United States Patent

Tokita et al.

[15] **3,668,464**

[45] **June 6, 1972**

[54] DEFLECTION COMPENSATION FOR TEMPERATURE CHANGES IN A COLOR PICTURE TUBE

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[22] Filed: **Feb. 11, 1970**

[21] Appl. No.: **10,369**

[30] **Foreign Application Priority Data**

Feb. 20, 1969 Japan.....44/12463

[52] **U.S. Cl.**.....**315/24,** 315/13 CG, 315/25

[51] **Int. Cl.**.....**H01j 29/70**

[58] **Field of Search**.....315/24, 25, 13; 335/217; 313/75

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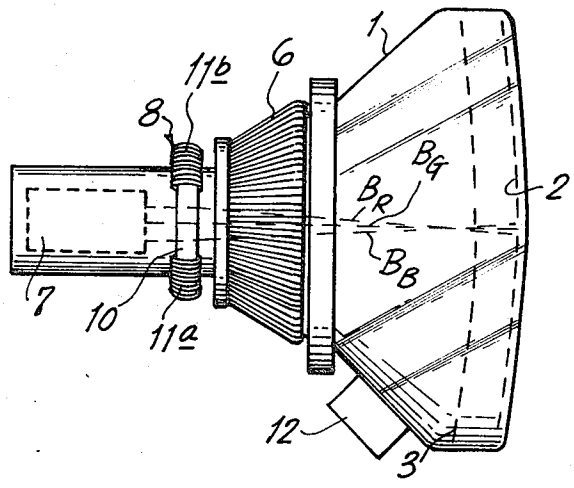
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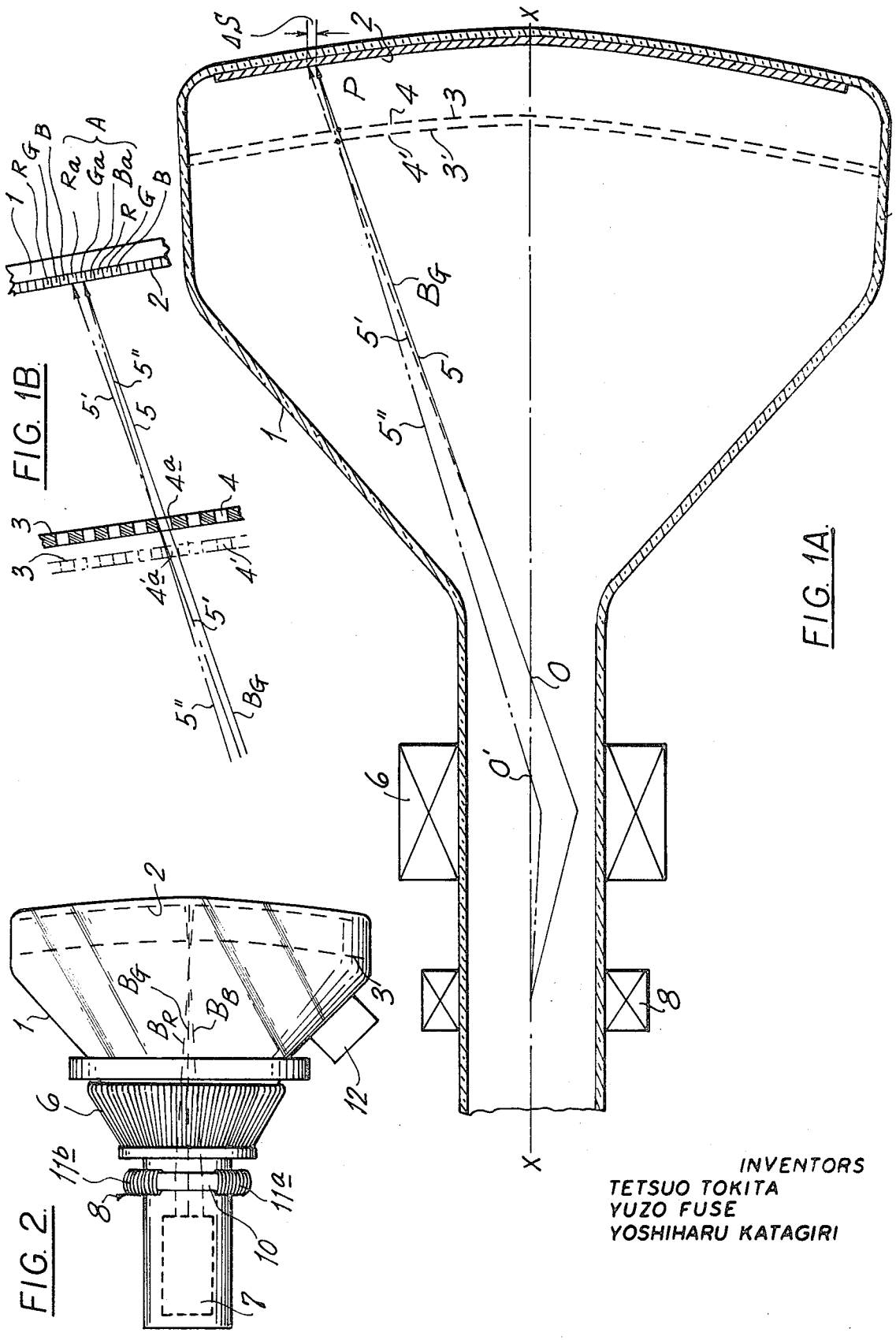
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[57] **ABSTRACT**

In a color picture tube having an apertured beam selecting grill or mask through one or more electron beams are made to land on predetermined color phosphors applied to the face plate of the tube, thermal expansion of the grill or mask is compensated for, so as to avoid mislanding of the beam or beams, by providing an auxiliary magnetic deflection means located in back of the main magnetic deflection or scanning means and operative in dependence on the operation of the main deflection means to produce magnetic flux in opposition thereto. The current flowing in the auxiliary magnetic deflection means is decreased with increasing temperature by means of a thermosensitive magnetic means so as to similarly decrease the magnetic flux opposing that of the main deflection means, whereby the effective center of deflection of the beam or beams is shifted rearwardly in response to increasing temperature.

8 Claims, 8 Drawing Figures





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FIG. 3.

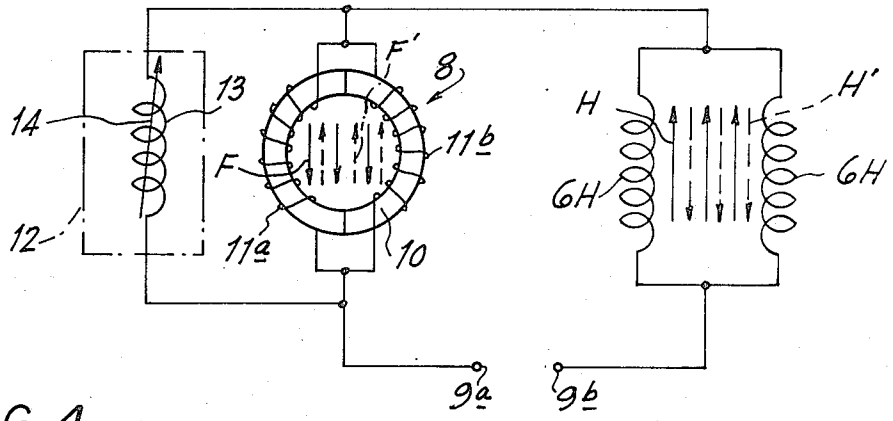


FIG. 4.

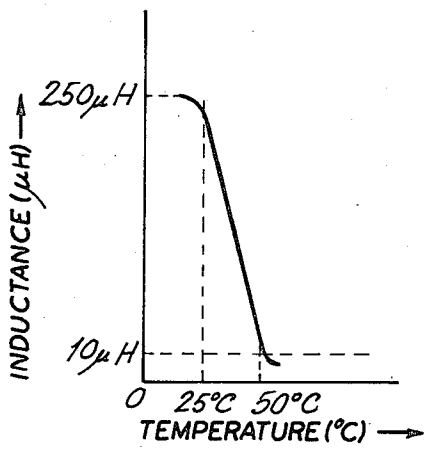
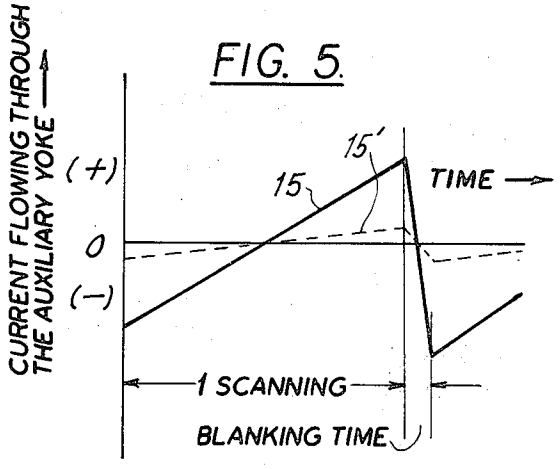


FIG. 5.



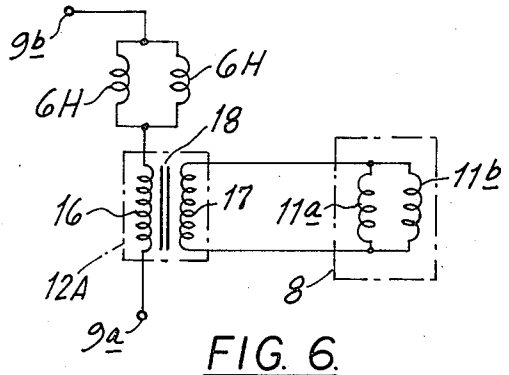


FIG. 6.

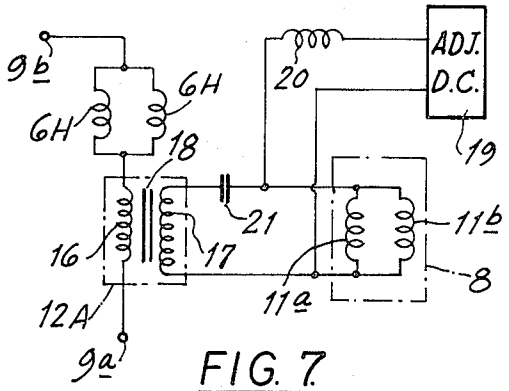


FIG. 7.

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DEFLECTION COMPENSATION FOR TEMPERATURE CHANGES IN A COLOR PICTURE TUBE

This invention relates generally to color picture tubes, and more particularly is directed to compensating for the mislanding of the electron beam or beams that may result from temperature variations in the tube.

A color picture tube generally includes an electron beam selecting device, such as, an apertured mask, grill or grid, disposed within the tube adjacent the screen of color phosphors applied to the face plate of the tube, and by which each beam is made to land on a predetermined color phosphor in dependence on the angle of incidence of the beam with respect to the beam selecting device when passing through an aperture of the latter. During operation of the color picture tube, the impingement of the electron beam or beams on the beam selecting device increase the temperature of the latter and thereby effects thermal expansion of the latter. Such thermal expansion changes the positions or alignments of the apertures of the beam selecting device in relation to the respective sets or arrays of color phosphors of the screen, and the change in alignment increases progressively from the center of the beam selecting device toward the periphery of the latter. The change in positions or alignment of the apertures relative to the respective sets or arrays of color phosphors results in mislanding of the beams, that is, in the impingement of the beams on other than the respective color phosphors of the screen, and this causes deterioration of the color purity of the resultant picture on the screen.

In order to avoid the described mislanding of the beams resulting from thermal expansion of the beam selecting device, it has been proposed to reduce the distance from the beam selecting device to the screen as the temperature of the beam selecting device increases. However, mounting the beam selecting device for temperature responsive movement relative to the screen requires the use of complicated structures for supporting the beam selecting device and such structures have reduced resistance to shocks or impacts.

Another previously proposed arrangement for avoiding the described mislanding of the beams resulting from variations in the temperature within the tube, includes an auxiliary deflection coil mounted on the neck of the tube, for example, adjacent the main deflection yoke by which the beam or beams are horizontally and vertically deflected so as to scan the screen, and a circuit by which a deflection current is made to flow through the auxiliary deflection coil and is varied in response to changes in the temperature of the beam selecting device. Such variation of the deflection current is selected so that the magnetic field produced by the auxiliary deflection coil serves to shift the effective center of beam deflection in response to temperature changes and thereby maintains proper landing of the beams on the respective color phosphors. However, such proposed arrangement does not provide sufficient compensation for fully and reliably avoiding the described mislanding, and the circuit required for varying deflection current in response to changes of temperature is complex and costly.

Accordingly, it is an object of this invention to provide a relatively simple and reliable arrangement by which the effective center of beam deflection in a color picture tube is shifted in response to temperature variations in the tube so as to effectively compensate for the mislanding of the beam or beams that would otherwise result from the thermal expansion or distortion of the beam selecting device.

Another object is to provide a compensating arrangement, as aforesaid, which is operable by a current supplied to the main deflection yoke of the tube for effecting the horizontal and/or vertical deflections of the beam or beams, and in which such current for operating the compensating arrangement is controlled by a simple, inexpensive and reliable circuit including a thermo-sensitive magnetic means.

In accordance with an aspect of this invention, a color picture tube is provided with an auxiliary magnetic deflection means disposed in back of the main deflection yoke and being

operative by a current passing through a coil of the main deflection yoke to produce magnetic flux in opposition to the magnetic flux provided by the latter, with such current for operating the auxiliary magnetic deflection means being supplied to the latter by way of a circuit including a thermo-sensitive magnetic means that decreases the current to the auxiliary magnetic deflection means with increasing temperature so as to similarly decrease the magnetic flux acting in opposition to the magnetic flux produced by the main deflection yoke, whereby the effective center of deflection of the beam or beams by the combined effects of the main deflection yoke and the auxiliary deflection means is shifted rearwardly in accordance with increasing temperature to compensate for thermal expansion of the beam selecting device.

More particularly, in a compensating arrangement according to an embodiment of this invention, the auxiliary magnetic deflection means includes a coil or coils wound on a magnetic core and connected with the corresponding coil or coils of the main deflection yoke by way of a circuit having the coil or coils of the auxiliary deflection means in parallel with a winding on a magnetic core of a permeability which decreases with increasing temperature of the tube so that the inductance of such winding decreases with increasing tube temperature. In other embodiments of this invention, the coil or coils of the auxiliary deflection means may receive the current for operation of the latter from the secondary winding of a transformer having a magnetic core of a permeability that decreases with increasing tube temperature and a primary winding connected with the corresponding coil or coils of the main deflection yoke.

The above, and other objects, features and advantages of this invention, will be apparent in the following detailed description of illustrative embodiments thereof which is to be read in connection with the accompanying drawings wherein:

FIG. 1A is a schematic, axial sectional view of a color picture tube to which reference will be made in explaining the mislanding of an electron beam that may result from thermal changes within the tube;

FIG. 1B is an enlarged detail view of a portion of the structure shown on FIG. 1A, and to which particular reference will be made in explaining the compensation effected according to this invention;

FIG. 2 is a schematic elevational view, as viewed from the top, of a color picture tube provided with a temperature compensating device according to this invention;

FIG. 3 is a schematic front elevational view of an auxiliary deflection yoke included in the device of FIG. and a wiring diagram of a circuit for 2 and the operating current thereto according to one embodiment of this invention;

FIG. 4 is a graph illustrating the variation of inductance with changing temperature for an element included in the circuit of FIG. 3;

FIG. 5 is a graph illustrating the current flow through the coils of the auxiliary deflection yoke for different tube temperature; and

FIGS. 6 and 7 are wiring diagrams of circuits for supplying the operating current to the coils of the auxiliary deflection yoke according to two other embodiments of the invention.

Referring to the drawings in detail and initially to FIG. 1A thereof, it will be seen that a color picture tube 1, as there illustrated, has a phosphor screen 2 formed on the inner surface of its face plate and an apertured beam selecting device 3, for example, in the form of a shadow mask or aperture grill or grid suitably supported within the tube and spaced rearwardly from the phosphor screen 2. As is well known and particularly shown on FIG. 1B, the phosphor screen 2 is made up of sets or arrays of primary color phosphors, as indicated at R, G and B, and the purpose of the beam selecting device 3 is to determine which of the color phosphors a particular electron beam lands upon in dependence on the angle of incidence of the beam with respect to device 3 at an aperture 4 of the latter through which the beam passes prior to impinging against the corresponding set or array of color phosphors. It will be un-

derstood that the beam selecting device **3** is heated by the impingement of the electron beam or beams thereon during scanning of the screen, and such heating of the beam selecting device causes its thermal expansion, for example, from the condition shown in full lines on FIGS. **1A** and **1B** to the condition shown in broken lines at **3'**, where the beam selecting device is spaced rearwardly from its normal or actual position merely for convenience of illustration. It will be seen that the thermal expansion of the device **3** to the condition indicated at **3'** results in the displacement of the apertures **4** away from the central axis x—x of the tube, and that the extent of such displacement of the apertures increases progressively towards the periphery of the screen **2** and the beam selecting device. Thus, for example, with respect to the aperture **4***a*, the heating of the beam selecting device **3** will effect the displacement of such aperture away from the tube axis to the position indicated at **4'***a*.

Assuming that an electron beam B_G is deflected about the effective center **0**, as by the usual main deflection yoke **6** provided on the color picture tube **1**, so as to follow the path **5** through the aperture **4***a* of beam selecting device **3** and to land on the corresponding color phosphor G_a of the array or set A when the beam selecting device **3** is at a relatively low temperature, it will be apparent that, in response to heating and the resulting thermal expansion of the beam selecting device, the electron beam B_G will be in a position **5'** when it passes through the displaced aperture **4'***a* and thus will no longer land on the corresponding color phosphor G_a, but rather will misland on the color phosphor R_a with resulting deterioration of the color purity of the picture.

However, if the effective center of deflection of the beam B_G is shifted from the position **0** in FIG. **1A** in the rearward direction, that is, away from the screen **2** or beam selecting device **3**, for example, to the position **0'**, the beam, when deflected to the position **5''**, will pass through aperture **4'***a* of the thermally expanded beam selecting device **3'** and again land on the corresponding color phosphor G_a of the respective phosphor set A, whereby to compensate for the thermal expansion of the beam selecting device and to avoid deterioration of the color purity of the picture. Thus, mislanding of the electron beam or beams can be avoided by suitably shifting the effective center of deflection of each electron beam in response to temperature changes within the tube.

In accordance with the present invention, particularly as illustrated on FIG. **2**, a color picture tube **1** having an electron gun **7** directing three beams B_R, B_G and B_B toward color screen **2** and causing such beams to converge at a common aperture of the beam selecting device **3** is provided with an auxiliary magnetic deflection device or yoke **8** in addition to the usual main deflection yoke **6** by which the three beams are deflected horizontally and vertically so as to scan the screen. When the color phosphors of screen **2** are applied in the form of vertical stripes and beam selecting device **3** is constituted by an aperture grill having vertical slits therein corresponding to the respective sets or arrays of color phosphor stripes, then the auxiliary deflection device **8** according to this invention need provide mislanding compensation only with respect to the horizontal deflections of the beams.

As shown on FIG. **2**, the auxiliary deflection device **8** is mounted on the neck of tube **1** at the side of main deflection yoke **6** remote from screen **2**, that is, in back of yoke **6**, and comprises an annular magnetic core **10** and two coil portions **11***a* and **11***b* (FIG. **3**) which are electrically connected, for example, in parallel, and wound on opposed side portions of core **10** so that, in response to a current flow through coil portions **11***a* and **11***b*, there is produced a magnetic flux, as indicated at F or F' on FIG. **3**, to effect horizontal deflections of the beams B_R, B_G and B_B. As indicated on FIG. **3**, the coil portions **11***a* and **11***b* of device **8** are connected, for example, in series, with the horizontal deflection coils or windings **6H** of the main deflection yoke **6** so that, when a horizontal deflection current is supplied to coils **6H** by way of terminals **9***a* and **9***b* to effect horizontal scanning deflection of the beams, a current will also flow in coil portions **11***a* and **11***b* to produce the magnetic flux F or F' in opposition to the magnetic flux produced by the current flowing in the coils **6H**.

In accordance with this invention, the current supplied to coil portions **11***a* and **11***b* to produce the magnetic flux F or F' is controlled by a circuit that includes a thermo-sensitive element **12** having a magnetic core, the permeability of which decreases with increasing temperature, and a winding or windings on such core connected with the coil portions **11***a* and **11***b* so as to decrease the current flowing through the latter as the permeability of the core decreases with increasing temperature. The thermo-sensitive element **12** is suitably mounted at a location adjacent the tube, for example, against the outer surface of the funnel portion of the tube envelope **1**, as shown, or against the outer surface of the neck portion of the tube envelope, where the temperature varies similarly to the temperature variations of the beam selecting device **3**.

In the embodiment of the invention shown in FIG. **3**, the thermo-sensitive element **12** is in the form of a variable inductance element including a winding **13** connected in parallel with coil portions **11***a* and **11***b* and being wound on a core **14** having a permeability that decreases with increasing temperature, for example, having the permeability characteristic illustrated on FIG. **4**. As mentioned above, the coil portions **11***a* and **11***b* are wound so that, when the deflection current flows through deflection coils **6H** to produce the flux H or H' of the main deflection field, the portion of that current passing through the coil portions **11***a* and **11***b* produces an auxiliary or pre-deflection field having its flux F or F', respectively, in opposition to the flux H or H'. Further, it will be apparent that the current flowing through coils **6H** is divided between coil portions **11***a* and **11***b* and the winding **13** of element **12** in dependence on the inductance of the latter.

When the operation of tube **1** is initiated, that is, when core **14** is relatively cool and has a high permeability, the inductance of element **12** is correspondingly high so that the major portion of the horizontal deflection current flowing through coils **6H** passes also through coil portions **11***a* and **11***b*, for example, as indicated by the full line **15** on FIG. **5**. As a result of such current flowing through coil portions **11***a* and **11***b*, the auxiliary deflection yoke or device **8** produces a strong flux which causes a relatively large pre-deflection of the beam in advance of the deflection caused by main deflection yoke **6**, whereby the beam follows the path indicated at **5** on FIG. **1**. Such path **5** has the deflection center **0** which is appropriate for the condition of the beam selecting device **3** prior to the thermal expansion of the latter. As the beam selecting device **3** is expanded due to the heating thereof coincident to continued operation of tube **1**, the core **14** of element **12** is similarly heated so as to decrease the permeability of core **14** and correspondingly decrease the inductance of element **12**. By reason of such decreased inductance, the horizontal deflection current flowing through coils **6H** is increasingly divided between coil portions **11***a* and **11***b* and winding **13**, that is, the proportion of the horizontal deflection current flowing through coil portions **11***a* and **11***b* is reduced, for example, as indicated by the broken line **15'** on FIG. **5**. The reduction of the current flowing in coil portions **11***a* and **11***b* similarly reduces the resulting flux F or F' which causes a small pre-deflection of the beam in advance of the main deflection by yoke **6**, whereby the beam follows the path indicated at **5''** on FIG. **1**. Such path **5''** has its deflection center at the location **0'**, that is, shifted rearwardly with respect to the original deflection center **0**, to ensure the proper landing of the beam on the respective phosphor for the thermally expanded condition of the beam selecting device **3**.

Referring now to FIG. **6**, it will be seen that, in another embodiment of the invention, the thermo-sensitive element **12A**, through which the coil portions **11***a* and **11***b* of auxiliary deflection yoke **8** are connected with the coils **6H** of the main deflection yoke, is in the form of a thermo-sensitive transformer including primary and secondary windings **16** and **17** which are separately wound on a core **18** having a permeabili-

ty which decreases with increasing temperature. The thermosensitive transformer 12A has its primary winding 16 connected in series with coils 6H of the main deflection yoke so that the horizontal deflection current flows therethrough, and the coil portions 11*a* and 11*b* of the auxiliary deflection yoke are connected with secondary winding 17.

It will be apparent that, in the embodiment of FIG. 6, when the tube and hence the core 18 are relatively cool, the high permeability of the core causes a relatively large current to be induced in secondary winding 17 and to flow through the coil portions 11*a* and 11*b* in response to the horizontal deflection current flowing through primary winding 16. On the other hand, with increasing temperature of the tube and hence of the core 18, the decreased permeability of the core reduces the current induced in winding 17 and flowing through coil portions 11*a* and 11*b*. Thus, as described previously with reference to FIGS. 1 and 3, increasing temperature of the tube is accompanied by decreasing predeflection of the beam by auxiliary deflection yoke 8 so that the deflection center of the beam is shifted rearwardly to compensate for the thermal expansion of the beam selecting device 3.

The auxiliary deflection yoke 8 provided according to this invention may be further utilized to compensate for deviations of the beam or beams from a desired path, for example, deviations resulting from relative misalignment of the tube parts occurring in the course of the assembly of the tube. For example, as shown on FIG. 7 in which the circuit is generally similar to that described with reference to FIG. 6, a DC current or bias may be applied to coil portions 11*a* and 11*b* of auxiliary deflection yoke 8 from an adjustable DC source 19. An inductance 20 may be connected between DC source 19 and coil portions 11*a* and 11*b* so that the pre-deflection current flowing through the latter will not also flow through source 19. Further, as shown, a capacitor 21 is preferably interposed between DC source 19 and secondary winding 17 of transformer 12A so that the DC current will not flow through the transformer, and thus cannot influence the compensation provided to correct for mislanding of the beam or beams.

In the foregoing description of embodiments of the invention, it has been assumed that the color phosphors of screen 2 are applied in the form of vertical stripes and beam selecting device 3 is constituted by an aperture grill with vertical slits so that mislanding compensation is required only with respect to horizontal deflection of the beam or beams. However, when the color picture tube has a shadow mask as its beam selecting device and the color phosphors are applied in sets or arrays of dots, then it is necessary to compensate for temperature induced mislanding in the vertical, as well as the horizontal directions. Such mislanding compensation in the vertical direction can be effected by providing additional coil portions (not shown) on the top and bottom portions of core 10, and by connecting the additional coil portions with the vertical deflection coils of main yoke 6 through circuits similar to those described with reference to FIGS. 3, 6 and 7.

Although illustrative embodiments of the invention have been described in detail herein with reference to the drawings, it is to be understood that the invention is not limited to those precise embodiments, and that various changes and modifications may be effected therein without departing from the scope or spirit of the invention.

What is claimed is:

1. In a color picture tube including an envelope having a face plate, a screen of phosphors coated on said face plate, an electron gun device for generating at least one electron beam directed toward said face plate, apertured beam selecting means disposed adjacent said face plate to land said beam on selected phosphors of said screen in accordance with the angle of incidence of said beam to said beam selecting means at the apertures of the latter, and main magnetic deflection means for deflecting said beam so as to cause scanning of said screen; the improvement comprising auxiliary magnetic deflection means disposed at the side of said main deflection means remote from said screen, and circuit means connecting said auxiliary magnetic deflection means with said main magnetic deflection means to cause a current flow through said auxiliary deflection means for producing a magnetic flux in opposition to that produced by the main deflection means in response to the supplying of a deflection current to said main deflection means, said circuit means including an element sensitive to the temperature of said tube and having a magnetic core member with a permeability that decreases with increasing temperature and at least one winding wound on said core member and connected with said auxiliary deflection means to decrease said current flow through the latter with increasing temperature of said tube, whereby said magnetic flux produced by the auxiliary deflection means is similarly decreased and the angle of incidence of the beam to the beam selecting means is changed to compensate for thermal expansion of said beam selecting means.

2. A color picture tube according to claim 1, in which said main deflection means includes coil means to produce the magnetic flux for deflecting said beam upon the flow of said deflection current therethrough, and said auxiliary deflection means includes a core and additional coil means wound on said core and electrically connected with said coil means of the main deflection means by said circuit means to produce said magnetic flux in opposition to the flux of said main deflection means in response to said current flow.

3. A color picture tube according to claim 2, in which said auxiliary deflection means is disposed adjacent to said main deflection means.

4. A color picture tube according to claim 2, in which said coil means of the main deflection means includes horizontal and vertical deflection coils to produce magnetic flux for deflecting said beam horizontally and vertically, respectively, said additional coil means is connected electrically by way of said circuit means with said horizontal deflection coil and is arranged to deflect said beam horizontally in opposition to the horizontal deflection of said beam resulting from said deflection current flow through said horizontal coil said phosphors are in the form of vertical stripes on said face plate, and said apertures of the beam selecting means are in the form of vertical slits.

5. A color picture tube according to claim 1, in which said element sensitive to the temperature of the tube is a variable inductance means having said one winding thereof connected in parallel with said auxiliary deflection means to said main deflection means so that said deflection current is proportioned between said auxiliary deflection means and said inductance means in dependence on the temperature sensed by said core member of variable permeability.

6. A color picture tube according to claim 1, in which said element sensitive to the temperature of the tube is in the form of a transformer having a primary winding in addition to said one winding, and said primary winding is connected with said main deflection means to receive said deflection current and to induce said current flow in said one winding by way of said core member of variable permeability.

7. A color picture tube according to claim 1, in which an adjustable DC current source is also connected with said auxiliary deflection means to cause the latter to compensate for deviations of said beam from a desired path.

8. A color picture tube according to claim 7, in which said element sensitive to the temperature of the tube is in the form of a transformer having a primary winding in addition to said one winding, said primary winding is connected with said main deflection means to receive said deflection current and to induce said current flow in said one winding by way of said core member of variable permeability, and means are provided to isolate said transformer from the influence of DC current from said source and to isolate said source from said current flow induced in said one winding.

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