

March 21, 1967

I. F. THOMPSON
DEFLECTION YOKE COIL

3,310,763

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2 Sheets-Sheet 1

Fig. 1.

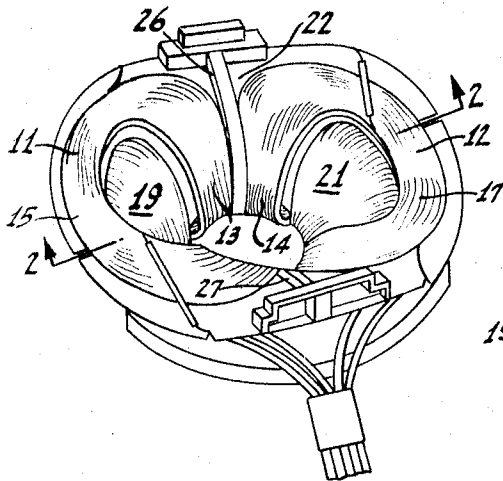


Fig. 3.

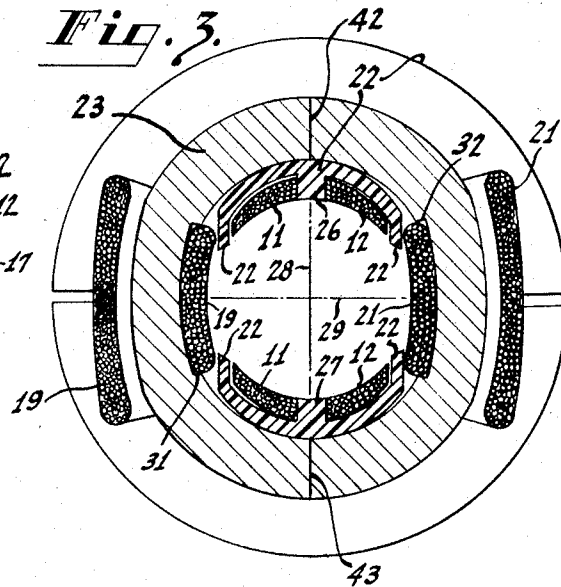
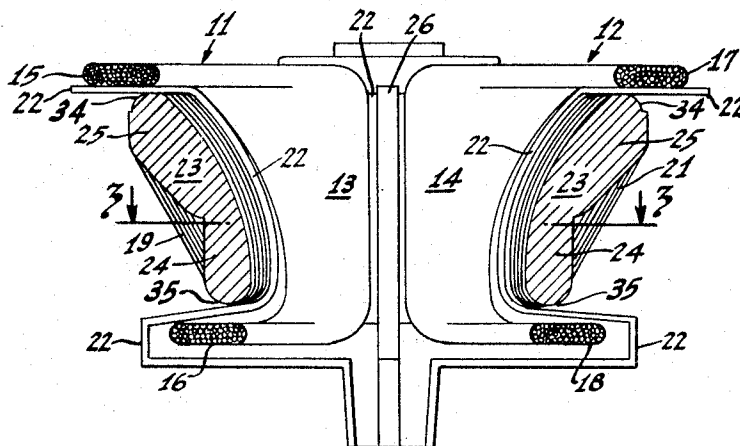


Fig. 2.



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Fig. 4.

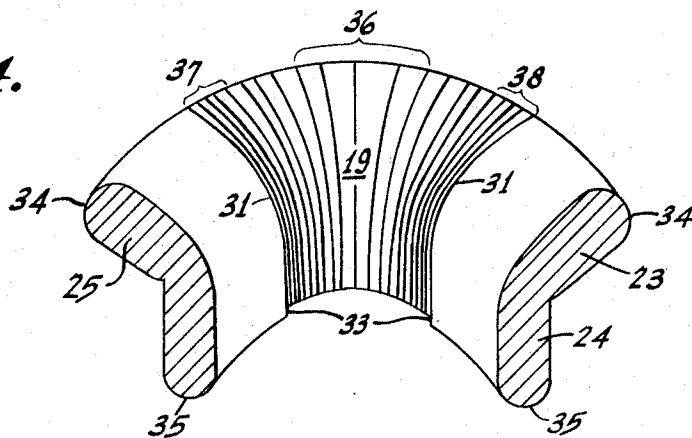


Fig. 5.

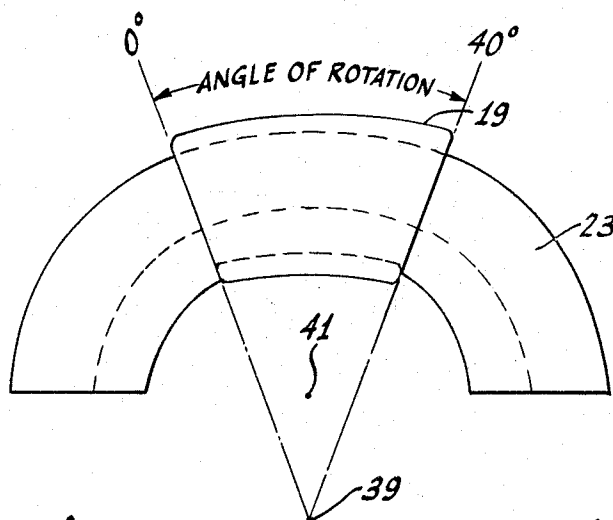
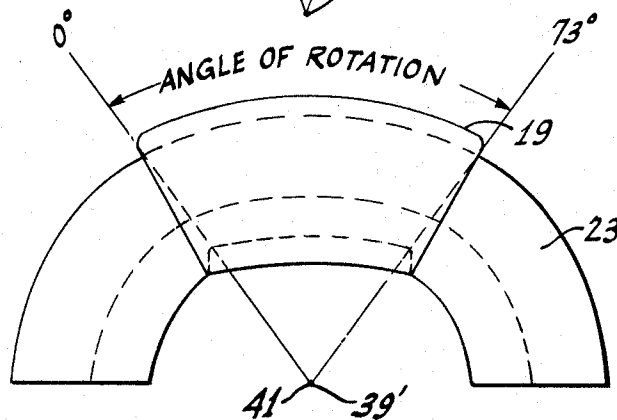


Fig. 6.



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DEFLECTION YOKE COIL

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This invention relates to the toroidally wound coils of an electromagnetic deflection yoke used for the deflection of an electron beam of a cathode ray tube.

It is customary to vary the turns distribution in deflection yoke coils in order to produce a desired flux pattern by which to deflect an electron beam and at the same time to maintain good beam focus and shape with a minimum or no raster distortion such as pincushioning or barreling. In order to achieve such objectives it has been proposed in the past to effect such turns distribution by winding toroidal coils in a plurality of layers in which there are different numbers of turns in the respective layers. In one such proposal the coils have more turns at their centers than at their edges. Another proposal which has been made is to provide a plurality of layers, each having the same number of turns but with the spacing between the turns varying so that the turns are closer at the center than at the edges of each layers. Both of such proposals, however, have been made for essentially round cylindrical ferromagnetic cores which have been used in deflection yokes for moderate deflection angles of the cathode ray beam. Neither of the two described techniques is effective with cores having both a straight and a flared section commonly used for relatively wide angle deflection of the electron beam. These proposed techniques also are not suitable for yoke cores having non-circular cross sections.

It is an object of the present invention, therefore, to provide a toroidally wound coil for ferromagnetic yokes suitable for wide angle beam deflection and particularly yokes with cores having both straight and flared sections and a generally oval cross sectional shape so as not only to effect relatively wide angle beam deflection but also to maintain good beam focus and shape with little or no raster distortion such as pincushioning.

According to the present invention toroidally wound coils are placed at opposite sides of a ferromagnetic core such as one having an oval cross section and a straight rear section joined to a flared forward section. Each of the coils has a plurality of layers of conductors and the same width, in which the spacing of the turns of each layer is a maximum at the center and gradually decreases to a minimum at the outer extremities of the layer.

For a better understanding of the invention reference now will be made to the following description which is taken in conjunction with the accompanying drawings, of which:

FIGURE 1 is a perspective view of the yoke embodying toroidally wound vertical deflection coils in accordance with the invention;

FIGURE 2 is a somewhat enlarged sectional view taken along the line 2-2 of FIGURE 1 showing the positioning of the saddle type horizontal coils and the toroidal type vertical coils relative to one another and to the ferromagnetic core which has a generally straight rear section joined to a flared front section;

FIGURE 3 is a somewhat enlarged sectional view taken generally along the line 3-3 of FIGURE 2 showing the relationship of the saddle type horizontal coils, the toroidal type vertical coils and their locations relative to the ferromagnetic core which has a generally oval shaped cross section;

FIGURE 4 is a perspective view of one half of the ferromagnetic core showing the placement thereon of a

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typical layer of a toroidally wound vertical coil and the turns distribution thereof according to the present invention, and;

FIGURES 5 and 6 are similar views of one half of the core looking generally at the front end thereof showing the positioning thereon of a completed toroidally wound vertical deflection coil and indicating two alternative centers and angles of rotation which have been used during the winding operation to produce two successfully used deflection yokes.

The general arrangement of a deflection yoke embodying the invention is shown in FIGURES 1, 2 and 3 in which corresponding parts are identified by the same reference characters. The yoke comprises a pair of saddle type horizontal coils 11 and 12 which have active conductors 13 and 14, respectively, and which extend generally longitudinally of the cathode ray tube (not shown) with which the yoke may be used. The active conductors 13 on opposite sides of the yoke of the coil 11 are joined at the forward or screen end of the yoke by end turns 15 and at the rear or electron gun end by end turns 16. Similarly the coil 12 is provided with forward end turns 17 and rear end turns 18.

A toroidal type vertical deflection coil 19 is disposed entirely within the window formed between the active conductors such as 13 of coil 11. Similarly, a toroidal vertical coil 21 is mounted in the window space between the active conductors 14 of the horizontal coil 12. An insulator 22 is placed on the undersides of the horizontal coils 11 and 12 so as to insulate these coils from a ferromagnetic core 23 which encircles the coils. The insulator 22, also, provides a small insulating barrier between the outer extremities of vertical coils 19 and 21 and the window edges of horizontal coils 11 and 12, respectively. The insulator, which comprises two identical halves for ease of assembly, additionally protectively envelopes the end turns 16 and 18 of the horizontal coils 11 and 12 as shown in FIGURE 2. The core 23, in a direction longitudinally of the yoke, has a rear straight portion 24 and a forward flared portion 25. This configuration corresponds generally to the overall shape of the deflection yoke so that the relatively straight portion encircles the tubular neck section of the cathode ray tube and the flared portion encircles the bulb section of the tube. The insulator 22 also has inwardly extending ribs 26 and 27 to separate the active conductors such as 13 and 14, respectively, of the horizontal coils 11 and 12 and to accurately position the coils in the yoke.

As may be seen more clearly in FIGURE 2, each of the toroidal coils such as 21 is made up of a number of turns of wire around the core 23. This figure also shows the physical relationship between the vertical deflection coil such as 21 and the horizontal coil such as 12.

FIGURE 3 shows the generally oval configuration of the core 23 in which are indicated the major axis 28 and minor axis 29. The active conductors of the horizontal coils 11 and 12 are disposed generally at the extremities of the major axis 28 of the core and the vertical coils 19 and 21 are located generally at the extremities of the minor axis 29 of the core. It will be understood that, with the illustrated conductor distribution of the horizontal coils 11 and 12 and the location of these coils at the extremities of the major axis 28 together with the disposition of the vertical coils 19 and 21 within the windows formed between the active conductors of the horizontal coils, the internal shape of the yoke is substantially circular so that it may fit snugly over the circular parts of the cathode ray tube with which it is to be used.

The core 23 is oval shaped as previously described having a major axis 28 and a minor axis 29. Slots 31 and 32 are provided internally of the core 23 at opposite

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ends of the minor axis 29. These slots extend generally from the large forward flared section 25 of the core 23 to the relatively small rear straight section 24 of the core (FIGURE 2). These slots have their maximum depth at the rear of the core and decrease in depth toward the front of the core finally merging with the front end. As indicated in FIGURE 4 each slot such as the slot 31, for example, terminates in a recess such as the recess 33, for example, formed in the end of the rear straight section 24. As may be seen, the slot 31 is wider at the front flared section 25 than at the rear straight section 24 of the core 23.

The purpose of the slots and recesses is to receive the toroidally wound vertical coils of the deflection yoke. By means of such features the toroidal coils may be placed on the core without any uneven building up of the coil at the rear end of the yoke. These features also enable the accurate positioning of the vertical coils relative to one another and to the horizontal coils and thereby minimize distortions such as trapezoidal misshaping of the raster scanned by the electron beam. Also, the recesses such as the recess 33 at the rear end of the straight section 24 of the core 23 enables the positioning of the conductors of the toroidal coils in such a way as to reduce the fringe field produced thereby at the back of the yoke and consequently minimize the amount of beam defocusing which otherwise might result.

The front and rear ends, respectively, of the core 23 are rounded as indicated at points 34 and 35 so that the toroidal vertical coils may be wound on the core at high speed under considerable tension without any insulation being provided between the wire and the core except for the enamel or other type of insulation provided on the wire itself.

As is the practice in placing toroidal windings on ferromagnetic cores, the core 23 is molded of suitable ferrite material in its final form such as shown in FIGURES 2 and 3. It is then broken into two pieces approximately along lines 36 and 37 corresponding generally with the major axis 28, after which each part is placed in a winding machine for the placement thereon of the two toroidal coils. It has been found that, with a core such as that described and embodying such features as the rounded front and rear ends indicated at points 34 and 35, the fabrication of such yokes may be materially facilitated without the provision of extra insulation, which previously has been found necessary, between the toroidal windings and the cores upon which they are wound. It is, however, advisable that the ferrite core be fabricated from the mixture which, after processing, has sufficient skin or surface resistance to provide the necessary electrical isolation of the vertical toroidal coils from the yoke without any additional insulation.

FIGURE 4 shows generally the type of turns distribution used in accordance with this invention for the fabrication of each of the toroidally wound vertical coils such as the coil 19, for example. In the central portion 36 of each layer of the coil the turns have maximum spacing. This spacing gradually decreases so that, at the outer extremities of each layer of the coil 19 such as in the regions 37 and 38, the turns have a minimum spacing therebetween. The relative spacing of the turns is the same at the rear end of the core as it is at the front end. It will be understood that the illustration in this figure is exaggerated for the purpose of more clearly illustrating the turns distribution in accordance with the invention. In one practical embodiment of the invention in a yoke produced for use in a commercial television receiver a toroidal winding such as the winding 19 comprises 9 layers of 62 turns per layer making a total of 558 turns per winding.

FIGURE 5 in conjunction with the following table indicates one manner in which such toroidal coils have been wound for use in a deflection yoke employed to deflect the electron beam through an angle of approximately

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114° in a 16" picture tube. Each half of the core 23 is placed in a machine fixture in such a manner that it may be rotated about a center 39 while a flyer feeding the wire revolves about the core. It will be noted that, in this mode of winding, the center of core rotation lies on the side of the longitudinal yoke axis 41 opposite to the position of the winding 19 relative to the axis 41. The rotation of the core about the center 39 occurs at a relatively slow varying rate from an angular position of 0° to an angular position of 40° at which point the core is returned to its starting position at a relatively rapid rate for the start of a succeeding layer of the winding. With the wire-feeding flyer revolving about the core at a constant rate, the desired turns distribution of the toroidal coil is obtained by varying the core rotation from a relatively slow rate at the 0° angular position to a gradually increasing rate at the 20° angular position, after which the core rotation rate is gradually decreased to the original rate at the 40° angular position. Another way of expressing the turns distribution of each layer of the winding is in terms of the number of winding turns per degree of core rotation. These values are given in the following table:

Table A

Angle of core rotation in degrees:	Number of turns per degree of rotation
0	2.00
2.5	2.00
5.0	1.80
7.5	1.61
10.0	1.43
12.5	1.28
15.0	1.16
17.5	1.12
20.0	1.11
22.5	1.12
25.0	1.16
27.5	1.28
30.0	1.43
32.5	1.61
35.0	1.80
37.5	2.00
40.0	2.00

In FIGURE 6 the winding 19 is formed on the core 23 by rotating the core about the center 39' which coincides with the longitudinal yoke axis 41. Such core rotation with a turns distribution in accordance with the following Table B has been used to produce deflection yokes by which to deflect electron beams through approximately 114° in both 16 inch and 19 inch picture tubes.

Table B

Angle of core rotation in degrees:	Number of turns per degree of rotation
0	1.002
4.56	1.002
9.12	.893
13.70	.794
18.25	.690
22.81	.614
27.38	.526
31.94	.521
36.50	.515
41.06	.521
45.62	.526
50.19	.614
54.75	.690
59.31	.794
63.88	.893
68.44	1.002
73.00	1.002

It has been found that, by use of the present invention

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in combination with a ferromagnetic core having a generally oval cross section with joining straight and flared sections in which the toroidally wound coils are placed in internal slots and rear recesses in the core, there is provided an electromagnetic deflection yoke which is capable of effecting relatively wide angle deflection of a cathode ray beam having good focus and shape without having to provide additional means such as permanent magnets for effecting any pincushion raster distortion caused by such coils. In such a yoke, where saddle type coils are used for horizontal beam deflection, it may be necessary in certain cases to employ such permanent magnet means for raster distortion correction at the sides of the picture. Material simplification of the yoke, however, is achieved by not having to provide such correction means for the top and bottom of the picture. This simplification results directly from the employment of toroidally wound vertical coils in accordance with the present invention.

What is claimed is:

1. In an electromagnetic beam deflection yoke:
a closed ferromagnetic core encircling said yoke; and
coils wound toroidally around said core at opposite sides thereof,
each of said coils having a plurality of layers each having the same width and the same number of turns, the spacing between turns of each layer being a maximum at the center and gradually decreasing to a minimum at the outer extremities of the layer.
2. In an electromagnetic beam deflection yoke:
a closed ferromagnetic core encircling said yoke and having a generally cylindrical rear section joined to a generally frusto-conical front section; and
coils wound toroidally around both cylindrical and frusto-conical sections of said core at opposite sides thereof,
each of said coils having a plurality of layers each having the same width and the same number of turns, the spacing between turns of each layer being a maximum at the center and gradually decreasing to a minimum at the outer extremities of the layer.
3. In an electromagnetic beam deflection yoke:
a ferromagnetic core having a generally cylindrical rear section joined to a generally frusto-conical front section,
transverse cross-sections of said core having an oval configuration with major and minor axes substantially at right angles to one another; and
coils wound toroidally around both cylindrical and frusto-conical sections of said core at the extremities of one of said axes,
each of said coils having a plurality of layers each having the same width and the same number of turns, the spacing between turns of each layer being a maximum at the center and gradually decreasing to a minimum at the outer extremities of the layer.
4. In an electromagnetic beam deflection yoke:
a ferromagnetic core having a generally cylindrical rear section joined to a generally frusto-conical front section,
transverse cross-sections of said core having an oval configuration with major and minor axes substantially at right angles to one another,
slots formed internally of said core and extending from the rear to the front of said core at the extremities of one of said axes; and

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coils wound toroidally around both cylindrical and frusto-conical sections of said core in said respective slots,
each of said coils having a plurality of layers each having the width of said slots and the same number of turns,
the spacing between turns of each layer being a maximum at the center and gradually decreasing to a minimum at the outer extremities of the layer.

5. In an electromagnetic beam deflection yoke:
a ferromagnetic core having a generally cylindrical rear section joined to a generally frusto-conical front section,
transverse cross-sections of said core having a generally oval configuration with major and minor axes substantially at right angles to one another,
slots formed internally of said core and extending from the rear to the front of said core at the extremities of one of said axes,
said slots being wider at the front than at the rear of said core; and
coils wound toroidally around both cylindrical and frusto-conical sections of said core in said respective slots,
each of said coils having a plurality of layers each having the width of said slots and the same number of turns,
the spacing between turns of each layer being a maximum at the center and gradually decreasing to a minimum at the outer extremities of the layer.

6. In an electromagnetic beam deflection yoke:
a ferromagnetic core having a generally cylindrical rear section joined to a generally frusto-conical front section,
transverse cross-sections of said core having a generally oval configuration with major and minor axes substantially at right angles to one another,
slots formed internally of said core and extending from the rear to the front of said core at the extremities of said minor axis,
said slots being wider at the front than at the rear of said core,
recesses formed in the rear end of said core in alignment with said slots; and
coils wound toroidally around both cylindrical and frusto-conical sections of said core in said respective slots and recesses,
each of said coils having a plurality of layers each having the width of said slots and recesses and the same number of turns,
the spacing between turns of each layer being a maximum at the center and gradually decreasing to a minimum at the outer extremities of the layer.

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