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(54) COLOUR TELEVISION DISPLAY APPARATUS INCLUDING A CATHODE-RAY TUBE

(71) We, PHILIPS ELECTRONIC AND ASSOCIATED INDUSTRIES LIMITED, of Abacus House, 33 Gutter Lane, London, E.C.2, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to colour television display apparatus incorporating a television display tube and a deflection coil system comprising first and second deflection coil units disposed around the neck of the display tube at the deflection region for deflecting at least one electron beam in two orthogonal directions when an associated deflection current is applied through each deflection coil unit, each deflection coil unit comprising two preferably symmetrical coil halves toroidally wound on a magnetic core, a correction current generator for supplying a first correction current to said first deflection coil unit for generating a quadripolar field at the deflection region, a second quadripolar field being generated at the deflection region by a second correction current induced in the coil halves of said second deflection unit by the first correction current when it flows in the coil halves of said first deflection unit, the voltage produced across each coil half of said second deflection coil unit by said second correction current summing substantially to zero.

Such apparatus is described and claimed in our copending Application No. 46206/72 (Serial No. 1,410,234). With such apparatus a quadripolar field system is generated having two components of the same frequency whose polar axes substantially coincide in order to correct for deflection errors. These axes of the quadripolar field either coincide with the deflection directions or with the diagonals thereof.

The invention provides colour television display apparatus of the type disclosed in the opening paragraph in which the first mentioned and second quadripolar fields are substantially coincident, and having means

for applying a third correction current to one of said deflection coil unit for generating a further quadripolar field at the deflection region, the polar axes of the further quadripolar field lying at approximately 45° to the substantially coinciding polar axes of the first and second quadripolar fields.

In one embodiment of the invention the third correction current flows through a tap of each coil half of one of the deflection coil units. Another embodiment has each coil half of one deflection coil unit divided up into first and second substantially equal coil parts one end of one coil part being connected through an impedance to one end of the other coil part of a first coil half of the deflection coil unit and through a further impedance to one end of one coil part of the second coil half of the deflection coil unit, both coil halves being connected in a parallel to their deflection current generator.

The above and other features of the invention will be described in detail by way of example with reference to the accompanying drawings, in which

Figures 1a and 1b show the desired field distributions and

Figures 2 to 10 show various embodiments of parts of the apparatus according to the invention.

Figure 1 is a simple elevational view of the cross-section of a colour television display tube 1 at the deflection region at right angles to the longitudinal axis of the tube in a direction opposite to the propagation direction of the electron beams, the deflection coils not being shown for the sake of simplicity. The electron beams B_R , B_G and B_B for the colours red, green and blue, respectively, are generated in this embodiment in one horizontal plane, beam B_G substantially coinciding with the axis of tube 1. As is known it is possible to design the deflection coils in such a manner that a dynamic convergence correction is not necessary i.e. the beams coincide at all points of the display screen of tube 1. Since in practice the beams will never exactly be generated in accordance with the theory, convergence errors

will occur. The invention is based on the recognition of the fact that such errors can be corrected using the deflection coils.

If a quadripolar field as shown in Figure 1a is generated i.e. a field whose polar axes coincide approximately with the diagonals U and V of the X—Y system of axes, the X-axis coinciding with the horizontal deflection direction and the Y-axis coinciding with the vertical deflection direction, beams B_a and B_b are subject to forces directed along the X-axis. These forces are superimposed on the forces exerted by the deflection fields. In the Figures these forces bring these beams towards one another. The reverse is effected when the quadripolar field of which only four lines of forces are shown reverses its polarity.

The quadripolar field does not exert any influence on the beam B_0 which is present in the middle of the deflection region. The same is the case for the quadripolar field of Figure 1b. Its polar axes coincide approximately with the X and the Y-axes and the Figure shows that beams B_a and B_b undergo vertical and opposite forces which in a corresponding manner may be reversed in polarity relative to that which is shown in the Figure. When two quadripolar fields one according to Figure 1a, and one according to Figure 1b are simultaneously present the convergence errors caused by tolerances could be corrected, provided that the variation of the fields as a function of time was suitable. An error theoretically remains, namely the error which can be corrected by vertical and/or horizontal shifts in the same direction of beams B_a and B_b , but it has been found that such an error does not often occur. It would have to be corrected in another manner not described in the present application.

In our above mentioned Patent Application either a quadripolar field system according to Figure 1a or a quadripolar field system according to Figure 1b is generated with the aid of the deflection coils. The accompanying Figure 2 diagrammatically shows a circuit arrangement in which the two quadripolar field systems can be generated simultaneously so that the convergence errors can be corrected using the deflection coils. In this case it has been assumed that the errors to be corrected are small and since they are caused by asymmetry errors it is therefore sufficient in the first instance to have linearly varying fields. As the two deflection currents also vary linearly, the arrangement employed may be simple. The coil halves 17^I , 17^{II} and 18^I , 18^{II} of the deflection unit for the horizontal (line) deflection are provided on the core of the deflection coil system. A line deflection current i_H originating from the line deflection generator 8 flows through the windings 17^I , 17^{II} and 18^I , 18^{II} and in this

case these windings are connected in parallel for this current. The coil halves 19^I , 19^{II} and 20^I , 20^{II} of the deflection unit for the vertical (field) deflection are likewise provided on the core. A field deflection current i_V originating from the field deflection generator 9 flows through these windings 19^I , 19^{II} and 20^I , 20^{II} and in this example they are arranged in series.

The ends of a potentiometer 40 are connected to the output terminals 14 and 15 of field deflection generator 9, while the ends of an inductor 41 are connected to the output terminals 10 and 11 of line deflection generator 8. The deflection coil halves are wound toroidally on the core and are each divided into two substantially equal coil parts, namely 17^I , 17^{II} , 18^I , 18^{II} , 19^I , 19^{II} , and 20^I , 20^{II} . Part 17^I is provided on the core (not shown) at the top left, part 17^{II} at the bottom left, part 18^I at the top right and, part 18^{II} at the bottom right. In a corresponding manner part 19^I is provided on the core at the top left, part 19^{II} at the top right, part 20^I at the bottom left and part 20^{II} at the bottom right. Here it is assumed that the deflection coils are viewed in the same manner as the display tubes in Figure 1.

The connection point between the coil parts 19^I and 20^I is connected to the wiper on the potentiometer 40. Two bifilarly wound coils 42 and 43, thus tightly coupled together, are arranged between the centre taps P and Q of coil halves 17^I , 17^{II} , and 18^I , 18^{II} and the connection point between these coils is connected to the centre tap of inductor 41. Inductor 41 is wound on a movable core so that the inductance of the two halves thereof can be unbalanced. The other ends of coil parts 17^I and 18^I are connected to output terminal 10 (point A in Figure 2) while the ends of coil parts 17^{II} and 18^{II} remote from the point P and Q are connected through an inductor 44 which has a central tap B. This tap is connected to the output terminal 11 and the inductance of the halves of inductor 44 may be unbalanced in the same manner as those of inductor 41.

The parallel network of a capacitor 45 and a potentiometer 47 is connected in parallel with coil halves 19^I , 19^{II} and the parallel network of a capacitor 46 and a potentiometer 48 is connected in parallel with coil halves 20^I , 20^{II} . The centre taps R and S of coil halves 19^I , 19^{II} and 20^I , 20^{II} are connected through chokes 49 and 50, respectively, to the wiper on the corresponding potentiometer.

When these adjusting members, i.e. the cores of inductors 41 and 44 and the wipers of potentiometers 40, 47 and 48 are "in balance", only the deflection currents i_H and i_V flow through the deflection coil parts. In fact, there is no field frequency potential

difference between point R and the electrical centre point of potentiometer 47 and point S and the corresponding point on potentiometer 48. Analogously there is no line frequency potential difference between point P or Q and the electrical central point of inductor 41. When one or more of these members is unbalanced, correction currents flow. When the wiper on potentiometer 40 is adjusted at a position deviating from its electrical centre point, a field frequency correction i_v flows through coil parts 19¹ and 19¹¹, for example, in the direction opposite to that of deflection current i_v while a current of the same intensity flows in the same direction as current i_v through coil parts 20¹ and 20¹¹. As a result a field frequency quadrupolar field as shown in Figure 1a is generated by these coil parts. A current i_{av} is induced in coil halves 17¹, 17¹¹ and 18¹, 18¹¹ so that a quadrupolar field having the same frequency and substantially the same shape is generated, while the voltage produced by current i_{av} between points A and B is zero because the voltages across coil halves 17¹, 17¹¹ and 18¹, 18¹¹ eliminate each other due to the parallel arrangement thereof. Since the output voltage of generator 9 is saw tooth-shaped and since coil halves 17¹, 17¹¹ and 18¹ have a predominantly resistive behaviour for the field frequency, the two correction currents are sawtooth-shaped.

A correction current i_{ah} is generated with the aid of inductor 44 through coil halves 17¹, 17¹¹, 18¹, 18¹¹, which correction current as shown in Figure 2 is opposite in coil halves 18¹, 18¹¹, for example, to deflection current i_h , whereas it flows in the same direction in coil halves 17¹, 17¹¹. As a result a line frequency quadrupolar field as shown in Figure 1a is generated. A current i_{ah} is induced in coil halves 19¹, 19¹¹ and 20¹, 20¹¹ which current generates a quadrupolar field having the same frequency and substantially the same shape. In order that the voltage caused by this current between output terminals 14 and 15 is zero, capacitors 45 and 46 are provided which provide a path having a very low impedance. If the output voltage of generator 8 between terminals 10 and 11 is pulsatory, the currents, i_h , i_{ah} and i_{av} are sawtooth-shaped because the path for these currents is predominantly inductive at line frequency.

Quadrupolar fields according to Figure 1b are realised with the aid of taps P, Q, R and S. By adjusting inductor 41 a line frequency sawtooth current i_{bh} is obtained which flows through winding 42 and coil part 18¹ and returns through point A to inductor 41. Similarly a current flows through winding 43 and coil part 17¹, one flows through winding 42 and coil part 18¹¹ and one flows through winding 43 and coil part

17¹¹, the two latter currents returning through point B. It will be noted that inductor 44 causes a small asymmetry but a position of adjustment of inductor 41 can be found where this asymmetry disappears. The inductance of inductor 44 is in fact low relative to that of the deflection coil halves. All four currents described are therefore substantially equal. Thus a line frequency quadrupolar field as shown in Figure 1b is produced. It is true that the flux caused thereby in the core induces voltages in coil parts 19¹, 19¹¹ and 20¹, 20¹¹, but these voltages are directed against each other. The total resultant voltage across coil halves 19¹, 19¹¹ and 20¹, 20¹¹ is therefore zero. The resultant voltage between points R and S is also zero so that no current flows.

Analogously four field frequency sawtooth currents are applied to taps R and S by adjusting potentiometers 47 and 48, which currents can be made equal. In Figure 2 they are denoted by i_{bv} and a field frequency quadrupolar as shown in Figure 1b is generated. In a manner analogously as described above current i_{bv} does not induce a corresponding component in coil halves 17¹, 17¹¹ and 18¹, 18¹¹. There is an extra degree of freedom with the aid of potentiometers 47 and 48, namely a separate adjustment for the upper and the lower part of the image. They may also be coupled mechanically if this degree of freedom is not necessary. It may be noted that all these correction currents can have their polarity reversed with the aid of the adjusting members.

A voltage is induced by the line deflection current between the taps R and S of the field deflection coils halves. Likewise the field deflection current and predominantly the current flowing during the field flyback period induces a voltage between the taps P and Q of the line deflection coil halves.

When it is assumed that the lines of force of the vertical deflection field vary from the right to the left in the core at the area of coil parts 19¹ and 19¹¹ and coil parts 20¹ and 20¹¹ so that they vary in the space within the core from the left to the right, it appears that a deflection field of field frequency is induced in the coil unit for the horizontal deflection whose lines of force at the area of parts 17¹ and 18¹¹ vary from the top to the bottom and at the area of parts 17¹¹ and 18¹ vary from the bottom to the top. These lines of force F_v are denoted by chain-link arrows. Thus a deflection potential difference of field frequency is produced between points P and Q. In order to prevent it producing a current the coils 42 and 43 are provided.

Due to the winding sense of coils 42 and 43 they do not provide any noticeable impedance for correction current i_{bh} , but they constitute a high impedance for possible

currents between taps P and Q. This is necessary so as not to short-circuit the induced field flyback pulse and it prevents also equalising currents between the two taps in case of symmetry errors in the line deflection coils. Analogously chokes 49 and 50 serve to prevent short circuit of the line deflection voltage induced between taps R and S and therefore for the output voltage of line deflection generator 8.

In the embodiment of Figure 2 taps P, Q, R and S are provided in the middle of each coil half. It is evident that they can be provided elsewhere other than in the middle, provided that the relevant adjusting members are adjusted in such a manner that the different quadripolar fields remain symmetrical as is shown in Figures 1a and 1b.

It has been assumed in the foregoing that the convergence errors can be corrected with the aid of linearly varying quadripolar fields. It may be that more complicated errors are required so that the adjusting members 40, 41, 44, 47 and 48 shown in Figure 2 must be replaced by generators which generate suitable correction currents. Also a static adjustment, i.e. by means of a direct current or currents may be used. If a parabolic correction current of line frequency is to be used to generate the quadripolar field of Figure 1a is to be superimposed on the above-described sawtooth current through the line deflection coil parts, the circuit arrangement of Figure 3 may be used in which Figure 3 only the important circuit elements are shown. A transformer 51 having three windings is included in the arrangement of which two windings 51¹ and 51¹¹ are arranged in series with coil halves 17¹, 17¹¹ and 18¹, 18¹¹, respectively. An adjustable inductor 52 is connected in parallel with inductor 41. The voltage at the centre tap of inductor 52 is integrated by means of an RC-series network 53 and is applied to the third winding 51¹¹¹ of transformer 51 so that a parabolic current is superimposed in current i_{LH} . The winding senses of windings 51¹ and 51¹¹ must be such that this current in coil halves 17¹, 17¹¹ flows, for example, from A to B and in coil halves 18¹, 18¹¹ flows from B to A. The current may be reversed in polarity with the aid of inductor 52. Figure 3 shows that current i_H does not cause a flux in the core of transformer 51.

The invention may alternatively be used when the line deflection coil halves are arranged in series. Figure 4 shows the relevant part of the arrangement according to the invention in such a case in which corresponding elements have the same reference numerals as those in Figure 2. As with coil halves 19¹, 19¹¹ and 20¹, 20¹¹ in Figure 2, coil halves 17¹, 17¹¹ and 18¹, 18¹¹ shown in Figure 4 are shunted by two adjusting mem-

bers namely inductors 41¹ and 41¹¹ which can be adjusted simultaneously by means of, for example, a mechanical coupling and which have a low impedance for the field frequency.

Figure 5 shows the field deflection circuit for the case where the field deflection coil halves are connected in parallel. Potentiometer 40 is included in Figure 5 between coil parts 19¹¹ and 20¹¹ in the same manner as inductor 44 between coil parts 17¹¹ and 18¹¹ in Figure 2 while a potentiometer 47¹ is arranged between output terminals 14 and 15, the wiper being connected to taps R and S in the same manner as with inductor 41 in Figure 2 relative to output terminals 10 and 11 and taps P and Q.

The described embodiments require adjusting members which are either inductive or resistive and have an electrical centre. They also include means, for example, chokes of a high impedance ensuring that the deflection field induced by one deflection coil unit in the other deflection coil unit cannot produce any current there.

Figure 6 shows the simplified diagrammatic arrangement of the coil parts 17¹, 17¹¹, 18¹ and 18¹¹ in which the sources (not shown) for currents i_{LH} and i_{LH} do not require an electrical centre and in which no path of high impedance for field frequency deflection currents is necessary. Figure 6 shows relative to Figure 2 parts 18¹ and 18¹¹ exchanged in position while their connection point is referred to as Q¹. Figure 6 shows that a path must be provided for current i_{LH} between points P and Q¹ in which path the source of this current will be present so that this source does not need an electrical centre. It is also apparent that lines of force F_v are directed towards the points P and Q¹ so that no induced field frequency deflection potential difference is produced between these points. Consequently a current which might be caused thereby does not flow between these points while no circulating field frequency deflection current flows through the coil parts. Due to the parallel arrangement, the field frequency correction currents induced in coils parts 17¹, 17¹¹, 18¹ and 18¹¹ do not produce a voltage between points A and B. As in Figure 2 correction current i_{LV} would induce a current i_{LV} through coil parts 17¹, 17¹¹, 18¹ and 18¹¹ in Figure 6 but the voltage caused thereby is zero between points A and B while correction current i_{LV} does not induce current in these coil parts.

A practical embodiment of Figure 6 is shown in Figure 7 in which coil parts 17¹, 17¹¹, 18¹, 18¹¹ are diagrammatically drawn in the positions they occupy in Figure 2 but are connected together in the manner indicated in Figure 6. Variable coils 61 and 62 are incorporated between the parts 17¹ and 130

17¹¹ and 18¹ and 18¹¹, respectively. When the inductance of coils 61 and 62 are equal, the deflection currents through the coil parts are equal. When the inductance of a coil, for example, 61 is lower than that of the other coil, for example, 62, the deflection current through parts 17¹ and 17¹¹ is larger than that through parts 18¹ and 18¹¹ which may be considered as if an extra sawtooth current is added to deflection current i_H through parts 17¹ and 17¹¹ while an extra sawtooth current is subtracted from deflection current i_H through parts 18¹ and 18¹¹. Coils 61 and 62 can be adjusted in such a manner that the above-mentioned sawtooth currents are equal in absolute value: in this manner correction current i_{Hc} is generated. In order that it does not exert any influence on line deflection generator 8 the total impedance of the network constituted by the elements 17¹, 61, 17¹¹, 18¹, 62 and 18¹¹ between output terminals 10 and 11 must remain constant, which means that the sum of the inductances 61 and 62 must remain substantially constant. Otherwise their adjustments would have an undesired influence on the line deflection, for example, on the horizontal amplitude. This can be realized by coupling both adjustments together mechanically, for example, by providing both coils on one and the same displaceable core.

A variable coil 63 is provided between the connection point of coil part 17¹ and coil 61 and that of coil part 18¹ and coil 62 and a variable coil 64 is incorporated between the connection point of coil part 17¹¹ and coil 61 and that of coil part 18¹¹ and coil 62. When the deflection current in Figure 7 flows through coil 61 from the top to the bottom and through coil 62 from the bottom to the top, a positive potential difference from the right to the left is produced across coil 63 and from the left to the right across coil 64. Consequently, sawtooth currents flow through these coils, which currents are different on the condition that the inductances of coils 63 and 64 are different while the variation of coils 61 and 62 substantially does not have any influence on these currents. When the inductance of, for example, coil 63 is lower than that of coil 64, more current flows through coil 63 than through coil 64 which may be considered as if one current circulates through coils 61, 64, 62 and 63 while a current through coil 63 is added thereto and a current through coil 64 is subtracted therefrom. These currents may be made equal in absolute value: in this manner correction current i_{Hc} is generated. Also the sum of the inductances of coils 63 and 64 must remain substantially constant and their adjustments may likewise be coupled.

It will be evident that the principle described in relation to Figure 6 may alter-

natively be used for the deflection unit for the vertical deflection. Figure 8 shows such an embodiment in which variable resistors 65, 66, 67 and 68 instead of variable inductors, serve as sources for the correction currents. By varying resistors 65 and 66 incorporated between coil parts 19¹ and 19¹¹ and 20¹ and 20¹¹, respectively, correction current i_{Lv} is adjusted while the variation of resistors 67 and 68 is used for adjusting correction current i_{Lv} . These adjustments may be mechanically coupled in order that the sum of the resistances of resistors 65 and 66 and 67 and 68 remains substantially constant. Also in this case other feasible arrangements of the coil parts do not lead to the desirable simplification.

As described above a parabolic correction current may be desirable. Such a current may alternatively be generated in the embodiments of Figures 7 and 8. Figure 9 shows as an example an embodiment derived from Figure 8 in which the parallel arrangement of potentiometers 69 and 71 and capacitors 70 and 72 is incorporated as shown between coil parts 19¹¹ and 20¹ and 19¹ and 20¹¹, respectively. As a result an integration of the deflection current is effected.

Figure 10 shows a further modification in which the coil parts of a deflection unit, for example, that which provides the vertical deflection are arranged in series. A variable resistor 73 is included between points R and S while a potentiometer 74 is arranged between the output terminals 14 and 15 of the field deflection generator 9, the wiper of this potentiometer being connected to the connection point of coil parts 19¹¹ and 20¹¹. It will be evident that variation of this wiper provides the adjustment of correction current i_{Lv} , while resistor 73 ensures the adjustment of correction current i_{Hc} . Coil halves 19¹, 19¹¹ and 20¹, 20¹¹ are short-circuited for line-frequency voltages by means of capacitors 45 and 46, respectively. Since the voltages induced by the horizontal deflection field in the coil parts 19¹ and 20¹ are equal, there is no line-frequency deflection potential difference between points R and S. This arrangement has, however, the drawback that resistor 73 can be adjusted in one direction only so that in the case of the other polarity being necessary coil halves 19¹ and 19¹¹, 20¹ and 20¹¹ are to be exchanged which is not very practical. One possibility to obviate this is to design the deflection unit in such a manner that the error then deliberately introduced can be corrected with one polarity.

Although in the foregoing the error to be corrected occurs when using a display tube in which the electron beams are generated in one flat plane, the principle of the invention need not be limited to its use with such

a tube. In a tube in which three electron guns are placed at the corners of an equilateral triangle it is known that astigmatic deflection errors may occur. The invention can be used to correct such errors, while the correction currents must have the variation as a function of the time suitable for the relevant correction.

As is known a quadripolar field which is active approximately at the area of the deflection region can be generated by means of a deflection coil unit. This means that a line-frequency correction quadripolar field can be generated by means of the one unit for the horizontal deflection or by means of the unit for the vertical deflection, or by both. Likewise a field-frequency correction quadripolar field can be generated by means of the unit for the vertical deflection or by means of the unit for the horizontal deflection, or by both. It will be evident that this also applies in the present application.

WHAT WE CLAIM IS:—

1. Colour television display apparatus incorporating a television display tube and a deflection coil system comprising first and second deflection coil units disposed around the neck of the display tube at the deflection region for deflecting at least one electron beam in two orthogonal directions when an associated deflection current is applied through each deflection coil unit, each deflection coil unit comprising two preferably symmetrical coil halves toroidally wound on a magnetic core, a correction current generator for supplying a first correction current to said first deflection coil unit for generating a quadripolar field at the deflection region, a second quadripolar field substantially coincident with said first mentioned quadripolar field being generated at the deflection region by a second correction current induced in the coil halves of said second deflection unit by the first correction current when it flows in the coil halves of said first deflection unit, the voltage produced across each coil half of said second deflection coil unit by said second correction current summing substantially to zero, means for applying a third correction current to one of said deflection coil units, for generating a further quadripolar field at the deflection region, the polar axes of the further quadripolar field lying at approximately 45° to the substantially coinciding polar axes of the first and second quadripolar fields.

2. Apparatus as claimed in Claim 1, in which the polar axes of the further quadripolar field approximately coincide with the deflection directions whilst the polar axes of the first and second quadripolar fields lie at approximately 45° to the deflection directions.

3. Apparatus as claimed in Claim 2, in

which the third correction current flows through a tap of each coil half of one of the deflection coil units.

4. Apparatus as claimed in Claim 1, characterized in that each coil half of one deflection unit is divided into first and second substantially equal coil parts one end of one coil part being connected through an impedance to one end of the other coil part of a first coil half of the deflection coil unit and through a further impedance to one end of one coil part of the second coil half of the deflection coil unit both coil halves being connected in a parallel to their deflection current generator.

5. Apparatus as claimed in Claim 4, in which the first, second, third and fourth coil parts of the deflection coil unit are sequentially disposed around the magnetic core, said first and second coil parts forming one coil half while said third and fourth coil parts form the other coil half, a first impedance being arranged between the first and the second coil parts while a second impedance is arranged between the third and the fourth coil part, a third impedance being connected between the junction of the first coil part and with the first impedance and that of the fourth coil part with the second impedance, a fourth impedance being connected between the junction of the second coil part with the first impedance and that of the third coil part with the second impedance, the ends of the first and the third coil parts remote from their associated impedances being connected together and to a terminal of the deflection current generator whilst the ends of the second and the fourth coil parts remote from their associated impedances are connected together and to the other terminal of the deflection current generator.

6. Apparatus as claimed in Claim 5, in which each of the impedances is capable of being varied, the variation being such that the sum of the impedance values of the first and second impedances is substantially constant while the sum of the impedance values of the third and fourth impedances is also substantially constant.

7. Apparatus as claimed in Claim 6, in which adjusting members for varying the first and second impedances are mechanically coupled whilst the adjusting members for varying the third and fourth impedances are also mechanically coupled.

8. Apparatus as claimed in Claim 3, in which the coil halves of the deflection coil unit are arranged in series for its deflection current, the third correction current flowing through a tap of an impedance which impedance is connected in parallel with the coil half, and through a further impedance.

9. Apparatus as claimed in Claim 3 in which the coil halves of the deflection unit are arranged in parallel for its deflection



a tube. In a tube in which three electron guns are placed at the corners of an equilateral triangle it is known that astigmatic deflection errors may occur. The invention can be used to correct such errors, while the correction currents must have the variation as a function of the time suitable for the relevant correction.

As is known a quadripolar field which is active approximately at the area of the deflection region can be generated by means of a deflection coil unit. This means that a line-frequency correction quadripolar field can be generated by means of the one unit for the horizontal deflection or by means of the unit for the vertical deflection, or by both. Likewise a field-frequency correction quadripolar field can be generated by means of the unit for the vertical deflection or by means of the unit for the horizontal deflection, or by both. It will be evident that this also applies in the present application.

WHAT WE CLAIM IS:—

1. Colour television display apparatus incorporating a television display tube and a deflection coil system comprising first and second deflection coil units disposed around the neck of the display tube at the deflection region for deflecting at least one electron beam in two orthogonal directions when an associated deflection current is applied through each deflection coil unit, each deflection coil unit comprising two preferably symmetrical coil halves toroidally wound on a magnetic core, a correction current generator for supplying a first correction current to said first deflection coil unit for generating a quadripolar field at the deflection region, a second quadripolar field substantially coincident with said first mentioned quadripolar field being generated at the deflection region by a second correction current induced in the coil halves of said second deflection unit by the first correction current when it flows in the coil halves of said first deflection unit, the voltage produced across each coil half of said second deflection coil unit by said second correction current summing substantially to zero, means for applying a third correction current to one of said deflection coil units, for generating a further quadripolar field at the deflection region, the polar axes of the further quadripolar field lying at approximately 45° to the substantially coinciding polar axes of the first and second quadripolar fields.

2. Apparatus as claimed in Claim 1, in which the polar axes of the further quadripolar field approximately coincide with the deflection directions whilst the polar axes of the first and second quadripolar fields lie at approximately 45° to the deflection directions.

3. Apparatus as claimed in Claim 2, in

which the third correction current flows through a tap of each coil half of one of the deflection coil units.

4. Apparatus as claimed in Claim 1, characterized in that each coil half of one deflection unit is divided into first and second substantially equal coil parts one end of one coil part being connected through an impedance to one end of the other coil part of a first coil half of the deflection coil unit and through a further impedance to one end of one coil part of the second coil half of the deflection coil unit both coil halves being connected in a parallel to their deflection current generator.

5. Apparatus as claimed in Claim 4, in which the first, second, third and fourth coil parts of the deflection coil unit are sequentially disposed around the magnetic core, said first and second coil parts forming one coil half while said third and fourth coil parts form the other coil half, a first impedance being arranged between the first and the second coil parts while a second impedance is arranged between the third and the fourth coil part, a third impedance being connected between the junction of the first coil part and with the first impedance and that of the fourth coil part with the second impedance, a fourth impedance being connected between the junction of the second coil part with the first impedance and that of the third coil part with the second impedance, the ends of the first and the third coil parts remote from their associated impedances being connected together and to a terminal of the deflection current generator whilst the ends of the second and the fourth coil parts remote from their associated impedances are connected together and to the other terminal of the deflection current generator.

6. Apparatus as claimed in Claim 5, in which each of the impedances is capable of being varied, the variation being such that the sum of the impedance values of the first and second impedances is substantially constant while the sum of the impedance values of the third and fourth impedances is also substantially constant.

7. Apparatus as claimed in Claim 6, in which adjusting members for varying the first and second impedances are mechanically coupled whilst the adjusting members for varying the third and fourth impedances are also mechanically coupled.

8. Apparatus as claimed in Claim 3, in which the coil halves of the deflection coil unit are arranged in series for its deflection current, the third correction current flowing through a tap of an impedance which impedance is connected in parallel with the coil half, and through a further impedance.

9. Apparatus as claimed in Claim 3 in which the coil halves of the deflection unit are arranged in parallel for its deflection



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5 current, the third correction current flowing through a tap on an impedance which impedance is arranged between output terminals of an associated deflection current generator, and through a further impedance.

10 10. Apparatus as claimed in any of Claims 4, 8 and 9 in which the deflection coil unit is for horizontal deflection, each of the said impedances being inductors.

10 11. Apparatus as claimed in Claim 4 in which the deflection coil unit is for vertical deflection, each of the said impedances being resistors.

15 12. Apparatus as claimed in Claim 8 or 9 in which the deflection coil unit is for vertical deflection, the impedance in parallel with the deflection coil half is a resistor

while the said further impedance is an inductor.

13. Apparatus as claimed in any of the preceding Claims, in which the three electron beams are generated in the cathode-ray tube in one flat plane. 20

14. Colour television display apparatus provided with a cathode-ray tube, substantially as herein described with reference to the accompanying drawings. 25

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