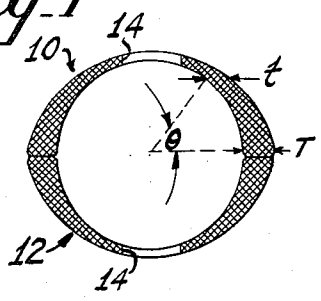
July 16, 1957 J. K. KRATZ ET AL 2,799,798

DEFLECTION YOKES

Filed May 29, 1953

Fig_1



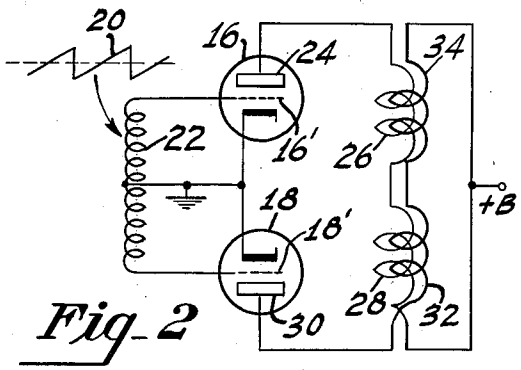


Fig_2

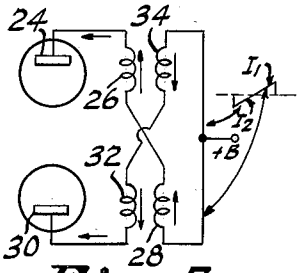


Fig_3

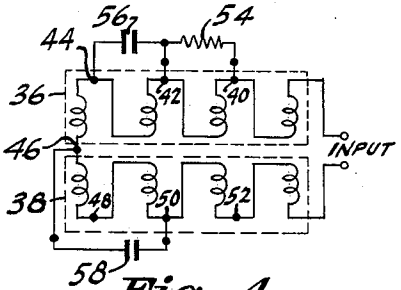


Fig_4

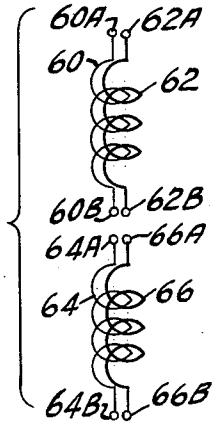


Fig_5

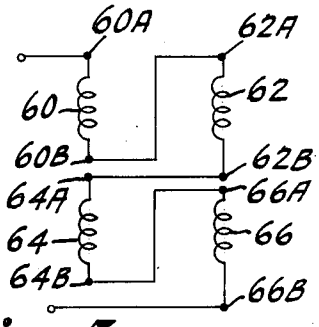


Fig_5a

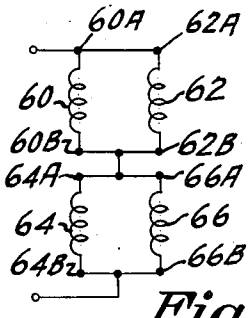


Fig_5b

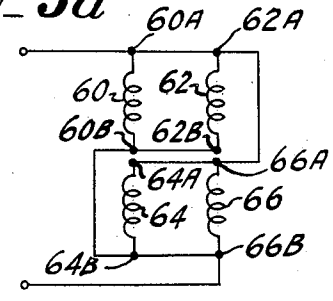


Fig_5c

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DEFLECTION YOKES

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5 Claims. (Cl. 315—27)

The present invention relates to new and improved electromagnetic deflection yokes of the type employed in conjunction with cathode ray tubes such as kinescopes and the like.

More specifically, the invention relates to the winding of coils in a manner which renders possible the attainment of effects heretofore considered beyond the realm of practicability in the deflection art. As persons skilled in that field will appreciate, certain problems common in electromagnetic deflection have included, in addition to the physical difficulties of forming uniform coils, the matters of efficiency, impedance matching and damping. For example, conventional yoke design in recent years has almost universally required "distributed" type windings in which the cross-section of the "active" turns is not constant. Ordinary single conductor windings of a given wire size often do not fit within the relatively small space allotted to the coils and, if such wire is to be accommodated, the coil section is necessarily enlarged, with the resultant loss of deflection efficiency.

It is, therefore, a principal object of the present invention to provide a novel deflection coil which presents a ready solution to the above-described problems.

Another object is that of providing such a deflection coil which, while effective in the manner set forth, is inexpensive and rugged and quite versatile in its practical uses.

In general, the present invention contemplates the formation of a deflection yoke in which one or more of the coils is formed of a plurality of individually insulated strands wound independently and concurrently, in physical parallelism or multi-filar relation. In accordance with the invention, the production of distributed type windings is facilitated by reason of the smaller size wire which may be used, so that there may be imparted to the coils any desired cross-sectional variations. In addition, the smaller wire size substantially reduces deflection losses which ordinarily result from eddy currents in conventional yokes.

One specific arrangement embodying the principles of the invention affords a convenient mode of push-pull operation for deflection, something which has been extremely difficult, if not impossible, of accomplishment in conventional yokes.

Thus, it is a further object of the invention to provide a deflection winding and energization means therefor in the form of a push-pull driving circuit, the combination of which produces linear deflection.

Another serious handicap in cathode ray tube deflection has been that of damping the ringing produced in the coils by the collapse of flux during retrace. This question, while a source of some consternation in monochrome television receivers, is even more vexatious in color television, since the ringing causes color errors to be introduced into the reproduced image.

Hence, a still further object is the provision of means for permitting increased damping in deflection coils, this aim being realized through the use of coils comprising a

plurality of simultaneously wound conductor strands interconnected to furnish a multiplicity of convenient external taps.

Insofar as "impedance matching" is concerned, the present invention permits, by reason of the plurality of strands in each coil, cross-connecting of the several strands in a variety of ways, whereby a great number of different impedances may be effected.

Additional objects and advantages of the invention will become apparent to persons skilled in the art from a study of the following detailed description of the accompanying drawing, in which:

Fig. 1 is a cross-sectional view of a deflection winding, illustrative of one form of conventional coil design to which the present invention lends itself with facility;

Fig. 2 is a schematic diagram of a deflection circuit according to one form of the invention;

Fig. 3 illustrates the coils of Fig. 2 in an extended form for ease of understanding the same;

Fig. 4 shows a pair of coils according to another form of the invention in which taps are provided for damping means;

Fig. 5 is illustrative of still another form of the invention; and

Figs. 5*a*, 5*b* and 5*c* show three different modes of connecting the conductor strands of Fig. 5.

Referring to the drawings and, more particularly, to Fig. 1 thereof, there is shown a vertical, cross-sectional view of a pair of deflection coils **10**, **12** which may, for example, constitute the horizontal winding of a television receiver deflection yoke (although the principles of the invention are equally applicable to vertical windings). As has been stated, conventional deflection technique often requires "distributed" type windings in which the cross-sectional thickness varies as a trigonometric function. Thus, by way of illustration, the coils of Fig. 1 are of the "cosine" type, in which the thickness of each of the coils varies in accordance with the cosine of the angle subtended by the distance from the widest point "T" to the point in question, whose thickness "*t*" is defined as

$$t = T \cos \theta$$

It will further be noted from Fig. 1 that each of the coils **10** and **12** has a central opening or "window" **14** toward which the thickness of the coil decreases. This window is defined by bundles of side and end turns of the coils. In typical yokes of this type, it has been found that wire sizes larger than No. 26 or No. 27, for example, will not fit into the relatively small space allotted to the winding, the effect of which is that, for a given mechanical design, the lowest value of inductance or resistance which may be realized is that which is rigidly determined by the values for the largest wire which does fit in the space. Thus, if it is required for operational characteristics that lower values be had, it is necessary with conventional windings to revise the yoke's mechanical design, thereby resulting in a coil of thicker section which, of course, increases the internal diameter of the magnetic core, such that the deflection efficiency of the completed yoke is appreciably diminished.

In accordance with a principle of the present invention, however, each of the coils **10** and **12** is formed of a plurality of conductors or strands of substantially smaller diameter, which strands are wound simultaneously or concurrently such that they are substantially contiguous and parallel along their length to produce a multi-filar coil. By reason of the smaller size of the individual strands which may be employed, the resultant coil quite readily lends itself to being "shaped" in any desired manner, such as the "cosine" form of Fig. 1. Adjacent ends of the strands may be connected so that the several

strands are electrically in parallel or, as will appear more fully hereinafter, they may be connected in any other desired manner, depending upon the required impedance of the coil and other considerations. Regardless of the specific mode of connection resulted to in a particular case, it will be appreciated by those skilled in the art that the coil fashioned of a plurality of strands may be shaped in a distributed manner with far more facility than has been possible with single-wire coils. Moreover the multi-filar coil, of the present invention, because of the smaller size strands of wire which may be employed, is more efficient in that it is not as subject to the loss of power through eddy currents in the case of high frequency deflection currents, a feature in which the coils of the prior art have long been deficient. Also of extreme importance is the fact that the manufacture of deflection coils involves a complicated winding operation, requiring that a great number of bends of various angles be imparted to the conductors. In cases such as color television deflection yokes and radar applications where precise deflection is essential, multi-filar coils provide substantially improved uniformity, since the smaller wire size afforded conforms more readily to the desired curvatures. Further, the above advantages of the invention are realized without loss of deflection efficiency, and, in fact, are coupled in many instances with increased deflection efficiency in a yoke of predetermined mechanical size.

In accordance with another aspect of the invention, as illustrated in Figs. 2 and 3, it will be seen that the use of multistrand deflection coils makes possible push-pull operation, which has many known advantages including the facility of adding D. C. centering currents and the ease of low frequency or D. C. deflection. These advantages, unfortunately, have not been available to the art heretofore, since, although conventional single-conductor coils might at first have seemed suited to push-pull driving, it has been found that such coils provide poor coupling between the two sections of a horizontal winding, for example, which results in severe distortion of the flux field produced by them if the currents in the two sections are not exactly equal. Hence, push-pull drive of conventional, single conductor coils has been impracticable because the deflection resulting from its use has been severely distorted. The circuit of Fig. 2, therefore, includes a pair of electron tubes **16** and **18** whose control electrodes **16'** and **18'**, respectively, are supplied with opposite phases of a sawtooth voltage such as that indicated by waveform **20** by means of transformer winding **22** which is center-tapped to ground in a conventional manner. The mode of controlling electrodes **16'** and **18'** does not constitute a part of the invention but is shown as one way of accomplishing such end. Anode **24** of tube **16** is connected to a source of positive potential B+ through conductors **26** and **28**, while anode **30** of tube **18** is connected to the same B+ terminal through conductors **32** and **34**. The relation of the simultaneously wound coils of Fig. 2 are more readily apparent from the extended view of Fig. 3 which further indicates, by means of the arrows, the direction of direct current flow through the several conductors **26, 28** and **32, 34**.

From the foregoing, those skilled in the art will understand that, in the operation of the circuit of Figs. 2 and 3, tube **16** conducts through conductors **28** and **26** and most heavily during that portion of the deflection cycle, for example, when the cathode ray beam (not shown) is deflected to one side of center, so that tube **16** contributes mainly the I_1 portion of the net deflection field. Tube **18** conducts through conductors **34** and **32** and most heavily during the other portion of the cycle, contributing mainly to the field portion I_2 to deflect the beam to the other side of center. It has, moreover, been found that, whereas ordinary, single-conductor coils driven in push-pull do not produce linear deflection fields, an arrangement such as

that of Fig. 2 employing two strands physically in parallel does effect satisfactory deflection with the additional advantages of push-pull driving.

As set forth briefly supra, a salient problem in deflection is that of damping "ringing" or oscillations which affect linearity deleteriously, and especially in color television work where improper scanning results in color errors by reason of the scanning beam or beams striking the wrong color phosphors, for example. So acute is the effect of ringing, even in monochrome television, that it has long been common practice to provide a damper tube across the deflection coils of a winding, which affords a low impedance path for the unwanted oscillations and further attempts have included the addition of a capacitor and/or resistor across one or both of the coils of a winding. Since the theoretical considerations on which these techniques are based are not a part of this invention, it is unnecessary to discuss the same here, beyond recognizing the fact of their value. In the case of conventional coils, the number of damping elements which may be employed in a given yoke is limited by the number of points which may be tapped for the purpose of making connections to such elements. Thus, in a horizontal coil pair, only three taps may be made, namely, at the two ends and in the center. Where special applications, such as color television, require additional damping, the present invention may be advantageously utilized as shown in Fig. 4, which illustrates a horizontal deflection winding made up of coils **36** and **38**. Each coil is shown as comprising four simultaneously wound conductor strands, connected in series. By virtue of the multi-filar structure, it should be apparent that there is available a plurality of taps indicated by reference numerals **40, 42, 44, 46, 48, 50** and **52**.

The coil pair of Fig. 4 affords, therefore, an excellent arrangement for connecting damping elements in a multitude of variegated forms. For example, a resistor **54** might be connected between taps **40** and **42**, a capacitor **56** between taps **42** and **44**, a capacitor **58** between taps **46** and **50**, and the like. Hence, as may be seen, the opportunities for specialized damping components are substantially increased. For experimental purposes, the form of the invention of Fig. 4 might be provided with variable capacitors across each separate strand, so that the varying effects on ringing might be determined through selectively adjusting each of such capacitors. Other arrangements will also suggest themselves to persons skilled in the art from the foregoing illustrative examples, so that the specific elements indicated should not be construed as in any way limiting.

Figs. 5, 5(*a*), 5(*b*) and 5(*c*) illustrate the versatility of the multi-filar coils of the invention with respect to varying the impedance of deflection coils, such as for the purpose of matching a coil pair to a source of driving energy. With conventional single-conductor coils, a given winding has a certain impedance which is unchangeable, with the result that that winding must have a driving source having an impedance matched to that of the winding, if efficient energy transfer is to be had. Fig. 5 shows a bifilar coil pair as wound, the several strands thereof being indicated at **60, 62, 64** and **66**. Each of the strands in question has, of course, two terminals as follows:

Strand **60**_____ terminals **60A** and **60B**
Strand **62**_____ terminals **62A** and **62B**
Strand **64**_____ terminals **64A** and **64B**
Strand **66**_____ terminals **66A** and **66B**

Assuming, merely for purposes of description, that the resistance of the deflection winding to be formed is of importance, the various values which may be obtained from the coils might be as follows, assuming further that each strand, **60, 62, 64** and **66**, has 3 ohms resistance. In the series arrangement of Fig. 5(*a*), the connections are as follows, energy being applied between terminals

60A and 66B: 60B to 62A; 62B to 64A; 64B to 66A. The resultant resistive impedance is 12 ohms.

In Fig. 5(*b*), connections are as follows, with driving energy being applied across terminals 60A and 66B:

60A to 62A; 60B to 62B; 64A to 66A; 64B to 66B; 62B to 64A. Thus, the effective resistance of the circuit is 3 ohms.

Fig. 5(*c*) illustrates still another mode of cross-connection, a parallel arrangement, the deflection source being coupled across terminals 60A and 66B, the other connections being as follows:

60A to 62A, 66A and 64A; 62B to 60B, 64B and 66B; 62A to 66A; and 60B to 64B. The net resistance of the winding is, in this case, 0.75 ohm.

Other specific connections will also suggest themselves for the purpose of obtaining intermediate values of net resistance of the winding, the three examples being intended as illustrative of a principle. Further, it should be borne in mind that the reactive impedance of a winding may also be varied through the use of different connections, where desirable or necessary. Finally, wires of different diameter may be wound together and connected in any of a variety of manners, as indicated by the above examples.

In view of the foregoing, it will be recognized that the present invention affords, by reason of its multi-filar deflection yoke coils (which may be horizontal and/or vertical), a plurality of advantageous effects not heretofore possible.

As employed hereinabove and in the appended claims, the terminology has the following meaning:

"Yoke" (as in television): a horizontal winding and a vertical winding;
"Winding": two coils;
"Coil": two or more conductors or strands wound simultaneously.
"Multi-filar": a plurality of individually insulated conductors or strands of wire wound simultaneously or concurrently such that they are substantially contiguous and parallel along their lengths.
"Parallel": (i. e., physically) having the same direction, course or tendency.
"Concurrently": occurring or existing together or side by side.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

1. An electromganetic deflection winding for a cathode ray tube which comprises a first coil and a second coil, each of said coils including a first conductor and a second conductor wound such that they are substantially contiguous along their length, each of said conductors having an external tap at each of its extremities and means connecting said external taps of said conductors so that said

first and second conductors of each coil are in parallel with each other.

2. Electromagnetic deflection apparatus which comprises: a first coil having a lrst strand and a second strand simultaneously wound so that they are contiguous along their length; a second coil having a first strand and a second strand simultaneously wound so that they are contiguous along their length; a pair of push-pull electronic tubes each having an anode; a source of direct current positive potential; said first strands of said coils being connected in series between said source of positive potential and the anode of one of said tubes; and said second strands being connected in series between said source of potential and the anode of the other of said tubes.

3. An electromagnetic deflection coil for deflecting an electron beam in a cathode ray tube, which coil comprises: a first wire conductor and a second wire conductor substantially contiguous along their length and wound as a unit to form a bundle of side and end turns defining a window opening and conforming to at least a portion of such cathode ray tube, the cross-sectional thickness of such bundle of side turns decreasing in thickness toward such window.

4. An electromagnetic deflection winding for deflecting an electron beam in a cathode ray tube, which winding comprises a first coil and a second coil, each coil comprising a first wire conductor and a second wire conductor substantially contiguous along their length and wound as a unit to form a bundle of side and end turns defining a window opening and conforming to at least a portion of such cathode ray tube, the cross-sectional thickness of each such bundle of side turns decreasing in thickness toward such window.

5. An electromagnetic deflection winding for deflecting an electron beam in a cathode ray tube, which winding comprises a first coil and a second coil, each coil comprising a first wire conductor and a second wire conductor substantially contiguous along their length and wound as a unit to form a bundle of side and end turns defining a window opening and conforming to at least a portion of such cathode ray tube, the cross-sectional thickness of each such bundle of side turns decreasing in thickness toward such window; and means electrically connecting said first and second wire conductors in parallel.

References Cited in the file of this patent

UNITED STATES PATENTS

2,320,551	Bahring	June 1, 1943
2,395,736	Grundmann	Feb. 26, 1946
2,569,343	Scull	Sept. 25, 1951
2,606,304	Moore	Aug. 5, 1952