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METHOD OF MANUFACTURING MAGNETIC DEFLECTION YOKES

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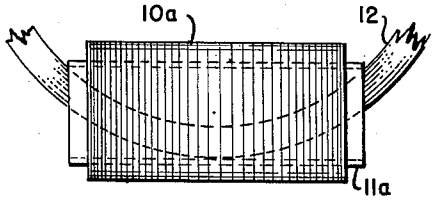



FIG.1

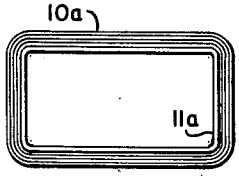



FIG.2

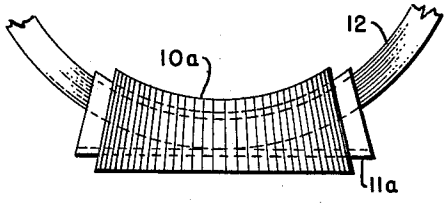



FIG.3

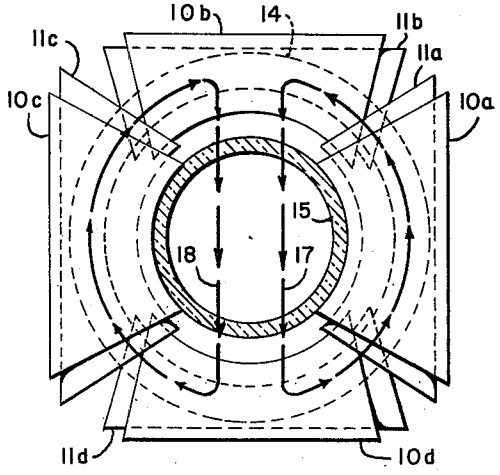



FIG.4

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# METHOD OF MANUFACTURING MAGNETIC DEFLECTION YOKES

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This invention relates to toroidal-type magnetic deflection yokes for cathode-ray tubes and to methods of manufacturing such deflection yokes.

Toroidal deflection yokes, that is, yokes comprising one or more coils the turns of which encircle a ferromagnetic core piece, have the desirable feature that the individual coils of such a yoke may, in general, be wound with a greater degree of precision than the corresponding coils for other types of deflection yokes, such as, for example, a saddle yoke. A high degree of precision in winding the yoke coils is especially desirable where it is desired that the coil turns should have a prescribed nonuniform distribution. Deflection yokes of increased precision are useful in critical radar and television application where the electron beam of a cathode-ray tube should traverse an accurately known raster pattern. A typical television application is for color-television picture tubes of the beam-indexing type.

In the past, toroidal deflection yokes have generally utilized a ferromagnetic core of rectangular shape. Where such rectangular cores are used the manufacture of the deflection yoke is rather straightforward and no undue difficulties are encountered. It is well known, however, that ferromagnetic cores having a circular ring shape are more efficient than corresponding rectangular cores of the same diameter, that is, less power is required to drive the deflection yoke where a circular ring core is utilized. Manufacturing a toroidal deflection yoke with a circular ring core presents considerable difficulty. One technique that has heretofore been utilized is to wind the individual yoke coils directly on the ring core. This, however, is difficult because of the curved nature of the ring core and consequently the precision of the resulting coils, that is, the accuracy of the spacing of the coil turns is generally less than is desirable.

Another method of obtaining a toroidal deflection yoke on a ring core is to break each yoke coil down into a number of narrow, lumped sections which may be prewound and then slipped over the ring core and interconnected to form a single coil. This method, however, is more time-consuming than is desirable, the resulting coil is not one smooth continuous coil, and it is more difficult to generate a uniform field with these lumped coil sections.

It is an object of the invention therefore to provide a new and improved method of manufacturing toroidal deflection yokes having a ring core which avoids the foregoing limitations of methods heretofore proposed.

It is another object of the invention to provide a new and improved method of manufacturing toroidal deflection yokes which enables high precision yoke windings to be placed on a circular ring core.

It is a further object of the invention to provide a new and improved toroidal deflection yoke of increased precision and efficiency.

In accordance with the invention, a method of manufacturing a deflection yoke for a cathode-ray tube comprises placing a cylindrical coil on an arcuate-shaped mandrel which resembles a portion of a ferromagnetic ring core so that the coil turns encircle the cross section of the arc. The method further includes deforming the coil in a direction normal to the cylindrical surface of the coil against the concave surface of the mandrel so that a portion thereof assumes the contour of the inner surface of



the ferromagnetic ring core. The method also includes placing the deformed coil on the ferromagnetic ring core so that the coil turns encircle the core with the deformed portion adjacent the inner surface thereof.

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 drawings, the scope of the invention being pointed out in the appended claims.

Referring to the drawings:

FIG. 1 shows a cylindrical coil formed in accordance with the present invention;

FIG. 2 is a side view of the cylindrical coil of FIG. 1;

FIG. 3 shows the coil of FIG. 1 after it has been deformed in accordance with the present invention, and

FIG. 4 is an end view of a complete deflection yoke including four yoke coils in accordance with FIG. 3.

Referring now to FIG. 1 of the drawings, there is shown a cylindrical coil 10*a* which consists of many turns of copper wire. The coil 10*a* may be formed on a suitable layer of backing material 11*a* which may be, for example, paper of a suitable thickness. FIG. 2 shows a side view of the cylindrical coil of FIG. 1 and indicates how it might be of rectangular cross section, the length of the longer dimension in FIG. 2 depending upon the corresponding dimension of the ferromagnetic ring core.

The coil 10*a* of FIG. 1 may be formed by any of the well-known methods for winding a cylindrical coil. For example, the paper former 11*a* might be mounted on a rotating spindle and the coil turns placed thereon by a suitable mechanism for feeding the wire thereto. Where desired, the coil 10*a* may include several layers of coil turns. Also, as indicated by the turns distribution of FIG. 1, it may be desirable that the coil turns be distributed in a nonuniform manner, such as that shown, where the turn density is greater at the ends of the coil. Such nonuniform turns distribution may be utilized to compensate or correct for any type of nonuniformity of the magnetic deflection field such as, for example, barrel or pin cushion distortion.

To form a deflection yoke in accordance with the present invention, the cylindrical coil 10*a* is placed over a mandrel or shaping tool 12 which is shaped to resemble a portion of a ferromagnetic ring core. In order to slip the cylindrical coil over the mandrel 12, it may be necessary that the diameter of the cylindrical coil 10*a* be somewhat oversized compared to the size it would have if wound directly on a piece of a ferromagnetic ring core. The amount of oversize required would, of course, depend on the span of the core which is to be covered by the coil. In this case, where a relatively large span of, say, 150° of the core is to be covered, it may be helpful to partially deform the cylindrical coil as it is slipped onto the mandrel 12. This may serve to reduce the amount of oversize required.

After the cylindrical coil 10*a* is placed over the mandrel 12, the coil 10*a* is deformed, as shown in FIG. 3, so that a portion thereof assumes the contour of the inner surface of the ferromagnetic ring core. More specifically, one side of the cylindrical coil 10*a* may be depressed by engagement of a suitably shaped forming tool (not shown) so as to cause this coil side to assume the curvature of the inner surface of the mandrel 12.

In order to form a complete deflection yoke, as shown in FIG. 4, four deformed cylindrical coils 10*a*–10*d*, inclusive, which have been deformed as shown in FIG. 3, are slipped over a ferromagnetic ring core 14 and positioned as indicated with the deformed portion adjacent the inner surface of the core 14. In order that the deformed coils may be placed on the ring core 14, it is necessary that the core 14 be made of, at least, two pieces or segments which may be separated. After the

coils 10*a*–10*d*, inclusive, have been placed on the core segments and the segments brought together, the core segments may be firmly joined, for example, by tightening a metal strap (not shown) about the exterior of the core 14. The coils 10*a*–10*d*, inclusive, may be permanently positioned relative to one another, for example, by utilizing suitable adhesive material for fastening each coil to the ring core 14. As indicated in FIG. 4, the coils may overlap one another to some extent in which case it is necessary that one set of coils may be of slightly larger diameter than the other.

Where desirable, instead of using a separate mandrel 12 for deforming the cylindrical coils, these coils may be deformed upon a portion of the actual ferromagnetic ring core to which they are to be permanently affixed in the assembled deflection yoke.

In operation, the deflection yoke shown in FIG. 4 is placed about the neck of a cathode-ray tube in a conventional manner. The cross section of the neck portion of such a cathode-ray tube is indicated by the structure 15 of FIG. 4. The pair of deflection coils 10*a* and 10*c* serve to deflect the electron beam of the cathode-ray tube 15 in a horizontal direction and, to this end, are effective to produce magnetic flux, as indicated by the corresponding flux lines 17 and 18 of FIG. 4. It will be noted, for example, that the flux line 17 produced by the coil 10*a* passes through the air gap corresponding to the neck of the cathode-ray tube 15 and then traverses the indicated flux return path through the ferromagnetic core 14. Because of the well-known right-angular relationship between flux direction and beam-deflection direction for magnetic fields, the magnetic fields represented by the flux lines 17 and 18 are effective to deflect the electron beam in a horizontal direction. In a corresponding manner, the other pair of coils 10*b* and 10*d* are effective to produce a horizontal magnetic field which, in turn, causes vertical deflection of the electron beam.

As mentioned, in many applications it is desirable that the turns distribution of the yoke coils be of a nonuniform nature in order to prevent nonuniformities in the magnetic deflection fields. In particular, where the deflection coils assume the contour of a circular ring core, it is desirable that the turns distribution of each coil follow a sinusoidal pattern with the turn density being greater at the ends of the coil. This type of distribution pattern serves to satisfy the requirement that for the coil 10*a*, for example, turns when projected on a vertical axis yield a uniform distribution. In this manner curvature of the coil is compensated so that an undistorted magnetic field is produced.

A feature of the present invention is that it combines two relatively simple steps to produce high precision deflection coils on a circular ring core. More specifically, a high precision coil is wound on a cylindrical form and the resulting cylindrical coil is deformed on one side to assume the contour of the ring core on which it is to be used, these steps yielding a relatively simple method of producing an efficient, high precision deflection yoke.

From the foregoing description of the invention, it will be apparent that a toroidal deflection yoke constructed in accordance therewith represents an improved toroidal deflection yoke of increased precision and efficiency, increased efficiency resulting from the use of a circular ring core and increased precision resulting from the inherent precision possible in winding a cylindrical coil.

While there has been described what is at present considered to be the preferred embodiment of this 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 method of manufacturing a deflection yoke for a cathode-ray tube, the method comprising: placing a cylindrical coil on an arcuate-shaped mandrel which resembles a portion of a ferromagnetic ring core so that the coil turns encircle the cross section of the arc; deforming the coil in a direction normal to the cylindrical surface of the coil against the concave surface of the mandrel so that a portion thereof assumes the contour of the inner surface of the ferromagnetic ring core; and placing the deformed coil on the ferromagnetic ring core so that the coil turns encircle the core with the deformed portion adjacent the inner surface thereof.

2. A method of manufacturing a deflection yoke for a cathode ray tube, the method comprising: winding a coil on a cylindrical form; placing the coil on an arcuate-shaped mandrel which resembles a portion of a ferromagnetic ring core so that the coil turns encircle the cross section of the arc; deforming the coil in a direction normal to the cylindrical surface of the coil against the concave surface of the mandrel so that a portion thereof assumes the contour of the inner surface of the ferromagnetic ring core; and placing the deformed coil on the ferromagnetic ring core so that the coil turns encircle the core with the deformed portion adjacent the inner surface thereof.

3. A method of manufacturing a deflection yoke for a cathode-ray tube, the method comprising: winding a coil on a cylindrical form with a winding pitch that varies so that the turns are distributed in a desired nonuniform manner; placing the coil on an arcuate-shaped mandrel which resembles a portion of a ferromagnetic ring core so that the coil turns encircle the cross section of the arc; deforming the coil in a direction normal to the cylindrical surface of the coil against the concave surface of the mandrel so that a portion thereof assumes the contour of the inner surface of the ferromagnetic ring core; and placing the deformed coil on the ferromagnetic ring core so that the coil turns encircle the core with the deformed portion adjacent the inner surface thereof.

4. A method of manufacturing a deflection yoke for a cathode-ray tube, the method comprising: placing a cylindrical coil on an arcuate-shaped mandrel which resembles a portion of a ferromagnetic ring core so that the coil turns encircle the cross section of the arc; deforming the coil in a direction normal to the cylindrical surface of the coil against the concave surface of the mandrel so that a portion thereof assumes the contour of the inner surface of the ferromagnetic ring core; repeating the preceding steps for each of a plurality of cylindrical coils; and placing a plurality of such deformed coils on the ferromagnetic ring core so that the coil turns encircle the core with the deformed portion of each coil adjacent the inner surface of the core.

5. A method of manufacturing a deflection yoke for a cathode-ray tube, the method comprising: placing a cylindrical coil on an arcuate-shaped portion of a ferromagnetic ring core so that the coil turns encircle the cross section of the arc; and deforming the portion of the coil that is on the inner side of the ring core against the core so that this coil portion assumes the contour of the inner surface of the ring core.

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