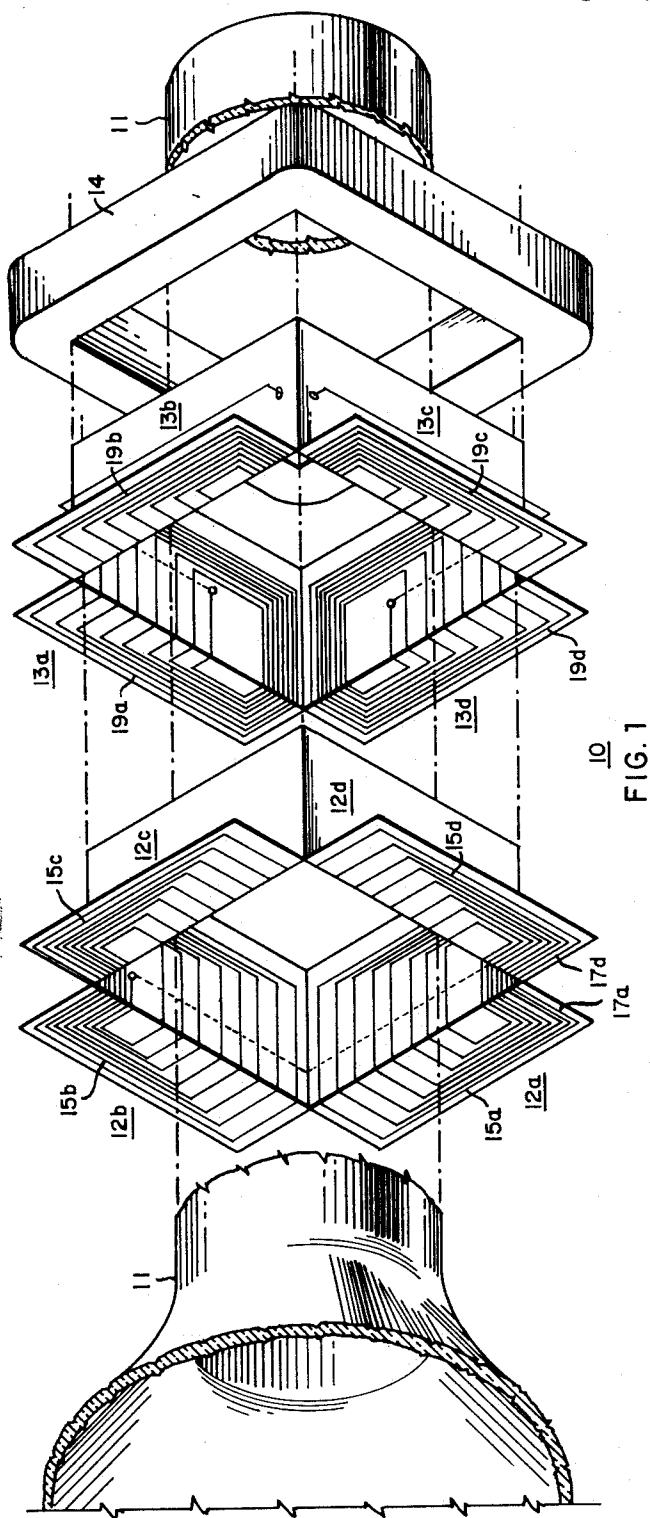
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CONSTRUCTION OF MAGNETIC DEFLECTION YOKES AND THE LIKE

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CONSTRUCTION OF MAGNETIC DEFLECTION YOKES AND THE LIKE

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11 Claims. (Cl. 317—200)

General

This invention is directed to the construction of electron-beam deflection yokes utilized to effect lateral motion of beams of electrons or similar electrical particles and is particularly directed to the construction of magnetic deflection yokes of this type. These yokes are particularly useful for deflecting the electron beams in cathode-ray tubes of the types conventionally employed in oscilloscopes, target indicators, and most commonly used in television receivers. To a large degree the stringency of the requirements of deflection yokes determines the methods of manufacturing these yokes. Since television deflection yokes have the most exacting requirements, the construction of such a yoke will be described herein. However, it should be understood that the construction of deflection yokes in accordance with the present invention may be employed in other than the construction of television yokes.

This application is a divisional application of now abandoned application Serial No. 530,490, filed August 25, 1955, and entitled "Method of Manufacturing Magnetic Deflection Yokes." Copending application, Serial No. 90,146, filed February 17, 1961, is a continuation of application, Serial No. 530,490.

The fundamental principles underlying television transmission and reception and the details of the apparatus employed are so well known it is deemed unnecessary for the purpose of the present invention to describe a complete television transmitter or receiver. It is well known in the art to employ cathode-ray tubes of various forms in conventional television receivers to reproduce televised images. To effect such reproduction, the cathode-ray tubes include means for emitting an electron beam which is intensity modulated by video-frequency information. This beam is focused into an extremely narrow beam to provide the high definition required in reproducing the televised image and is deflected in two orthogonal directions to scan a rectangular raster on the image screen of the picture tube to provide a two-dimensional reproduced image. Focusing of the electron beam is ordinarily accomplished by providing nonuniform magnetic or electric fields of regular configuration in the space traversed by the electron beam between the cathode and the image screen. Deflection of the focused electron beam is effected by developing varying electric or magnetic fields in the space traversed by the beam between the point of focusing and the image screen. The present invention is directed to deflection yokes for developing such varying magnetic deflection fields.

As is well known, a beam of electrons passing through a magnetic field is deflected in a direction perpendicular to the instantaneous direction of motion of the electrons in the beam and to the lines of magnetic force cut by the beam. In order to effect continuous and uniform deflection of the beam in the horizontal and vertical directions, the intensities of the components of the magnetic field in these two directions are varied, usually by employing separate coils of complex configurations with their axes mutually perpendicular and in which the magnitudes of the currents in the separate coils are varied independently to provide mutually perpendicular fields.

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Progressive advancements in the art of television have imposed rather stringent requirements upon deflection yokes. A deflection yoke should be an efficient power converter, provide linear scanning, develop uniform deflection fields which do not cause defocusing, and be free from resonant ringing and from undesired interaction of the vertical and horizontal fields. In addition, the yoke should be inexpensive and there should be a high degree of consistency between the deflection fields developed by yokes of the same construction. With the advent of the wide angle picture tubes having deflection angles approaching 90° and having an extremely short neck portion, it has become difficult to satisfy these requirements.

It has been conventional to utilize saddle yokes, so-called because of the saddle-like configuration of each of the four coils which combine to form the yoke. Because of the complex configuration of these coils, saddle yokes require complex coil winding apparatus which individually winds each of the four coils and which, in spite of its complexity, fails to maintain a uniform or any other desired spacial relationship of the turns in each coil or to wind coils which are consistently the same. After the winding process, the coils usually require additional shaping by manual or mechanical means to assume the "saddle" form. The latter operation introduces additional inconsistencies between coils and additional irregularities within each coil. Four coils so formed are then nested with a winding of one coil in the cavity or window of another to provide the complete deflection yoke. The latter assembly operation introduces additional inconsistencies between yokes of the same type. As a result of the above-mentioned factors saddle yokes have field irregularities and a lack of consistency in fields developed by yokes of the same type. To compensate for the field irregularities and the variations between fields developed by different coils of the same type, only a small segment at the center of the field pattern developed by a yoke of this type is used for deflection, the inner surfaces of the coils forming the yoke being spaced from the neck of the tube in order to minimize the effects of field irregularities which are strongest in the vicinity of the coil surfaces. Since only a relatively small portion of the total field developed by a yoke is employed, conventional saddle yokes tend to be expensive, large, and heavy, and they develop deflection fields which are less uniform than is desired and which fail to provide the degree of control of deflection of the beam required for best reproduction of the image. The present methods of physically winding wire into complex coil forms and then assembling the complex coils into a saddle yoke makes the elimination of the above-described undesired factors extremely difficult. Therefore, it is desirable to practice new methods of manufacturing saddle-type deflection yokes.

It is, therefore, an object of the present invention to provide deflection yokes which do not have the deficiencies and limitations of prior yokes.

It is an additional object of the present invention to provide deflection yokes utilizing printed-wiring techniques.

It is still another object of the present invention to provide deflection yokes which are easily and simply practiced to provide yokes with consistent magnetic characteristics.

It is a further object of the present invention to provide deflection yokes in which a plurality of windings are preformed in fixed spacial relationship.

In accordance with the present invention, a cathode-ray tube deflection yoke comprises a hollow yoke core and a dielectric sheet bearing a conductor pattern which comprises a series of loop type coils positioned side by side and electrically interconnected. This dielectric sheet is positioned around the inner wall of the core with one

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coil per layer of the sheet on each segment of the wall.

For a better understanding of the present invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

Referring to the drawing:

FIG. 1 is an exploded view in perspective of a deflection yoke in accordance with the present invention mounted on the neck of a cathode-ray tube shown in fragmentary form; and

FIG. 2 is a plan view of a strip of dielectric material including one series of coils utilized in the yoke of FIG. 1.

Description of Deflection Yoke

In FIG. 1 an exploded view of a deflection yoke 10 manufactured in accordance with the present invention is shown mounted on the neck 11 of a cathode-ray tube which may be, for example, the picture tube of a television receiver. The yoke 10 is square in cross section and preferably fits closely around the neck of the tube 11 with one end of the yoke, more specifically, the beam-exit end extending over at least a small length of the flared portion of the tube 11. The yoke 10 includes two groups of coils 12a-12d, inclusive, forming one group and 13a-13d, inclusive, forming the other group. FIG. 2 represents the group 12a-12d, inclusive, in unfolded form. These groups of coils are so disposed with respect to each other as to develop mutually perpendicular magnetic axes to effect horizontal and vertical deflection of the beam in the tube. Though each of the groups of coils is represented as having a single layer of conductors, preferably many layers of conductors are employed to effect the desired deflection sensitivity. For example, in FIG. 2 the coil 12a₁ would be superimposed to form a second layer of conductors for the coil 12a and similarly the coil 12b₁ superimposed with respect to the coil 12b, and any desired number of additional coils (not shown) would be folded into a superimposed position with respect to the coils 12a-12d, inclusive. The coils of each layer, and preferably all of the coils combining to form the horizontal or vertical deflecting windings, are permanently fixed in spacial relationship by being an integral part of a sheet of dielectric material on which they are formed by using printed-wiring techniques. The number of coils on a single sheet is limited only by the limitations of the printing process used to form the coils. The coils on a dielectric sheet are electrically connected in the manner represented by the dashed lines in FIG. 2 to provide a continuous current path through the many coils.

Each of the coils is of rectangular pattern and includes a pair of similar end windings, for example, the end windings 15a and 16a of coil 12a and a pair of dissimilar side windings, for example, the sides 17a and 18a of coil 12a. The coils have alternating patterns in the form of mirror images of each other, sometimes referred to as right-hand and left-hand patterns. For example, in FIG. 2, the coil 12a is a mirror image of the coil 12b, the densely wound sides of these coils being separated by the greatest distance along the dielectric sheet, and the sparsely wound sides being adjacent each other on the sheet. The conductors are, for example, 15 mils wide, 1.5 mils thick and those in the ends 15a, 16a and the side 17a are separated from each other by, for example, 15 mils. The windings in the side 17a are dense in order to confine the field developed by these windings, and adjacent dense windings have opposing current paths in order to minimize the magnetic effects of the dense windings. The windings on the side 18a provide the usable deflection energy. For simplicity of representation, only a few windings are shown for each coil and the relative spacing between the densely and sparsely wound sides is exaggerated. It is to be understood, of course, that the terms "dense" and "density" as used in

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the specification and claims refer to the number of conductors in a given area in the dielectric sheet. In practice, the density of winding in the sparsely wound side, for example side 18a of the coil 12a, is controlled by the field strength desired. The pattern of the spacing of the windings in the sparsely wound side is determined by the field pattern desired. For example, if a cosine field pattern is desired to correct for pin-cushion or barrel distortion of the raster, then the winding will have a cosine density pattern.

The longitudinal axes of the coils, being the axes parallel to the conductors in the sides of the coils, for example, parallel to the conductors in the sides 17a and 18a of coil 12a, are parallel to the axis of the electron beam in its normal or undeflected path. Preferably the coils are mounted on the inner walls of a square, frame-like core 14 with one coil or layer of coils flat along each of the four walls of the core. The core may be, for example, of ferromagnetic material such as ferrite to provide a lower reluctance return path for the magnetic flux developed by the coils. The two sets of coils 12a-12d, inclusive, and 13a-13d, inclusive, are mounted in such manner that the conductors of one set of coils, for example, the set 12a-12d, inclusive, providing the horizontal deflection field, are parallel to the conductors of the other set, for example, the set 13a-13d, inclusive, providing the vertical deflection field. In addition, the conductors forming the densely wound sides of one set of coils are positioned adjacent the conductors forming the sparsely wound sides of the other set of coils. For example, notice in FIG. 1 that the dense sides 17a and 17d of the coils 12a and 12d are adjacent the less dense sides of the coils 13c and 13d when the yoke is assembled. The end turns 15a-15d, inclusive, and 19a-19d, inclusive, of the two sets of coils extend outwardly from the front end of the core 14 and flare out preferably at a sharp angle from the axis of the core 14 circumferentially around the beam exit end of the yoke. Preferably, the end turns 15a-15d, inclusive, and 19a-19d, inclusive, are so disposed with respect to the core 14 and the area of the yoke through which the beam passes as to be as remote as possible from an extreme deflection path of the electron beam in order that these end turns have a minimum magnetic effect.

The sheets of coils are secured in close contact with the walls of the core. This securing can be accomplished by many of well-known means, for example, by employing a jig to position the coils in the proper places and then by dipping the yoke in wax or some similar material. Adhesive tape may also be used to fix the coils in the desired positions.

Construction of Deflection Yoke

The construction of a deflection yoke in accordance with the present invention commences with the forming of a series of coils with substantially rectangularly disposed flat sides and ends on each of a plurality of flexible dielectric sheets. Referring to FIG. 2 the dielectric sheet which may be, for example, of some flexible, thin plastic material such as vinylite or a phenolic Fiberglass, has formed thereon by a conventional printed-wiring process the series of coils 22a-22d, inclusive. The printing process may, for example, comprise etching the series of coils out of a thin copper plating, conventionally known as copper clad, which covers one side of the dielectric sheet. Alternately, the coils may be stamped or sprayed onto the dielectric sheet in copper, silver, or other conductive material by means of a conventional stamping or spraying process. The coils in each set of four have substantially equal dimensions and are formed in alternating patterns conventionally designated as right-hand and left-hand patterns. Succeeding sets of four coils have progressively larger size for each set in order that they may be folded as layers on prior sets. The coils 12a-12d, inclusive, are electrically connected in series in the manner

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represented by the dashed lines in FIG. 2 either by a separate wiring step or, preferably, by an additional printed-wiring step in which connecting conductors are formed on the reverse side of the dielectric material and connected to the printed coils on the obverse side by conductive eyelets. The coils are so wired that the current paths in the adjacent sides which are sparsely wired are in the same direction so as to provide aiding magnetic fields and those in the adjacent densely-wired sides are in opposite directions. This assists in providing the desired results of having the currents flowing in the sparsely-wired sides as series-aiding currents developing the desired magnetic fields while the return currents flowing in the densely-wired sides are opposing, resulting in the cancellation of any magnetic effects due to such currents.

A plurality of slits, for example the slits 20a-20d, inclusive, represented in FIG. 2 are cut or otherwise made in each of the sheets between adjacent sides of the coils on the sheets. The slits are parallel to the coil sides and have a depth at least equal to the widths of the end turns in the vicinity of the slits, for example, the slit 20a is slightly deeper than the widths of the end turns 15a and 15b. If desired, similar slits could be made on the opposite side of each sheet.

Referring now to FIG. 1, a sheet having at least one series of four coils, for example the coils 13a-13d, inclusive, is inserted along the inner walls of the hollow rectangular core 14 with adjacent coils on the sheet on adjacent walls of the core. The coil sides are positioned parallel to the axis of the core 14 and the slits 20a-20d, inclusive, extend from the front or beam-exit end of the core. If slits are made in the beam-entry end, then these will also extend beyond the back end of the core.

The set of coils so mounted on the core 14 provides one of the orthogonal deflection fields, for example, the vertical deflection field (horizontal flux). To develop the horizontal deflection field (vertical flux), continuing to refer to FIG. 1, the other set of coils 12a-12d, inclusive, printed on another of the dielectric sheets is inserted within the hollow interior of the core 14 in contact with the exposed surface of the previously inserted sheet on which the coils 13a-13d, inclusive, are printed. The sides of the coils 12a-12d, inclusive, are positioned parallel to the sides of the coils 13a-13d, inclusive, with the densely-wired sides of one set of coils adjacent the sparsely-wired sides of the other set. The slits in the second sheet of coils also extend from the beam-exit end of the core 14, and from the beam-entry end if slits are formed in that portion of the sheet, and are superimposed on the slits in the sheet first inserted in the core. The sheets on which such coils are mounted are secured in close contact with the inner wall of the core 14 by being taped in such position or by other conventional securing means and the slitted ends of the sets of coils are bent upward away from the axis of the deflection yoke and fixed in position around the periphery of the beam-exit end and, if slits are available, around the periphery of the beam-entry end of the core 14.

In a deflection yoke of the type just described, the conductors of the coils are constrained by the use of printed wiring to have fixed and consistent spatial relationships with respect to each other. As a result, uniform coils or coils with controlled nonuniformities utilized to correct, for example, the well-known pin-cushion or barrel distortions of defocussing are obtained. The magnetic fields developed by coils constructed in accordance with the procedure described above are exactly as desired and are consistently duplicated by different yokes of the same type. This results in a relatively inexpensive and light-weight yoke which provides improved quality of deflection and does not affect the focusing of the electron beam.

Though the construction of a yoke has been described in terms of the preparation of a simple type of deflection yoke in which no consideration has been given to con-

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trolled nonuniformities in the coil windings, it should be apparent to those skilled in the art that many of the coil winding practices conventionally employed to develop magnetic field patterns which provide improved uniformity of deflection or improved focusing may be employed in preparing the coils described herein. In fact, the employment of printed wiring for the coils facilitates grading the size of conductors so that conductor size may be varied in any desired manner for different coils or for different parts of the same coil. In addition, printed wiring simplifies controlling of the spacing of conductors in any desired pattern.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A cathode-ray tube deflection yoke comprising: a hollow yoke core; and a dielectric sheet bearing a conductor pattern which comprises a series of loop-type coils positioned side-by-side and electrically interconnected, this dielectric sheet being positioned around the inner wall of the core with one coil per layer of said sheet on each segment of the wall.

2. A cathode-ray tube deflection yoke comprising: a hollow yoke core; and a dielectric sheet bearing a conductor pattern which comprises a series of loop-type coils positioned side-by-side and electrically interconnected, this dielectric sheet being positioned around the inner wall of the core with one coil per layer of said sheet on each segment of the wall and with an end portion of each coil bent outwardly and away from the center axis of the core.

3. A cathode-ray tube deflection yoke comprising: a hollow yoke core; and a dielectric sheet bearing a conductor pattern which comprises a series of loop-type coils positioned side-by-side and electrically interconnected, this dielectric sheet being positioned around the inner wall of the core with one coil per layer of said sheet on each quadrant of the core wall.

4. A cathode-ray tube deflection yoke comprising: a hollow rectangular yoke core; and a dielectric sheet bearing a conductor pattern which comprises a series of loop-type coils positioned side-by-side and electrically interconnected, this dielectric sheet having orthogonal slits spaced along one edge thereof intermediate the coils and this dielectric sheet being positioned around the inner walls of the core with one coil per layer of said sheet on each of the four walls with the slitted end of each coil extending from one end of the core and bent outwardly and away from the center axis of the core.

5. A cathode-ray tube deflection yoke comprising: a hollow yoke core; and a dielectric sheet bearing a conductor pattern which comprises a series of loop-type coils positioned side-by-side in a row, this dielectric sheet having orthogonal slits spaced along one edge thereof intermediate the coils and this dielectric sheet being positioned around the inner walls of the core with one coil per layer of said sheet on each of four walls with the slitted end of each coil extending from one end of the core and bent outwardly and away from the center axis of the core, the conductor pattern also comprising conductors interconnecting successive coils so that for alternate boundaries between coils the current will flow axially of the core in the same direction in the two adjacent coil sides and for the intervening boundaries the current will flow in opposite directions in the two adjacent coil sides, the magnetic fields adjacent the latter boundaries tending to cancel each other.

6. A cathode-ray tube deflection yoke comprising: a hollow yoke core; and a dielectric sheet bearing a conductor pattern which comprises a series of loop-type coils

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positioned side-by-side in a row, this dielectric sheet having orthogonal slits spaced along one edge thereof intermediate the coils, each coil having two sides perpendicular to the slitted edge of the sheet with the conductors on one of these sides closely spaced to one another and the conductors on the other side more widely spaced from one another, adjacent sides of adjacent coils being of the same conductor spacing, this dielectric sheet being positioned around the inner walls of the core with one coil per layer of said sheet on each of four walls with the slitted end of each coil extending from one end of the core and bent outwardly and away from the center axis of the core, the conductor pattern also comprising conductors interconnecting successive coils so that current will flow axially of the core in the same direction in adjacent widely spaced conductor sides and in opposite directions in adjacent closely spaced conductor sides, the adjacent magnetic fields in the latter case tending to cancel each other.

7. A cathode-ray tube deflection yoke comprising: a hollow yoke core; a first set of deflection coils for developing a first deflection field and comprising a dielectric sheet bearing a conductor pattern which comprises a series of loop-type coils positioned side-by-side and electrically interconnected, this dielectric sheet being positioned around the inner wall of the core with one coil per layer of said sheet on each segment of the wall; and a second set of deflection coils for developing a second deflection field at right angles to the first field and comprising a second dielectric sheet bearing a conductor pattern which comprises a series of loop-type coils positioned side-by-side and electrically interconnected, this dielectric sheet being positioned around the inner wall of the core on top of the first dielectric sheet and with one coil per layer of said second sheet on each segment of the wall.

8. A cathode-ray tube deflection yoke comprising: a hollow rectangular yoke core; a first set of deflection coils for developing a first deflection field and comprising a dielectric sheet bearing a conductor pattern which comprises a series of loop-type coils positioned side-by-side and electrically interconnected, this dielectric sheet having orthogonal slits spaced along one edge thereof intermediate the coils, each coil having two sides perpendicular to the slitted edge of the sheet with the conductors on one of these sides closely spaced to one another and the conductors on the other side more widely spaced from one another, adjacent sides of adjacent coils being of the same conductor spacing, this dielectric sheet being positioned around the inner walls of the core with one coil per layer of said sheet on each of the four walls with the slitted end of each coil extending from one end of the core and bent outwardly and away from the center axis of the core; and a second set of deflection coils for developing a second deflection field at right angles to the first field and comprising a second dielectric sheet bearing a conductor pattern which comprises a series of loop-type coils positioned side-by-side and electrically interconnected, this dielectric sheet having orthogonal slits spaced along one edge thereof intermediate the coils, each coil having two sides perpendicular to the slitted edge of the sheet with the conductors on one of these sides closely spaced to one another and the conductors on the other side more widely spaced from one another, adjacent sides of adjacent coils being of the same conductor spacing, this dielectric sheet being positioned around the inner walls of the core on top of the first dielectric sheet and with one coil per layer of said second sheet on each of the four walls but in a reverse sense such that widely

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spaced conductor sides of the second sheet fall on top of closely spaced conductor sides of the first sheet and vice versa, the slitted end of each coil of the second sheet extending from the same end of the core as those of the first sheet and bent outwardly and away from the center axis of the core.

9. A printed circuit element for a cathode-ray tube deflection yoke, the element comprising: a sheet of dielectric material; and a conductor pattern affixed to the dielectric sheet and comprising a series of loop-type rectangular coils positioned side-by-side in a row and also comprising conductor means for interconnecting successive coils so that for alternate boundaries between coils the current will flow in the same direction in the two adjacent coil sides and for the intervening boundaries the current will flow in opposite directions in the two adjacent coil sides.

10. A printed circuit element for a cathode-ray tube deflection yoke, the element comprising: a sheet of dielectric material; a conductor pattern affixed to the dielectric sheet and comprising a series of loop-type rectangular coils positioned side-by-side in a row, each coil having two sides perpendicular to the direction of the row with the conductors on one of these sides closely spaced to one another and the conductors on the other side more widely spaced from one another, adjacent sides of adjacent coils being of the same conductor spacing, the conductor pattern also comprising conductors interconnecting successive coils so that current will flow in the same direction in adjacent widely spaced conductor sides and in opposite directions in adjacent closely spaced conductor sides.

11. A printed circuit element for a cathode-ray tube deflection yoke, the element comprising: a sheet of dielectric material having orthogonal slits spaced along one edge thereof; and a conductor pattern affixed to the dielectric sheet and comprising a series of loop-type rectangular coils positioned side-by-side in a row, each coil being positioned between an adjacent pair of slits and each coil having two sides perpendicular to the slitted edge of the sheet with the conductors on one of these sides closely spaced to one another and the conductors on the other side more widely spaced from one another, adjacent sides of adjacent coils being of the same conductor spacing, the conductor pattern also comprising conductors interconnecting successive coils so that current will flow in the same direction in adjacent widely spaced conductor sides and in opposite directions in adjacent closely spaced conductor sides.

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