

PATENT SPECIFICATION

(11) 1 541 484

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(21) Application No. 9058/76 (22) Filed 6 March 1976

(44) Complete Specification published 7 March 1979

(51) INT CL² H01J 29/54

(52) Index at acceptance

H1D 4A4 4A7 4B2 4B3A 4B3Y 4C1 4CY 4K4 4K7Y

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(54) MAGNET ASSEMBLY FOR ADJUSTING THE COLOUR PURITY OR CONVERGENCE OF THE ELECTRON BEAMS OF COLOUR PICTURE TUBE

(71) We, HITACHI LIMITED, a Corporation organized and existing under the laws of Japan, of 5-1, 1-chome, Marunouchi, Chiyoda-ku, Tokyo, Japan, 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:—

This invention relates to a magnet assembly for adjusting the colour purity or convergence of the electron beams of a colour picture tube, and more particularly to a magnet assembly for adjusting the colour purity or convergence of the electron beams including at least one pair of annular magnets surrounding the neck portion of a colour picture tube, preferably of the in-line electron gun type.

Generally, in a colour picture tube provided with in-line electron guns, the axes of three electron guns are arranged on the same plane including the tube axis such that the paths of the two outside electron beams emitted by the electron guns located on either side of the central electron gun will be symmetrical with respect to the path of the electron beam emitted by the central gun. It is advantageous to construct the electron gun assembly of such a colour picture tube so that the electron beams emitted by respective guns, but not deflected by deflecting means, converge at the centre of a fluorescent screen located in front of the electron gun assembly so as to produce pictures of high colour purity.

Actually, however, it is difficult to produce picture tubes satisfying such an ideal condition, because of manufacturing errors in the component parts of the tube, or permissible tolerances in the dimensions of the component parts. For this reason, colour picture tubes generally have slightly differing characteristics. Accordingly, it is necessary to provide suitable means to correct such error. As is well known in the art, an adjustable

magnetic field has been used to provide the required colour purity adjustment, as well as the static convergence adjustment.

For example, the colour purity has been adjusted by mounting a two-pole magnet assembly, including two superimposed two-pole annular permanent magnets, on the outside of the neck of the colour picture tube, so as to surround the running paths of three electron beams, and by relative rotation of the two annular permanent magnets.

On the other hand, static convergence adjustment has been accomplished by providing a pole-piece structure for directing the magnetic field on the inside and outside of the neck of the tube, and an adjusting magnet combined with the pole-piece structure.

It has also been proposed to perform static convergence adjustment by mounting a four-pole magnet assembly, including two superimposed four-pole annular permanent magnets, and a six-pole magnet assembly, including two six-pole annular permanent magnets, on the outside of the neck of the tube to surround the paths of three electron beams. These arrangements are described, for example, in British Patent Specification No. 1391798. By adjusting the intensity of the magnetic field produced by respective magnets of the assembly, the electron beams from respective electron guns are caused to converge at the centre of the fluorescent screen under the condition of no deflection.

It is necessary to adjust the intensity of the magnetic field of the magnet assembly over a range between the maximum shift of the electron beam, in which the beam is deviated to the maximum extent from the ideal condition described above, and the minimum shift of the electron beams. More particularly, where the colour picture type is ideally manufactured, so that the electron beams converge at the centre of the fluorescent screen with high colour purity, it is not necessary to provide a magnetic field. Accordingly, the construction of the magnet assembly

should be such that when it is mounted upon the tube, it can be so adjusted as not to affect the electron beams. In the ideal case, it is not necessary to vary the intensity of the magnetic field produced by the magnet assembly.

In order to vary the intensity of the magnetic field of the magnet assembly, it is usual to constitute the magnet assembly by superimposing two annular permanent magnets having the same polarity and the same flux density. When the polarities of the two permanent magnets are aligned, the intensity of the field of the magnet assembly becomes maximum. On the other hand, when the two permanent magnets are rotated relatively over a predetermined angle, for example 180° , 90° or 60° , the intensity of the field of the magnet assembly reaches a minimum.

With this construction, however, a magnet assembly capable of shifting the electron beams to the maximum extent is easily obtained by increasing the flux density of the magnets, whereas it is difficult to manufacture a magnet assembly that will produce a small shift of the electron beam or substantially no shift. Accordingly, when such a magnet assembly is mounted on a substantially ideal colour picture tube, the minimum shift of the electron beam is too large, thus making it impossible to obtain excellent convergence adjustment.

The present invention provides a colour purity or convergence magnet assembly for adjusting the paths of the electron beams of a colour picture tube of the type having a magnet assembly comprising a pair of superimposed annular permanent magnets mounted around the neck of the colour picture tube, wherein the flux density at its respective axis of the magnet on the inlet side of the electron beam is from 10 to 30% larger than the flux density at its respective axis of the magnet on the exit side of the electron beam.

The advantages of the invention can be more fully understood from the following detailed description, taken in conjunction with the accompanying drawings in which:

Fig. 1 is a diagrammatic longitudinal section showing the basic construction of an in-line electron gun type colour picture tube, provided with a magnet assembly according to the invention;

Fig. 2 is a side view showing an electron beam adjusting device, comprising three types of magnet assembly of this invention for adjusting the electron beams;

Fig. 3 is a plan view showing the magnetized states of two permanent magnets which constitute a purity magnet assembly shown in Fig. 2;

Fig. 4 shows a cross-sectional view of the purity magnet assembly shown in Fig. 2;

Fig. 5 is a diagram to illustrate the manner of adjusting the path of an electron beam by

utilizing the purity magnet assembly shown in Figs. 3 and 4; and

Fig. 6 is a graph showing the relationship between the minimum and maximum shifts of the electron beam, and the intensity of the beam inlet side magnet with respect to the beam exit side magnet.

Referring now to the drawings, Fig. 1 shows an in-line type colour picture tube 11 incorporating a magnet assembly according to this invention for adjusting the electron beams. The colour picture tube 11 comprises a neck 12, an in-line type electron gun assembly 13, and a fluorescent screen 14 coated on the inner surface of the face plate of the tube. About the neck 12 are disposed a purity magnet assembly 15, a six-pole magnet assembly 16, and a four-pole magnet assembly 17, which are used to adjust the static convergence.

As shown in Fig. 2, these magnet assemblies 15, 16 and 17 are mounted on a magnet holder 20 made of non-magnetic material, for example a plastics material, and provided with an opening (not shown) for receiving the neck. The magnetic assemblies are spaced from each other by non-magnetic spacers 21 and 22, and the magnet holder is clamped to the neck by a stainless steel clamp 23. As shown in Figs. 3 and 4, the purity magnet assembly 15 comprises two annular plate magnets 31 and 32, made for example from barium ferrite, with a thin non-magnetic spacer 33 between them. The magnets 31 and 32 are provided with tabs 31a and 32a and are magnetized to have north and south poles, as shown. In the illustrated example, the north poles are in the portions of the magnets near the tabs. These magnets are magnetized such that, when they are mounted on the neck 12 of the tube, the flux density of the magnet 31 on the inlet side of the electron beams will be higher than that of the magnet 32 on the exit side. Such a magnet assembly is adjusted to position the electron beams at the centre of the tube in the following manner. When the magnets are rotated with respect to each other by means of the tabs, so that the poles of the same polarity face each other as shown in Fig. 3, the electron beams passing through the central openings of the magnets are shifted to the maximum extent towards the lower part of the drawing. When either of the magnets is rotated 180° from this position, causing poles of opposite polarity to face each other, the intensity of the magnetic field of the magnet assembly acting upon the electron beams is minimized. This function is the same as that of the known adjusting magnet. The magnet assembly of the invention operates as follows, however.

Fig. 5 shows, as an example the relation between a purity magnet assembly comprising magnets 31 and 32 and the travel of an electron beam, the magnet assembly, for the convenience of illustration, being depicted 90° rotated about its central axis. Actually,

however, the respective poles of the magnets 31 and 32 will be on a plane perpendicular to the drawing which includes the central axis of the magnets 31 and 32, the N pole of the magnet 31 and the S pole of the magnet 32 being arranged to be on the near side of the drawing and the S pole of the magnet 31 and the N pole of the magnet 32 being arranged to be on the far side".

It is assumed now that the magnetic flux near the centre of the magnet 31 runs from the near side to the far side of the drawing substantially parallel to a plane perpendicular to the drawing and including the central axis of the magnets, and that the flux near the centre of magnet 32 runs from the far side to the near side of the drawing and substantially parallel to the above-mentioned perpendicular plane.

Electron beam 40 coming from the left is firstly deflected downwards by the field produced by magnet 31 and passes into the field of magnet 32. The deflection of the electron beam caused by the field of magnet 32 is smaller than that caused by the field of magnet 31, because the intensity of the former field is less than that of the latter field, so that the electron beam passing through the magnet assembly reaches the centre 14a of the fluorescent screen 14 through a path 41. In other words, the magnet 31 is located further from the fluorescent screen 14 than the magnet 32, and the spacing between the magnet 32 and the fluorescent screen is much larger than the spacing between the two magnets. For this reason, the electron beam 40, which has been greatly deflected downwards by the field of the magnet 31, will be deflected a little by the field of magnet 32. If the intensity of the field of the magnet 32 were the same as that of the field of the magnet 31, as in the prior art magnet assembly, the electron beam would be deflected to a considerable extent, as shown by the dot and dash line 42. Thus, when the novel magnet assembly is combined with an ideal colour picture tube, wherein the electron beams from the electron gun assembly travel along a dotted line path 44, shown in Fig. 5, and can reach the centre of the fluorescent screen 14 without using any magnet assembly, it is possible to reduce the shift of the electron beams on the fluorescent screen substantially to zero, thus providing an excellent purity adjustment.

The flux density of the magnet 31 at its axis is from 10 to 30% larger than that of the magnet 32 at its axis. If this difference were to be lower than 10%, errors in the magnetization of respective magnets would reduce the novel effect of this invention, whereas if this difference were to exceed 30%, even with an ideal colour picture tube described above, the deflection caused by magnet 31 would be too large, thus hindering efficient purity adjustment.

Fig. 6 is a graph showing the relationship between the maximum and minimum beam shifts and the intensity of magnetization of the purity magnets, in which the abscissa represents the percentage magnetization of the magnet on the beam inlet side with respect to the magnet on the beam exit side, and the ordinate represents the maximum and minimum beam shifts. Curve A shows the maximum beam shift, whereas curve B shows the minimum beam shifts. The range P is the range of percentage magnetization employed according to the present invention.

It should be understood that the invention is applicable not only to the purity magnet assembly but also to the static convergence magnet assembly for adjusting the path of the electron beam (six-pole magnet assembly 16 and four-pole magnet assembly 17), and that the relative position of the assemblies 15, 16 and 17 is not limited to that shown in Fig. 1. Thus, the invention is applicable to any one or all of the magnet assemblies mounted on the neck of the colour picture tube. The magnet assembly to which the invention should be applied is determined by the manufacturing errors of the colour picture tube, such as improper beam centring and improper convergence.

The Table below compares the amount of electron beam shift on the fluorescent screen of a tube utilizing the magnet assemblies of this invention and of a tube utilizing the prior art magnet assemblies. As the Table shows, a purity magnet assembly, a six-pole magnet assembly or a four-pole magnet assembly which is manufactured in accordance with this invention, can reduce the electron beam shift to a greater extent than the prior art magnet assemblies, so that it is possible accurately to adjust the purity and static convergence of the colour picture tube, thus producing clear and high quality pictures.

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TABLE

Comparison of the Electron Beam Shift on the Fluorescent Screen

	Sample No.	Purity magnet assembly (for centre electron beam)		6-pole magnet assembly (for electron beams on both sides)		4-pole magnet assembly (for electron beams on both sides)	
		Maximum shift	Minimum shift	Maximum shift	Minimum shift	Maximum shift	Minimum shift
Prior art magnet assembly	1	7.5 mm	0.7 mm	5.5 mm	0.6 mm	8.0 mm	0.5 mm
	2	7.5	0.8	5.0	0.7	8.1	0.6
	3	7.5	0.6	6.0	0.6	8.3	0.8
	4	7.5	0.7	5.5	0.8	8.3	0.8
	5	8.0	0.6	5.5	0.6	8.5	1.0
	mean	7.6	0.7	5.5	0.7	8.2	0.7
	max.	8.0	0.8	6.0	0.8	8.0	0.5
	min.	7.5	0.6	5.0	0.6	8.5	1.0
Novel magnet assembly	1	8.0	0.1	5.5	0.1	7.0	0.1
	2	7.5	0.1	5.2	0.1	7.5	0.2
	3	8.0	0.2	5.2	0.2	7.0	0.1
	4	8.0	0.1	5.5	0.1	7.0	0.1
	5	8.0	0.1	5.0	0.1	7.0	0.3
	mean	7.9	0.1	5.3	0.1	7.1	0.2
	max.	8.0	0.2	5.5	0.2	7.5	0.3
	min.	7.5	0.1	5.2	0.1	7.0	0.1

It should be understood that the invention is not limited to the illustrated embodiment, and that many changes and modifications may be made within the scope of the invention as defined in the appended claims. For example, the spacer between two magnets may be omitted or the magnets may be made of materials other than barium ferrite.

WHAT WE CLAIM IS:—

1. A colour purity or convergence magnet assembly for adjusting the paths of the electron beams of a colour picture tube of the type having a magnet assembly comprising a pair of superimposed annular permanent magnets mounted around the neck of the colour picture tube, wherein the flux density at its respective axis of the magnet on the inlet side of the electron beam is from 10 to 30% larger than the flux density at its

respective axis of the magnet on the exit side of the electron beam.

2. A magnet assembly as claimed in claim 1 wherein each magnet is made of barium ferrite.

3. A magnet assembly as claimed in claim 1 or 2 wherein the superimposed magnets have a non-magnetic spacer interposed therebetween.

4. A magnet assembly as claimed in any preceding claim wherein the colour picture tube is of the in-line electron gun type.

5. A magnet assembly as claimed in any preceding claim wherein each magnet comprises an annular permanent magnet magnetized to have poles of opposite polarity around the periphery and is provided with a radially extending tab.

6. A magnet assembly as claimed in any preceding claim wherein the magnet assembly

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TABLE

Comparison of the Electron Beam Shift on the Fluorescent Screen

	Sample No.	Purity magnet assembly (for centre electron beam)		6-pole magnet assembly (for electron beams on both sides)		4-pole magnet assembly (for electron beams on both sides)	
		Maximum shift	Minimum shift	Maximum shift	Minimum shift	Maximum shift	Minimum shift
Prior art magnet assembly	1	7.5 mm	0.7 mm	5.5 mm	0.6 mm	8.0 mm	0.5 mm
	2	7.5	0.8	5.0	0.7	8.1	0.6
	3	7.5	0.6	6.0	0.6	8.3	0.8
	4	7.5	0.7	5.5	0.8	8.3	0.8
	5	8.0	0.6	5.5	0.6	8.5	1.0
	mean	7.6	0.7	5.5	0.7	8.2	0.7
	max.	8.0	0.8	6.0	0.8	8.0	0.5
	min.	7.5	0.6	5.0	0.6	8.5	1.0
Novel magnet assembly	1	8.0	0.1	5.5	0.1	7.0	0.1
	2	7.5	0.1	5.2	0.1	7.5	0.2
	3	8.0	0.2	5.2	0.2	7.0	0.1
	4	8.0	0.1	5.5	0.1	7.0	0.1
	5	8.0	0.1	5.0	0.1	7.0	0.3
	mean	7.9	0.1	5.3	0.1	7.1	0.2
	max.	8.0	0.2	5.5	0.2	7.5	0.3
	min.	7.5	0.1	5.2	0.1	7.0	0.1

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1. A colour purity or convergence magnet assembly for adjusting the paths of the electron beams of a colour picture tube of the type having a magnet assembly comprising a pair of superimposed annular permanent magnets mounted around the neck of the colour picture tube, wherein the flux density at its respective axis of the magnet on the inlet side of the electron beam is from 10 to 30% larger than the flux density at its

respective axis of the magnet on the exit side of the electron beam.

2. A magnet assembly as claimed in claim 1 wherein each magnet is made of barium ferrite.

3. A magnet assembly as claimed in claim 1 or 2 wherein the superimposed magnets have a non-magnetic spacer interposed therebetween.

4. A magnet assembly as claimed in any preceding claim wherein the colour picture tube is of the in-line electron gun type.

5. A magnet assembly as claimed in any preceding claim wherein each magnet comprises an annular permanent magnet magnetized to have poles of opposite polarity around the periphery and is provided with a radially extending tab.

6. A magnet assembly as claimed in any preceding claim wherein the magnet assembly

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comprises a purity magnet assembly and a static convergence magnet assembly.

7. A magnet assembly as claimed in claim 6 wherein the static convergence magnet assembly comprises a six-pole magnet assembly and a four-pole magnet assembly.

8. A magnet assembly as claimed in claim 1 substantially as hereinbefore described with reference to the accompanying drawings.

9. A colour picture tube which comprises a magnet assembly as claimed in any of the preceding claims. 10

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Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1979.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from
which copies may be obtained.