

PATENT SPECIFICATION

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(54) COLOUR TELEVISION DISPLAY APPARATUS

(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, and a correction current generator for supplying a correction current for generating a quadrupolar field at the deflection region. The direction of the quadrupolar field is dependent upon the type of astigmatic error to be corrected.

Such apparatus is described in our Patent Specification 1,230,162 in which anisotropic astigmatic deflection errors are corrected. The correction current is dependent on the product of the instantaneous magnitudes of the two deflection currents. In this known apparatus deflection coils which are wound in any known manner may in principle be used. Toroidally wound coils have the advantage that they can be wound in an easier manner than saddle shaped coils and that they have a lower impedance so that the deflection currents can be supplied through substantially ideal switches (such as transistors or thyristors). However, there is the problem that the correction current generator must supply a large power output.

The invention provides 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 quadrupolar field at the deflection region, a second quadrupolar 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 voltages produced across each coil half of said second deflection coil unit by said second correction current summing substantially to zero.

The polar axes of said second quadrupolar field may substantially coincide with the polar axes of said first quadrupolar field. The first correction current and a first deflection current may flow in the same direction through one coil half of said first deflection coil unit and in opposite direction through its other coil half, whilst said second correction current and a second deflection current may flow in the same direction through one coil half of said second deflection coil unit and in the opposite direction through its other coil half.

The coil halves of said second deflection coil unit may be arranged in parallel for said second deflection current. Alternatively, the coil halves of said second deflection coil unit may be arranged in series for said second deflection current in which case each of these coil halves will be shunted by an impedance which is low for the frequency of said first correction current.

The second correction current may be shifted in phase relative to that of said first correction current.

The magnetic resistance of said core may differ at different places along said core.

With the invention apparatus may be provided by means of which isotropic astigmatic

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errors can be corrected. Our co-pending applications 32716 of 1970 (Serial No. 1,323,154) and 12241 of 1973 (Serial No. 1,323,155) describe arrangements in which
 5 four auxiliary windings toroidally wound on the deflection coil system core generate a quadripolar field for correcting such deflection errors, the correction current being a function of the instantaneous magnitude of one or of both deflection currents. A similar
 10 measure is also possible with apparatus according to the invention.

Embodiments of display apparatus according to the invention will be described in detail by way of example with reference to the accompanying Figures in which:—

Figure 1 shows a display apparatus provided with a three-gun cathode-ray tube,

Figure 2 shows a system of deflection coils and associated generators which can be used in apparatus to the invention,

Figures 3a and 3b show alternative connections for the system of deflection coils and generators which can be used in apparatus to the invention,

Figure 4 shows the equivalent circuit diagram of part of the arrangement of Figure 2 or 3,

Figures 5a and 5b show details of further embodiments, and

Figures 6 and Figure 7 show further alternative connections for the system of deflection coils and generators which can be used in apparatus according to the invention.

In Figure 1, 1 denotes an aerial by which the colour television signal can be received. This colour television signal is applied to an RF and IF amplifier 2 which amplifies and detects the signal and subsequently applies it to a video amplifier 3. This video amplifier 3 applies the actual video signal consisting of a luminance signal and colour difference signals to a first output 4. These signals are processed in a matrix circuit 5 so that the three colour signals R, G and B become available at the output of this matrix circuit, which signals are applied to the three cathodes K_R , K_G and K_B of the cathode-ray tube 6 operating as a colour television display tube. This tube 6 may be of the shadow-mask type and the colour image is displayed on its screen. A synchronizing signal which is applied to a line deflection generator 8 and also to a field deflection generator 9 is derived from a second output 7 of video amplifier 3. Two output terminals 10 and 11 of generator 8 are connected to the system 12 of deflection coils for supplying a line deflection current and an output terminal 13 is connected to the acceleration anode of display tube 6 for the supply of the acceleration anode voltage of approximately 25 kV. The output terminals 14 and 15 of field deflection generator 9 are also
 65 connected to the system 12 of deflection

coils for supplying a field deflection current. As a rule, the line deflection current derived from output terminals 10 and 11, together with a deflection unit of deflection coil system 12 ensures the deflection of the electron beams in the horizontal (line) direction, generated by the three cathodes K_R , K_G and K_B . Simultaneously the field deflection current derived from output terminals 14 and 15, in cooperation with a further deflector unit of deflection coil system 12, ensures the deflection of the three electron beams in the vertical (field) direction.

Figure 2 shows the system 12 of deflection coils in greater detail. The coil halves 17 and 18 of the first-mentioned deflection unit, i.e. for the horizontal (line) deflection, are provided on a core 16. A line deflection current i_H originating from line deflecting generator 8 flows through windings 17 and 18 which are in this example connected in parallel between two points A and B. The coil halves 19 and 20 of the deflection unit for the vertical (field) deflection are likewise provided on core 16. A field deflection current i_V originating from field deflection generator 9 flows through windings 19 and 20 which are connected in series in this example. Furthermore Figure 2 shows the X-axis which coincides with the horizontal deflection direction of the three electron beams in display tube 6. The Y-axis which coincides with the vertical deflection direction is also shown. The centre C_0 is the centre of deflection coil system 12 and coincides with the longitudinal axis of display tube 6 which axis is at right angles to the plane of the drawing of Figure 2.

The output terminals 14 and 15 of field deflection generator 9 are additionally connected through the series arrangement of two blocking impedances 21 and 22. A correction current generator 23 has two output terminals 24 and 25. Output terminal 24 is connected to the junction D between impedances 21 and 22 and output terminal 25 is connected to the junction E of field windings 19 and 20. As a result a correction current i_K is generated by generator 23 flows through windings 19 and 20, current i_K being in one winding added to the field deflection current i_V while it is subtracted therefrom in the other winding. Under these circumstances windings 19 and 20 not only generate the magnetic field for the vertical deflection, but also a quadripolar field whose polar axes coincide, in a first approximation, with the diagonals U and V between axes X and Y. The object of the impedances 21 and 22 is to decouple the generators 9 and 23 relative to each other.

Windings 17, 18, 19 and 20 are toroidally wound on the core 16 of deflection coil system 12. Since toroid deflection coils are wound about the core and not against it, such as

saddle coils, a comparatively large coupling is produced therebetween through core 16. As a result quite a considerable current i'_x is induced in windings 17 and 18, which current has the same frequency and approximately the same shape as current i_x . Under these circumstances windings 17 and 18 not only generate the magnetic field for the horizontal deflection, but also produce a second quadripolar field whose polar axes coincide, in a first approximation, with those of the above-mentioned quadripolar field.

Figure 2 shows in a simplified manner the magnetic fluxes θ_x and θ'_x which are generated by currents I_x and i'_x , respectively. The Figures show that fluxes θ_x and θ'_x counteract each other in core 16, whereas they support each other in the space within core 16. This has the advantage that little flux generated by the correction currents circulates in the core, which would be a pure loss because correction current generator 23 would have to supply a larger power for a given effect, and it has the advantage that the two quadripolar fields support each other where stated above. Windings 17 and 18 are arranged in such a manner and must have a winding sense such that the voltages thereacross due to correction current cause the voltage present between points A and B to be zero. If this were not so other effects whether wanted or unwanted would be obtained which will not be further referred to. Generators 8, 9 and 23 hardly influence one another. Since the said windings are deflection coil halves they have automatically the correct winding sense as is shown in Figure 2.

The same result is also obtained with the arrangement of Figure 3a which is shown in simpler details than that in Figure 2. In this Figure correction current generator 23 and field deflection generator 9 have exchanged positions. In the embodiment of Figure 2 windings 19 and 20 for field deflection current i_v are arranged in series whilst in the embodiment of Figure 3a they are arranged in parallel, while the opposite situation applies for correction current i_x .

When the correction current generated by generator 23 is approximately proportional to the square of the instantaneous magnitude of line deflection current i_x the arrangement according to Figure 2 or 3a is suitable to correct deflection errors which have been caused by the deflection coil system 12 due to deflection in the X-direction when these errors are of the isotropic astigmatic type. This is further described in our application 32716 of 1970 (Serial No. 1,323,154). For this purpose generator 23 must receive information originating from line deflection generator 8 which is indicated by the broken line connection 26 in Figures 1, 2, and 3a. In a corresponding manner isotropic astigmatic de-

flection errors due to deflection in the Y-direction can be corrected if the correction current generated by generator 23 is approximately proportional to the square of the instantaneous magnitude of field deflection current i_v . For this purpose generator 23 must receive information originating from field deflection generator 9 which is indicated by the broken line connection 27 in Figures 1, 2 and 3a. As stated in the above mentioned application a combination of the two corrections is also possible. Generator 23 may be formed in known manner, for example as described in the above application.

Figure 3b shows part of an apparatus according to the invention in which windings 17 and 18 are connected in series for the line deflection current and are connected in parallel for the correction current which is induced in these windings. The junction of windings 17 and 18 is connected to the central tap of an output winding associated with generator 8. It is evident that the principle of the invention is not affected when the line and/or field deflection coil halves for a given current are arranged in series and for a different current are arranged in parallel, provided that the voltage caused by the induced current across the deflection coil half is zero. If, for one reason or other this voltage is not zero, it can be made substantially zero, for example, by connecting in parallel therewith an impedance which is low for the relevant frequency.

In the embodiments described the correction current flows through the field deflection coil halves so that a second correction current is induced in the line deflection coil halves. It is evident that alternatively the line deflection coil halves may be chosen for the correction current while the second correction current is induced in the field deflection coil halves. Different embodiments are also possible in such a case. A further possibility is the following. Each coil unit 17, 18 and 19, 20 receives its own deflection current i_x and i_v , respectively, and additionally a correction current. Thus an induced correction current flows through each coil unit and the quadripolar field generated has four components instead of two. In all cases the windings through which an induced current flows are to be arranged either in series or in parallel in such a manner that the voltage produced thereacross by the induced correction current is zero.

It may be noted that in a given configuration or deflection coil system 12 the U and V polar axes of the correction quadripolar field are not necessarily the diagonals of the X and Y-axes, but may constitute an angle which differs from 45°. Windings 17, 18, 19 and 20 must be designed in such a manner that the said polar axes are directed such that the isotropic astigmatic deflection errors

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are actually corrected. In view of the symmetry of the configuration it will be evident that the U and V directions will always be symmetrical relative to the X axis and relative to the Y-axis. An extra degree of freedom could of course be obtained if the windings through which the correction current flows and/or the windings through which the induced current flows are not deflection coil halves but additional windings wound on core 16. This is, however, not necessary for the invention because separate windings can be connected directly to the correction generator as described in our above application. The position of the U and V directions may also be influenced by using a non-homogeneous core, that is to say, a core which consists of parts having different permeabilities or whose cross-section is not constant.

One reason why, in case of toroidally wound deflection coils the correction current generator could have to supply a large power if the deflection coils are not arranged and connected in the manner described has already previously been mentioned, namely the fact that the flux generated by the correction current would circulate in the core and therefore would exert little influence on the electron beams. A second reason is the following. Figure 2 shows that the fluxes ϕ_K in core 16 support each other so that the mutual inductance $M=kL$ between windings 19 and 20 must be considered to be positive, in which k is the coupling factor, while L is the inductance of windings 19 and 20 which are assumed to be identical. When windings 19 and 20 are arranged in parallel, the following relation applies for correction current i_K for its total inductance:

$$L_t = \frac{L^2 - M^2}{2(L - M)} = \frac{L^2(1 - k^2)}{2L(1 - k)} = \frac{L}{2} (1 + k)$$

if they are arranged in series, there applies:

$$L_t = 2(L + M) = 2L(1 + k).$$

On the other hand, the deflection fluxes generated by windings 19 and 20 support each other in the space within core 16 and therefore oppose each other in the core itself so that inductance M is to be considered negative. The total inductance of these windings for deflection current i_V is, in case of parallel arrangement:

$$L'_t = \frac{L^2 - M^2}{2(L + M)} = \frac{L^2(1 - k^2)}{2L(1 + k)} = \frac{L}{2} (1 - k)$$

and in case of series arrangement:

$$L'_t = 2(L - M) = 2L(1 - k).$$

Since the coupling factor is large (i.e. $k \approx 1$) in toroidally wound cores, it is found that the value L_t in all cases is much higher than the value L'_t . A correction current generator will in practice behave as a voltage source rather than as a current source and it must therefore be capable of supplying a large power for a correct magnitude of the correction current to low impedance windings. However, with the apparatus described the impedance for the correction current is already low as it is the impedance of the toroidal deflection windings. Figure 4 shows the T network equivalent circuit diagram for the windings provided on core 16. In this diagram L_t represents the total inductance of windings 19 and 20, L' represents the inductance of windings 17 and 18 based on the same number of turns as that of windings 19 and 20 and taking their mutual inductance into account and

$$M' = k' \sqrt{L_t L'}$$

represents the mutual inductance between the two deflection units, while points A and B are the same as points A and B in Figures 2, 3a and 3b and points D and E are the same as points D and E in Figures 2 and 3a. Since the coupling factor k' is large, M' is very large so that correction current i_K would indeed be low. However, since the voltage between points A and B is zero, these points of Figure 4 may be considered to be connected. As a result inductance M' is, as it were, short-circuited by the much lower inductance $L' - M'$ and current i_K may have the required magnitude without the power supplied by generator 23 being very large while the magnitude of current i'_K is almost equal to that of current i_K , which is also an advantage.

Figure 5 shows a modification of part of the apparatus according to the invention. It may be desired to shift the induced correction current i'_K in phase relative to the correction current i_K , for example, to give the correction quadripolar field a spatial configuration which in amplitude and shape has the same frequency as either of the two deflection frequencies. As a result the geometrical properties of the image displayed on the screen of display tube 6 can be further corrected. This may be realized with the aid of the deflection coil halves in cooperation with two substantially identical impedances 28 and 29 which may be coupled together and which are arranged in series with the deflection coil halves (Figure 5a) or in parallel therewith, or with two substantially identical networks 30 and 31 having two inputs and two outputs (Figure 5b). In Figure 5 the induced correction current i'_K flows through windings 17 and 18. In this case the voltage between points A and B is also zero. Im-

pedances or networks having two inputs and two outputs may alternatively be arranged in the path through which the correction current i_K flows.

5 Figure 6 shows an embodiment in which a combination of the above mentioned possibilities is used. Windings 17 and 18 for the horizontal deflection are arranged in parallel for the line deflection current, whereas they
10 are arranged in series through two coils 28 and 29 coupled together for a correction current originating from a generator 23'. Windings 19 and 20 for the vertical deflection are arranged in series for the field
15 deflection current, whereas they are arranged in parallel through two coils 28' and 29' coupled together for a correction current originating from a generator 23. If desired, generators 23 and/or 23' may comprise
20 phase-shifting networks. Blocking impedances 21 and 22 are formed by two capacitors whose reactance is high for the field frequency and low for the line frequency so that they provide a decoupling between
25 generators 8, 23 and generator 9, while the voltage produced by the induced correction current across windings 19 and 20 is substantially zero. The inductance of coils 28' and 29' is in fact negligible relative to that
30 of windings 19 and 20. In this embodiment the correction current generated by generator 23 is approximately proportional to the square of the instantaneous magnitude of the field deflection current while the correction current generated by generator 23' is approxi-
35 mately proportional to the square of the instantaneous magnitude of the line deflection current.

40 The invention as so far described cannot be immediately used for the correction of anisotropic astigmatism. In fact, the polar axes of the correction quadripolar field must for such correction coincide with the X and Y axes, which is not possible with the
45 construction of Figure 2. A suitable quadripolar field for such correction is produced when a deflection coil unit, for example, that for the field deflection is split up as is shown in Figure 7, the windings 17 and 18 for the
50 line deflection current remaining as they were. In this unit windings 19 and 20 are each split up in two substantially equal coil parts 19', 19'' and 20', 20'', respectively, wound in the correct directions. In Figure 7, as in
55 Figure 2, the field deflection coils are arranged in series for field deflection current i_V and in parallel for correction current i_K , while output terminal 25 of correction current generator 23 is connected to the common
60 point E between parts 20' and 20''. Generator 23 then provides a correction current i_K which is approximately proportional to

the product of the instantaneous magnitude of the two deflection currents. It is evident that the nature of the correction current or currents and their application for the deflection unit 12 can be performed in various ways as described in relation to the other
65 Figures.

WHAT WE CLAIM IS:—

- 70 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
75 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 voltages pro-
80 duces across each coil half of said second deflection coil unit by said second correction amount summing substantially to zero.
- 85 2. Apparatus as claimed in Claim 1, in which the polar axes of said second quadripolar field substantially coincide with the polar axes of said first quadripolar field.
- 90 3. Apparatus as claimed in Claim 1 or 2, in which said first correction current and a first deflection current flow in the same direction through one coil half of said first deflection coil unit and in opposite direction through its other coil half, whilst said second correction current and second deflection current flow in the same direction through one coil half of said second deflection coil unit and in the opposite direction through its other coil half.
- 95 4. Apparatus as claimed in Claim 1, 2 or 3 in which the coil halves of said second deflection coil unit are arranged in parallel for said second deflection current.
- 100 5. Apparatus as claimed in Claim 1, 2 or 3 in which the coil halves of said second deflection coil unit are arranged in series for said second deflection current each of these coil halves being shunted by an impedance which is low for the frequency of said first correction current.
- 105 6. Apparatus as claimed in any of the preceding Claims, in which said second correction current is shifted in phase relative to that of said first correction current.
- 120

pedances or networks having two inputs and two outputs may alternatively be arranged in the path through which the correction current i_k flows.

5 Figure 6 shows an embodiment in which a combination of the above mentioned possibilities is used. Windings 17 and 18 for the horizontal deflection are arranged in parallel for the line deflection current, whereas they are arranged in series through two coils 28 and 29 coupled together for a correction current originating from a generator 23'. Windings 19 and 20 for the vertical deflection are arranged in series for the field deflection current, whereas they are arranged in parallel through two coils 28' and 29' coupled together for a correction current originating from a generator 23. If desired, generators 23 and/or 23' may comprise phase-shifting networks. Blocking impedances 21 and 22 are formed by two capacitors whose reactance is high for the field frequency and low for the line frequency so that they provide a decoupling between generators 8, 23 and generator 9, while the voltage produced by the induced correction current across windings 19 and 20 is substantially zero. The inductance of coils 28' and 29' is in fact negligible relative to that of windings 19 and 20. In this embodiment the correction current generated by generator 23 is approximately proportional to the square of the instantaneous magnitude of the field deflection current while the correction current generated by generator 23' is approximately proportional to the square of the instantaneous magnitude of the line deflection current.

40 The invention as so far described cannot be immediately used for the correction of anisotropic astigmatism. In fact, the polar axes of the correction quadripolar field must for such correction coincide with the X and Y axes, which is not possible with the construction of Figure 2. A suitable quadripolar field for such correction is produced when a deflection coil unit, for example, that for the field deflection is split up as is shown in Figure 7, the windings 17 and 18 for the line deflection current remaining as they were. In this unit windings 19 and 20 are each split up in two substantially equal coil parts 19', 19'' and 20', 20'', respectively, wound in the correct directions. In Figure 7, as in Figure 2, the field deflection coils are arranged in series for field deflection current i_v and in parallel for correction current i_k , while output terminal 25 of correction current generator 23 is connected to the common point E between parts 20' and 20''. Generator 23 then provides a correction current i_k which is approximately proportional to

the product of the instantaneous magnitude of the two deflection currents. It is evident that the nature of the correction current or currents and their application for the deflection unit 12 can be performed in various ways as described in relation to the other Figures.

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 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 voltages produced across each coil half of said second deflection coil unit by said second correction amount summing substantially to zero.
2. Apparatus as claimed in Claim 1, in which the polar axes of said second quadripolar field substantially coincide with the polar axes of said first quadripolar field.
3. Apparatus as claimed in Claim 1 or 2, in which said first correction current and a first deflection current flow in the same direction through one coil half of said first deflection coil unit and in opposite direction through its other coil half, whilst said second correction current and second deflection current flow in the same direction through one coil half of said second deflection coil unit and in the opposite direction through its other coil half.
4. Apparatus as claimed in Claim 1, 2 or 3 in which the coil halves of said second deflection coil unit are arranged in parallel for said second deflection current.
5. Apparatus as claimed in Claim 1, 2 or 3 in which the coil halves of said second deflection coil unit are arranged in series for said second deflection current each of these coil halves being shunted by an impedance which is low for the frequency of said first correction current.
6. Apparatus as claimed in any of the preceding Claims, in which said second correction current is shifted in phase relative to that of said first correction current.



7. Apparatus as claimed in any of the preceding Claims, in which the magnetic resistance of said core differs at different places along said core.
- 5 8. Colour television display apparatus substantially as herein described with reference to the accompanying drawings.

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