Jan. 7, 1964 A. E. ALLEN 3,117,258

TOROIDAL DEFLECTION YOKE WINDING

Filed Feb. 8, 1962 2 Sheets-Sheet 1

FIG. 1

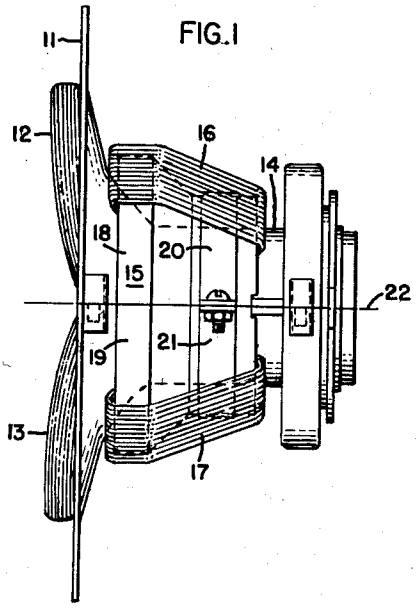
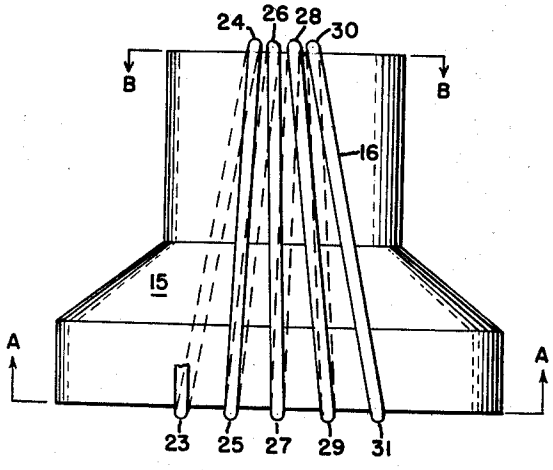


FIG. 2



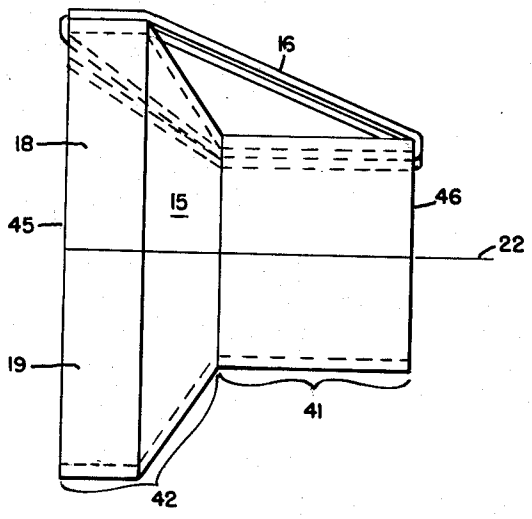
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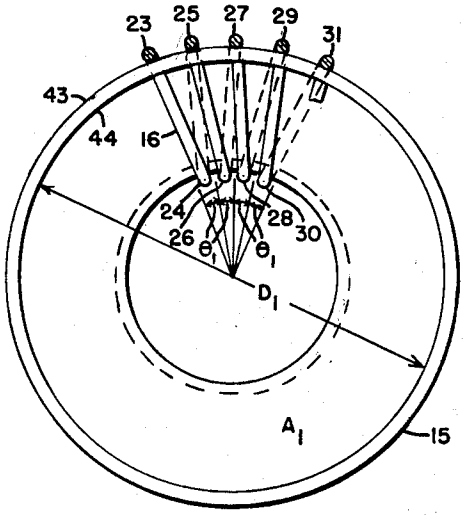
TOROIDAL DEFLECTION YOKE WINDING

Filed Feb. 8, 1962 2 Sheets-Sheet 2

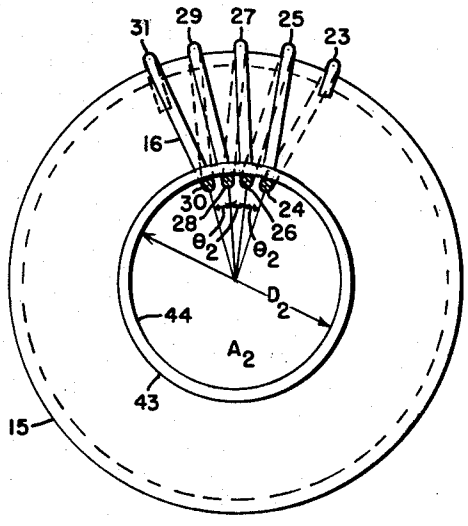
FIG.3



A-A
FIG.4



B-B
FIG.5



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TOROIDAL DEFLECTION YOKE WINDING

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5 Claims. (Cl. 317—200)

This invention relates to a deflection yoke for providing electromagnetic deflection of an electron beam in a cathode ray tube and more specifically to an improvement in a yoke having a toroidally wound deflection coil wound on a core of the yoke.

The advantages of providing a toroidally wound deflection coil on a core of a beam deflection yoke are well known in the art.

However, yokes having a deflection coil toroidally wound on conventionally shaped circular ring yoke cores of constant diameter are not fully compatible with cathode ray tubes having wide beam deflection angles. Specifically, for purposes of providing a large beam deflection angle and for attaining maximum beam deflection sensitivity, it is desirable to provide close physical proximity between the yoke and a bulbous portion of the cathode ray tube at a point where the bulbous portion flares out from the neck of the tube. The desired proximate arrangement requires, for best mechanical mating between the yoke and the tube, that an end portion of the yoke core which is positioned adjacent to the flare on the tube include a corresponding flare. Consequently, the core will generally have a larger cross sectional area at the flared end of its length than at an opposite end. Because of this difference in cross sectional areas and since each of the turns of wire of the deflection coil are conventionally wound radially on the core in a manner so that adjacent turns of the coil subtend equal azimuthal angles at opposite ends of the core, the adjacent turns of wire at the flared end of the core will be linearly spaced apart a relatively large distance in a lateral direction while the same adjacent turns of wire will be spaced relatively close together at an opposite end of the core.

This varied spacing arrangement of turns at opposite ends of the core results in a restriction on the amount of pincushion distortion correction which can be realized in a reproduced raster. The spaced apart turns at the flared end of the core do not provide as concentrated a deflection field as is desirable. On the other hand, while the closely grouped turns at the other end of the core will provide a degree of correction for pincushion distortion, the amount of correction will be limited by the physical arrangement of the yoke and the neck of the cathode ray tube. A space between the surface of the tube neck and an inner surface of a surrounding yoke core mounted thereon is limited and restricts the number of turns which can be utilized in a deflection coil. The aforementioned close grouping of turns in the deflection coil at one end of the core creates layers of turns within a relatively small arcuate area of the core and provides inefficient utilization of the aforementioned space to further restrict the number of turns of wire which can be employed in the coil.

In addition to this limitation on correction of pincushion distortion resulting from the restricted number of turns in the deflection coil, a further undesirable result is that a suitable magnetic deflection field can be provided only by coupling larger amounts of electrical power to the deflection coil than is ordinarily necessary when a larger number of turns are utilized in the coil. This results in an attending increase in the cost of associated deflection circuitry.

Accordingly, it is an object of this invention to provide a deflection yoke including a core having an improved toroidally wound deflection coil positioned thereupon.

Another object of this invention is to provide a yoke having an improved toroidally wound deflection coil which is particularly suitable for use with relatively wide angle deflection cathode ray tubes.

Another object of this invention is to increase pincushion distortion correction when utilizing a toroidally wound deflection coil on the core of a yoke.

A further object of this invention is to improve, for a given value of input power, the deflection sensitivity of a cathode ray tube which utilizes a yoke having a deflection coil toroidally wound on the yoke core.

In accordance with this invention, an electron beam deflection yoke is provided which includes a core of ferromagnetic material and a pair of deflection coils. The core comprise a body having inner and outer annular surfaces. The inner surface defines a cavity extending longitudinally through the core. The outer surface has different first and second linear perimetrical dimensions at opposite ends of the core. One of the deflection coils is toroidally wound on the core and each turn of the coil circumscribes the inner and outer surfaces and includes a segment extending through the cavity. An azimuthal angle between turns, which are wound successively in the general direction of coil winding advancement, at the end of the core having the smaller perimeter has a value less than an azimuthal angle between the same turns at the opposite end of the core.

Further objects, features and the attending advantages of this invention will be apparent with reference to the following specification and drawings in which:

FIGURE 1 is a side view of an assembled deflection yoke;

FIGURE 2 is a plan view of a core portion of the yoke, enlarged for clarity, having a portion of a deflection coil toroidally wound thereupon and illustrating a winding arrangement of this invention;

FIGURE 3 is a side view of the core of FIGURE 2;

FIGURE 4 is a view taken on line A—A of FIGURE 2, illustrating an azimuthal angle between turns at one end of the core, and

FIGURE 5 is a view taken on line B—B of FIGURE 2, illustrating an azimuthal angle between corresponding turns at another end of the core.

The yoke illustrated in FIGURE 1 includes a deflection coil support form **11**, a first deflection coil which may be the horizontal deflection coil of a television receiver, comprising a pair of diametrically opposed windings **12** and **13** partially positioned within a cavity of the form **11** and fixed in position by any suitable adhesive, not visible in FIGURE 1. The cavity of the form **11** is defined by a circular shaped neck portion **14** which is surrounded by core of ferromagnetic material **15**. A second deflection coil which may be the vertical deflection coil of a television receiver is provided and comprises a pair of diametrically opposed toroidal windings **16** and **17** wound about the core **15** in a manner hereinafter described. Suitable electrical energizing circuitry, not shown, may be coupled to the coils in order to provide electromagnetic fields for deflecting an electron beam in a cathode ray tube, not shown.

The core **15** is comprised of two semi-circular elements **18** and **19** which may be formed of a ferromagnetic material of a type suitable for application in television receiver yoke cores, whose composition, properties, and method of manufacture are well known in the art. The semi-circular core elements, **18** and **19**, are held together by any suitable means such as the semi-circular retaining bands **20** and **21** to form the composite core **15** which is symmetrical about a longitudinal axis **22**.

Referring now to FIGURES 2 through 5, and more particularly to the subject matter of the present invention, the subject core **15** is illustrated as having only a

portion of the winding 16 shown thereupon in order to clearly illustrate the features of this invention. Four turns of the toroidal deflection coil winding 16, exaggerated in size, are shown having positions on the winding designated by the numerals 23 through 31. For purposes of the accompanying discussion, the winding will be assumed to advance in a generally clockwise direction as viewed in FIGURE 4. The core 15 is circular and includes a neck portion indicated generally by numeral 41 and a flange portion indicated generally by numeral 42. The flanged portion 42 surrounds a corresponding flange portion on the coil form 11 of FIGURE 1 which correspondingly mates with a flange on the bulbous portion of a cathode ray tube upon which the yoke is mounted. Yoke 15 has an outer annular surface 43 and an inner annular surface 44 best seen in FIGURES 4 and 5, the inner surface defining a cavity extending longitudinally through the core. The cavity terminates in apertures 45 and 46 which exist at opposite ends of the core. Inner surface 44 has a diameter D_1 at aperture 45 and defines a circular cross section area A_1 at the aperture 45 in a plane perpendicular to the axis 22. At the opposite end of the core, the inner surface 44 has a diameter D_2 which is less than D_1 and defines a circular cross section area A_2 at the aperture 46 which is correspondingly less than the value of the cross sectional area A_1 at aperture 45. Since cross sectional area A_1 is greater than cross sectional area A_2, the perimetrical dimension or circumference at aperture 45 will be larger than a corresponding perimetrical dimension measured at aperture 46.

The enlarged portion of the winding 16 shown in FIGURES 2 through 5 includes four turns. A first of the four turns comprises that portion of the winding between positions 23 and 25 and includes a segment 23—24 extending through the aforementioned aperture for the length of the core. The first turn also includes a segment 24—25 laying on the outer surface 43 of the core 15 and the complete first turn including all portions of the wire between positions 23—25 circumscribes both inner and outer surfaces of the core. Three additional turns 25—27, 27—29 and 29—31 each circumscribe the inner and outer surfaces and include segments extending through the cavity for the length of the core.

In accordance with this invention, an azimuthal angle θ_1, which is measured at aperture 45 between a longitudinal axis of the wire of the winding 16 at corresponding segments of turns which are wound successively in the general direction of coil winding advancement, has a lesser value than a corresponding azimuthal angle θ_2, which is measured at aperture 46 between said longitudinal axis of said same segments of said same turns. The longitudinal axis of the wire is not shown but it will constitute the axis or center line of the wire regardless of the cross sectional area of the wire. The azimuthal angles θ_1 and θ_2 are illustrated in FIGURES 4 and 5 respectively.

As an illustrative example, θ_1 and θ_2 may be measured between segments of turns 23—25 and 25—27. The corresponding segments of the turns between which θ_1 is measured are segment 25—24 for turns 23—25 and segments 27—26 for turns 25—27. θ_1 is measured between the axis of the wire at a cross section of the segments at aperture 45 as illustrated in FIGURE 4 while θ_2 is measured between the axis of the same segments of wire at a cross section of the segments at aperture 46 as illustrated in FIGURE 5. θ_1 and θ_2 could also be measured between segments 23—24 and 25—26 of turns 23—25 and 25—27 respectively.

The above winding arrangement defined by the relation between the azimuthal angles at opposite extremes of the length of the core may be conveniently provided by winding the portions 16 and 17 of the deflection coil independently on their respective core elements 18 and 19 in a manner so that the winding is non-radial. That

is, the individual semi-circular core element 18 or 19 may be wound with turns of the deflection coil by rotating the element about an axis which is offset from the longitudinal axis 22. The offset would be in a direction measured away from the core element rather than toward the element. The windings 16 and 17 may be fabricated by then winding continuously along the core element until a desired number of turns is provided. If necessary, more than a single winding layer may be built up by the well known flyback method of winding or by other suitable methods of winding. It will, of course, be understood that the above described angles θ_1 and θ_2 would not be measured between turns when the winding progresses in the general direction of the coil winding advancement normally laid down and a flyback turn or other such turn on the winding which is not laid down when the winding progresses in the general direction of the coil winding advancement.

The above described arrangement of turns permits a reduced arcuate spacing between segments of the turns at aperture 45 over conventional toroidal windings having similar core configurations while increasing the arcuate spacing between the same segments of the turns at aperture 46. This results in improved pincushion distortion correction. The described winding arrangement also reduces the undesirable "bunching" of turns at one end of the core thereby allowing more turns to be laid down in the limited space hereinbefore referred to and consequently reducing the cost of accompanying yoke energizing circuitry.

While I have illustrated and described and pointed out in the annexed claims certain novel features of my invention, it will be understood that various omissions, substitutions, and changes in the forms and details of the apparatus illustrated may be made by those skilled in the art without departing from the spirit of the invention and the scope of the claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A deflection yoke for a cathode ray tube comprising: a core of ferromagnetic material having a length, an annular outer surface, an annular inner surface, said inner surface defining a cavity extending longitudinally through said core from a first aperture at one extreme of said length to a second aperture at another extreme of said length, a horizontal deflection coil and a vertical deflection coil, one of said deflection coils having a plurality of wire turns wound about said core, each of said wire turns circumscribing said inner and outer surfaces and having a segment extending through said cavity, said one deflection coil having turns of wire which are wound successively in the general direction of coil winding advancement separated by a first azimuthal angle θ_1 at said first aperture and separated by a corresponding second azimuthal angle θ_2 at said second aperture, said first and second azimuthal angles having the relation

$$\theta_2 > \theta_1$$

where θ_1 and θ_2 are measured in degrees.

2. A deflection yoke for a cathode ray tube comprising: a core of ferromagnetic material having a length, an annular outer surface, an annular inner surface, said inner surface defining a cavity extending longitudinally through said core from a first aperture having a cross sectional area A_1 at one extreme of said length to a second aperture having a cross sectional area A_2 at another extreme of said length, a horizontal deflection coil and a vertical deflection coil, one of said deflection coils having a plurality of wire turns wound about said core, each of said wire turns circumscribing said inner and outer surfaces and having a segment extending through said cavity, said one deflection coil having turns of wire which are wound successively in the general direction of coil winding advancement separated by a first azimuthal angle θ_1 at said first aperture and separated by a corre-

sponding second azimuthal angle θ_2 at said second aperture, said first and second cross sectional areas and said azimuthal angles having the relation

$$A_1 > A_2$$
$$\theta_2 > \theta_1$$

where A_1 and A_2 are measured in square inches and θ_1 and θ_2 are measured in degrees.

3. A deflection yoke for a cathode ray tube comprising: a core of ferromagnetic material having a length, a longitudinal axis, an outer annular surface, an inner annular surface, said inner surface defining a cavity extending longitudinally through said core from a first aperture at one extreme of said length to a second aperture at another extreme of said length, said outer surface having linear perimetrical dimensions p_1 and p_2 measured in a plane perpendicular to said axis at points along said surface corresponding to said first and second apertures respectively, a horizontal deflection coil and a vertical deflection coil, one of said deflection coils having a plurality of wire turns wound about said core, each of said wire turns circumscribing said inner and outer surfaces and having a segment extending through said cavity, said one deflection coil having turns of wire separated which are wound successively in the general direction of coil winding advancement by a first azimuthal angle θ_1 at said first aperture and separated by a corresponding second azimuthal angle θ_2 at said second aperture, said first and second perimetrical dimensions and said first and second azimuthal angles having the relation

$$p_1 > p_2$$
$$\theta_2 > \theta_1$$

where p_1 and p_2 are measured in inches and θ_1 and θ_2 are measured in degrees.

4. A deflection yoke for a cathode ray tube comprising: a core of ferromagnetic material having a length, an outer circular surface, an inner circular surface, said inner surface defining a cavity extending longitudinally through said core from a first aperture at one extreme of said length to a second aperture at another extreme of said length, said outer circular surface having diameters D_1 and D_2 at positions along the length of said core corresponding to said first and second apertures respectively, a horizontal deflection coil and a vertical deflection coil, one of said deflection coils having a plurality of wire turns wound about said core, each of said wire turns comprised of segments circumscribing said inner and outer surfaces and having a segment extending through said cavity, said one deflection coil having corresponding segments of turns of wire which are wound successively in the general direction of coil winding advancement separated by a first azimuthal angle θ_1 at said first aperture and separated by a corresponding second azimuthal angle θ_2 at said second aperture, said diameters D_1 and D_2 and said first and second azimuthal angles having the relation

$$D_1 > D_2$$
$$\theta_2 > \theta_1$$

where D_1 and D_2 are measured in inches and θ_1 and θ_2 are measured in degrees.

5. The apparatus of claim 4 wherein said one deflection coil having a plurality of wire turns consists of said vertical deflection coil.

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Disclaimer

3,117,258.—*Alford E. Allen*, Liverpool, N.Y. TOROIDAL DEFLECTION YOKE WINDING. Patent dated Jan. 7, 1964. Disclaimer filed Mar. 31, 1966, by the assignee, *General Electric Company*.

Hereby enters this disclaimer to claims 1–5 of said patent.

[*Official Gazette May 3, 1966.*]

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