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FOUR IDENTICAL PRINTED COILS FOR HORIZONTAL AND VERTICAL DEFLECTION ON FLEXIBLE DIELECTRIC

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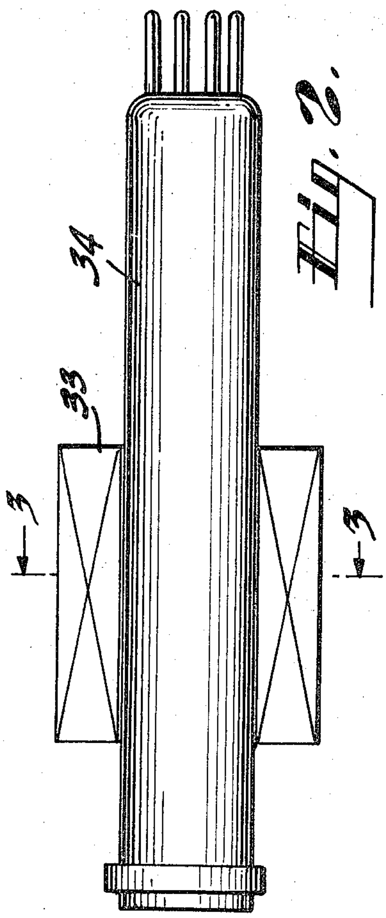

Fig. 2.

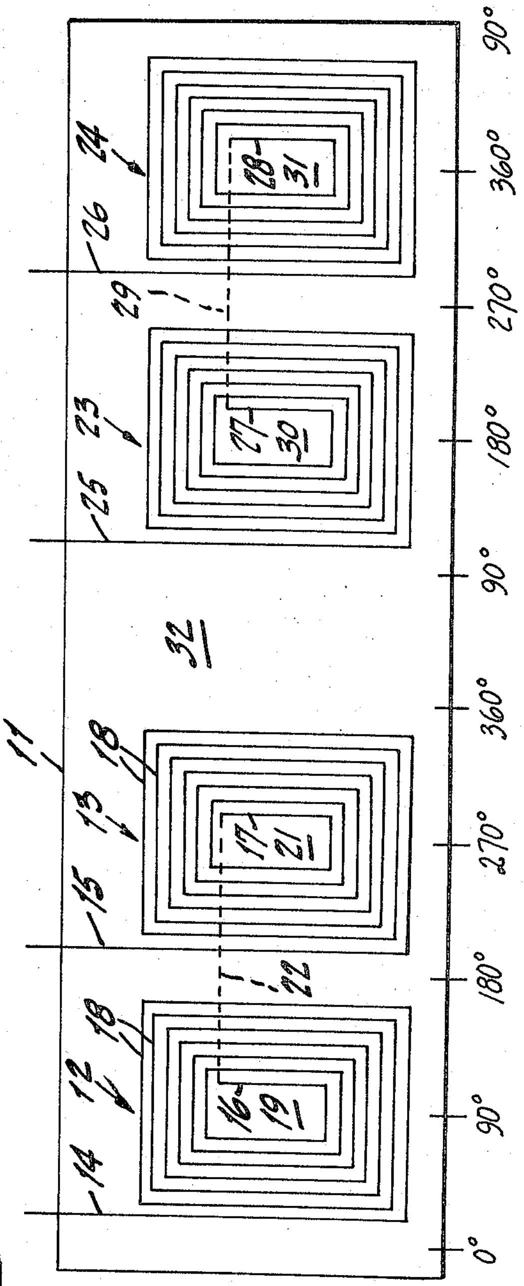

Fig. 1.

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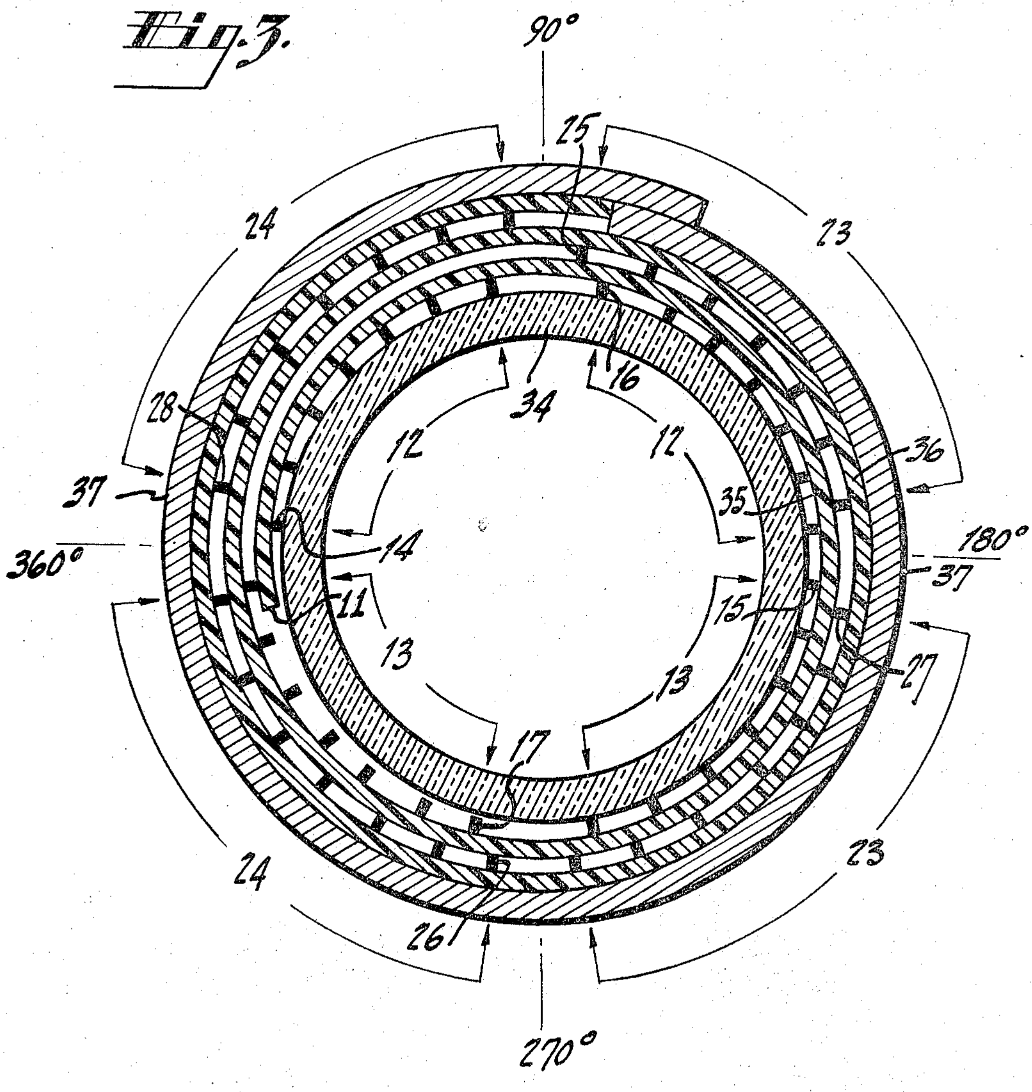
Fig. 3.



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FOUR IDENTICAL PRINTED COILS FOR HORIZONTAL AND VERTICAL DEFLECTION ON FLEXIBLE DIELECTRIC

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ABSTRACT OF THE DISCLOSURE

Four identical conductor coil patterns are printed in two pairs on a strip of flexible dielectric material which is rolled into a hollow cylinder having slightly more than two substantially concentric layers. The spacings of the coil patterns on the strip are such that the respective pairs of coils on the inner and outer layers are diametrically opposed to one another, and the coils of one pair are disposed 90° circumferentially to the coils of the other pair.

This invention relates to electron beam deflection yokes and particularly to such apparatus for use with television camera tubes.

Electromagnetic beam deflection yokes used with camera tubes in the past have numerous disadvantages. Wire wound yokes are bulky, have considerable weight, require substantial driving power, generate heat and are difficult to fabricate with sufficient precision to effect undistorted scansion of the target electrode. This last disadvantage has been largely overcome by using preformed coils printed on dielectric supports. The complete yoke is obtained by stacking a number of such coils on one another and electrically connecting them together, either in series or parallel. Such arrangements, however, do not overcome the other disadvantages.

Also, it has been the practice to provide such wire wound and stacked printed coil yokes with a magnetic return path by placing magnetic material on the outside of the yoke. It has been found, however, that the deflection efficiency is increased by a maximum of 25% and at the cost of added weight and bulk and a decrease in the ability to dissipate heat.

It is an object of the present invention, therefore, to provide a small, light weight, low impedance and efficient deflection yoke for a television camera tube.

In accordance with the invention, the yoke comprises a hollow cylindrical support consisting of only two substantially concentric layers of dielectric material, on each of which is formed a pair of substantially identical conductor patterns. The two patterns of each pair are disposed diametrically opposite to one another and the two pairs of patterns are mutually displaced by 90° circumferentially. A thin layer of magnetic material is placed around the outside of the two dielectric layers.

According to a particular feature of the invention, both pairs of conductor patterns are placed on a single continuous strip of dielectric material. The identical conductor patterns are spaced linearly on the strip so that, when at least two convolutions of the strip form the cylindrical support, the conductor patterns have the proper positional relationship to one another.

For a further disclosure of the invention, reference may be made to the following description which is given in connection with the accompanying drawings, of which:

FIGURE 1 is a developed view of one form of a deflection yoke embodying the invention;

FIGURE 2 is a view of a television pickup tube provided with a deflection yoke, embodying the invention, shown in section with the thickness of the yoke grossly exaggerated; and

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FIGURE 3 is an enlarged sectional view taken on the line 3—3 of FIGURE 2 and showing the novel constructional features of a deflection yoke in accordance with the invention.

FIGURE 1 shows the basic components of the deflection yoke in a developed form which is that in which the device is fabricated. A support 11 for the deflection coil components of the yoke comprises a thin strip of flexible dielectric material. A pair of identical conductor patterns 12 and 13 are produced side by side adjacent one end of the dielectric strip 11. The patterns 12 and 13 comprise starting conductors 14 and 15, respectively, and finishing conductors 16 and 17, respectively. Each of the patterns, such as the pattern 12, consists of a series of rectangular turns or loops 18 formed of a good electrical conductor, such as copper, on the dielectric strip 11 by any well known process for fabricating so called "printed circuits." The loops 18 decrease in size from the starting conductor 14 to the finishing conductor 16. The conductor patterns 12 and 13 which, for example, may comprise the horizontal deflection winding of the yoke are spaced apart on the dielectric strip 11 so that, when the strip is formed into a hollow cylinder having a diameter substantially equal to the outside diameter of the camera tube, the two conductor patterns 12 and 13 will be located diametrically opposite to one another. Such an arrangement is demonstrated in FIGURE 1 by a scale of circular degrees wherein the window portions 19 and 21 of the conductor patterns 12 and 13, respectively, are indicated as located respectively at 90° and 270°. The two conductor patterns 12 and 13 are energized by connecting a suitable source of deflection energy to the respective starting conductors 14 and 15, the circuit being completed by electrically connecting the finishing conductors 16 and 17 by means of a conductor 22.

In a presently preferred form of the invention, a second pair of conductor patterns 23 and 24 is formed on the same dielectric strip 11 adjacent the end thereof remote from the end supporting the conductor patterns 12 and 13. The second pair of conductor patterns 23 and 24 are identical to one another and to the first pair of conductor patterns 12 and 13. The patterns 23 and 24 also have starting conductors 25 and 26, respectively, and finishing conductors 27 and 28, respectively, the latter of which are electrically inter-connected by a conductor 29. The second pair of conductor patterns 23 and 24 also are spaced from one another such that the respective windows 30 and 31 thereof, are located at 180° and 360° points of the cylindrical support formed by rolling the dielectric strip 11 upon itself. Thus, the two patterns 23 and 24 may comprise the vertical deflection winding of the yoke, the two parts of which are located diametrically opposite to one another in the completed yoke. It will be noted that the second conductor pattern 23 is separated from the first conductor pattern 13 by a section 32 of the dielectric strip 11 which has a width such that the respective windows 30 and 21 are located at 180° and 270° points on the cylindrical support. Also, by reason of the described angular location of the conductor patterns 12 and 24 relative to their mates 13 and 23, respectively, the patterns 12 and 24 are located, respectively, at angular positions 90° and 360°. In other words, the pair of conductor patterns 23 and 24 are disposed 90° circumferentially relative to the pair of conductor patterns 12 and 13.

As previously explained, the dielectric strip 11 of FIGURE 1 is rolled upon itself to form a hollow cylindrical support for the deflection yoke 33 of FIGURE 2 which is mounted on a television camera tube such as a photoconductive type, one form of which is a vidicon 34. As may also be seen in FIGURE 3, the yoke proper comprises slightly more than two substantially concentric layers of dielectric material. The inner layer 35 supports the first pair of conductor patterns 12 and 13 comprising the horizontal deflection winding. A second layer 36, formed from the dielectric strip 11 of FIGURE 1 is substantially concentric with the inner layer 35 and supports the second pair of conductor patterns 23 and 24 comprising the vertical deflection winding. Alternatively, each pair of conductor patterns may be formed on separate strips of dielectric material, in which case the two strips are assembled into the completed yoke with the two pairs of conductor patterns having the required 90° circumferential relationship to one another. It will be understood that the thickness of the two concentric layers 35 and 36 and of the representative conductors 14, 15, 16, 17, 25, 26, 27 and 28 of the patterns 12, 13, 23, 24 are shown in grossly exaggerated form for clarity and, in actuality, are much thinner and are not spaced from one another as illustrated in FIGURE 2. The yoke 33 also includes a thin layer 37 of magnetic material which is placed on the outside of the outer layer 36 of the dielectric material. The magnetic material may be in tape form wound about the cylindrical yoke and secured thereon by such means as pressure-sensitive adhesive tape, for example. This layer of magnetic material provides a return path for the flux produced by the yoke, thereby effectively halving the total length of the magnetic path. Thus, the deflection sensitivity is at least doubled.

In one practical form of yoke embodying the invention for use with a 1" vidicon, the overall dimensions of the yoke were approximately 3" in length and about 1$\frac{1}{10}$" in outside diameter. Each of the conductor patterns 12, 13, 23 and 24 had a total number of about 40 turns or loops. Each pair of conductor patterns had a resistance of about 12.0 ohms and an inductance of about 175 microhenries. In operation, the series connected conductor patterns 12 and 13 comprising the horizontal deflection winding were driven by a substantially sawtooth current having a peak-to-peak amplitude of approximately 130 milliamperes. The series connected conductor patterns 23 and 24 comprising the vertical deflection windings were driven with a substantially sawtooth current having a peak-to-peak value of 100 milliamperes. It will be observed that the required 4:3 aspect ratio of the scanned area of the target electrode of the vidicon 34, for example, is achieved by driving the identical conductor patterns with currents of appropriately different magnitudes.

FIGURE 3 illustrates to a greatly enlarged scale the relationship between the two convolutions of the dielectric strip and the relative positioning of the conductor patterns 12, 13, 23 and 24 to one another. For convenience of reference the angular positions of the various components are indicated so that a ready comparison may be made with the development layout of the apparatus as shown in FIGURE 1.

It will be appreciated that other than the illustratively disclosed embodiment of the invention may be made without departing from the principle of the invention. For example, the dielectric strip supporting the two pairs of conductor patterns may be permanently attached to the camera tube as by potting. Alternatively, the conductor patterns may be printed directly on the glass envelope of the tube—one pair of patterns being applied on the inside and the other pair on the outside of the envelope.

A deflection yoke embodying the present invention is small, compact, light weight, simple and, hence, can be fabricated at a low cost. Such a yoke has relatively low resistance and low inductance and, thus, can be operated efficiently at low voltages and high currents, compatible with transistor circuits. Power required to operate this

yoke, including circuit losses, is only approximately ½ watt. Thus, transistor circuits may readily be used to drive such a device. The yoke may be used with, not only vidicons and other photoconductive types of camera tubes, but also with such tubes as image orthicons. Any camera tube with which the yoke may be used may also employ either magnetic or electrostatic beam focussing apparatus.

What is claimed is:

1. A deflection yoke for an electron beam of a television camera tube, comprising:
   - a dielectric support formed into a generally cylindrical configuration having first and second substantially concentric surface areas;
   - a pair of electrically continuous substantially identical conductor patterns formed side-by-side on each of said dielectric support surface areas;
   - each of said patterns having a starting conductor and a finishing conductor and consisting of a series of substantially rectangular loops of decreasing dimensions from said starting to said finishing conductors with said finishing conductors of each pair of patterns being electrically interconnected;
   - the two conductor patterns of each pair being disposed diametrically opposite to one another and one pair of said conductor patterns being disposed 90° circumferentially relative to the other pair; and
   - a layer of magnetic material around the outside of said cylindrical support.
2. A deflection yoke as defined in claim 1, wherein:
   - a first pair of said conductor patterns formed on the inner one of said two concentric dielectric support surface areas is positioned relative to said tube to effect horizontal deflection of said electron beam; and
   - a second pair of said conductor patterns formed on the outer one of said two concentric dielectric support surface areas is positioned relative to said tube to effect vertical deflection of said electron beam.
3. A deflection yoke as defined in claim 2, wherein:
   - said support comprises flexible dielectric material formed into a cylindrical configuration.
4. A deflection yoke as defined in claim 3, wherein:
   - both of each pair of said conductor patterns are formed on a single continuous strip of said flexible dielectric material;
   - one convolution of said strip forming one of said concentric support surface areas, and
   - said conductor patterns being spaced from one another linearly of said strip so as to effect said diametrically opposite disposition of said conductor patterns.
5. A deflection yoke as defined in claim 4, wherein:
   - both pairs of said conductor patterns are formed on a single continuous strip of said flexible dielectric material;
   - at least two convolutions of said strips respectively forming said two concentric support surface areas;
   - said pairs of conductor patterns being spaced from one another linearly of said strip so as to effect said 90° circumferential mutual displacement of said conductor pattern pairs.

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