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(54) Colour cathode ray tube.

(57) By selecting the number of apertures in the shadow mask of a colour cathode ray tube to be in the range between 690 and 770, such a cathode ray tube can be used both in a PAL and an NTSC system without the occurrence of disturbing Moiré effects.

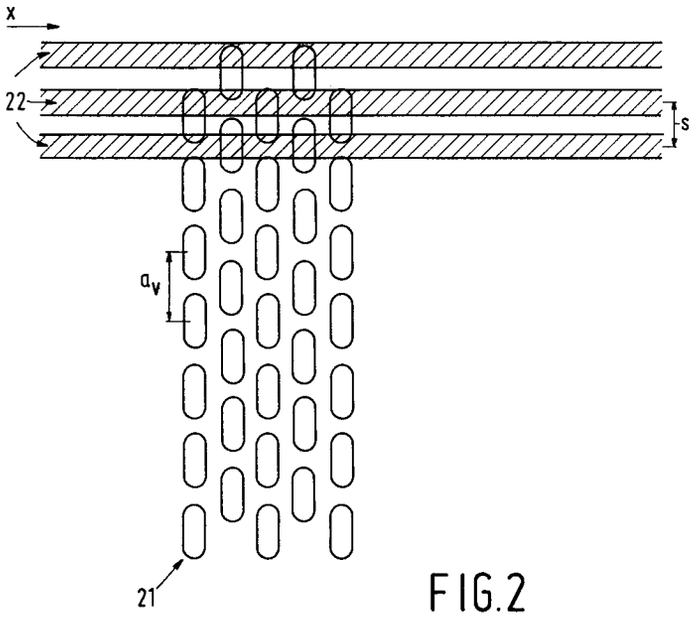

FIG.2

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The invention relates to a colour cathode ray tube comprising an electron gun for generating at least one electron beam, a colour selection electrode having rows of apertures, a display screen and means for deflecting the electron beam across the colour selection electrode in a line deflection direction transverse to the row of apertures.

Such display devices are known. They are used, *inter alia*, in television receivers.

A disturbing effect which may occur in such display devices is the so-called Moiré effect. This effect causes light and dark lines or lines of a deviating colour in the image.

In operation, lines are written on the display screen in the line deflection direction by the electron beam(s). The number of lines written on the display screen (the so-called number of active lines) is system-dependent. In PAL and SECAM systems approximately 540 lines are written on the display screen, (in these systems the signal comprises 625 lines; approximately 50 of said lines are used for coded information; of the remaining 575 lines approximately 7% is scanned beside the display screen, the so-called "overscan"; thus, the overall number of active lines is approximately (625 - 50)/1.07 = 537). In the NTSC system approximately 450 active lines are written (the NTSC signal comprises 525 lines). For so-called HDTV applications of these systems the number of lines is doubled to, respectively, 1250 and 1050 in the signal and approximately 1040 and 900 active lines. In operation, a colour cathode ray tube preferably does not exhibit disturbing Moiré effects for "normal" display or HDTV-display, irrespective of whether such a tube is used in a PAL, SECAM or NTSC system.

It is an object of the invention to provide a colour cathode ray tube which can be used in several systems and in which no disturbing Moiré effect occurs.

To this end, the colour cathode ray tube in accordance with the invention is characterized in that the number of apertures per row ranges between 690 and 780.

Hitherto, "standard" systems customarily have in the order of 500 to 600 apertures per row. In this range (≈ 500-600) Moiré effects can be avoided for a specific application or system but for other applications or systems such colour cathode ray tubes exhibit very disturbing Moiré effects. The colour cathode ray tube in accordance with the invention does not exhibit such disturbing Moiré effects. By virtue thereof, a substantial saving in costs can be achieved.

Within the range from 690 to 770, there are a number of preferred ranges. These ranges are very suitable for specific combinations of applications or systems. A first preferred range is defined in that the number of apertures ranges between 705 and 750, more particularly between 705 and 730. This range is very suitable for PAL (or SECAM) systems both for normal and HDTV display.

A second preferred range is defined in that the number of apertures ranges between 730 and 750. This range is very suitable for dual PAL-NTSC HDTV applications.

A third preferred range is defined in that the number of apertures ranges between 730 and 780, more particularly between 750 and 780. This range is very suitable for NTSC applications both for normal and HDTV display.

The invention also relates to a display device comprising such a colour cathode ray tube.

The invention further aims at providing a display device comprising a colour cathode ray tube having an electron gun for generating at least one electron beam, a colour selection electrode having rows of apertures, a display screen and means for deflecting the electron beam across the colour selection electrode in a line deflection direction transverse to the rows of apertures, so that no disturbing Moiré effects occur.

To this end, the display device in accordance with the invention is characterized in that, in operation, the lines are subjected to interlaced scanning and the ratio between the number of apertures and the number of lines scanned across the apertures is approximately 4/6 or 5/6.

The above-mentioned ratio is equal, within a 0.1% margin, to the so-called s/a_v ratio, where s is the scan pitch for the entire frame and a_v is the mask pitch. Preferably, for a PAL or SECAM display device a ratio of approximately 4/6 is used and for an NTSC display device a ratio of approximately 5/6 is used. A PAL (SECAM), NTSC display device is to be understood to mean within the scope of the invention a display device which is suitable for receiving, respectively, a PAL (SECAM) and an NTSC signal.

These and further aspects of the invention will be explained in greater detail by means of an example and with reference to the accompanying drawing, in which

Fig. 1 is a colour cathode ray tube;

Fig. 2 is a detail of a colour selection electrode.

The Figures are diagrammatic.

In the Figures, like reference numerals refer to like parts.

Fig. 1 is a partly perspective view of a cathode ray tube 1. Said cathode ray tube 1 comprises an evacuated envelope 2 having a display window 3, a cone 4 and a neck 5. In the neck there is provided an

electron gun 6 for generating, in this example, three electron beams 7, 8 and 9. On the inside of the display window 3 there is provided a luminescent display screen 10 which, in this example, comprises phosphor elements luminescing in red, green and blue. On their way to the screen 10, said electron beams 7, 8 and 9 are deflected across the screen 10 by means of a deflection unit 11, which is located at the junction between the neck and the cone, and pass through the colour selection electrode, in this example the shadow mask 12 which comprises a thin plate having apertures 13. The electron beams 7, 8 and 9 pass through said apertures 13 at a small angle with respect to each other and each electron beam impinges on phosphor elements of only one colour. Said Figure also diagrammatically shows the drive mechanism 14 of the electron gun and the deflection unit as well as the receiving means 15 for receiving a signal 16.

Fig. 2 is a top view of a detail of a colour selection electrode. Said colour selection electrode 20 comprises a number of rows of apertures 21. Said rows extend transversely to the line deflection direction x. In successive rows the apertures are offset relative to each other in a direction transverse to the line deflection direction. Scanning lines 22 are also shown. Said lines diagrammatically show where the electron beam(s) is (are) incident on the shadow mask.

In the case of the so-called PAL and SECAM system, which is used in Europe, Asia, Africa and parts of South-America, the number of lines which are incident on the shadow mask and which impinges on the display screen after passing through the apertures of the shadow mask is approximately 540 for a "standard" display and twice as many for a HDTV display. The number of active lines of the NTSC system is approximately 450 for "standard" display and 900 for HDTV display. In Fig. 2 the scanning-line pitch s is shown. This is the distance between the scanning lines. The distance between the apertures (mask pitch) a_v is also shown.

Interference of the pattern of apertures in the colour selection electrode with the scanning-line pattern causes Moiré effects. Moiré effects occur in horizontal directions (in which case horizontal bars are visible in the image displayed) and at oblique angles (oblique bars appear in the image). Combinations thereof, which appear for example in the form of a diamond pattern, are also possible. In each of the systems (PAL-SECAM; NTSC) and display variants ("standard" or HDTV) different Moiré effects occur. Table 1 diagrammatically shows the extent to which said Moiré effects as a whole are perceived as disturbing by test persons. The number of apertures in a row (N) is listed in the vertical direction, the systems (PAL; PAL-HDTV; NTSC; NTSC-HDTV) are listed in the horizontal direction. This Table does not distinguish between PAL and SECAM because in said systems use is made of an equal number of scanning lines. The qualifications given have the following meaning:

+ + = very good
+ = good
0 = fairly good.

Table 1

Number of apertures per row	PAL	PAL-HDTV	NTSC	NTSC-HDTV
690-770	+	+	o	o
705-730	+ +	+ +	+	+
730-750	+	+	+	+ +
750-780	o	o	+ +	+ +

Table 1 shows that if N ranges between approximately 690 and 780 a fairly good display is obtained for each of the systems and display variants. Thus, a colour cathode ray tube comprising a colour selection electrode having such a number of apertures can be used in each system. In PAL systems, the range between 705 and 750, more particularly 705-730, is very suitable. For a dual PAL-NTSC application, the range between 730 and 750 is very suitable and for NTSC applications the range between 730 and 780, in particular 750-780, is suitable.

The invention makes it possible to provide a colour cathode ray tube which can be used in the various existing systems and applications without the occurrence of disturbing Moiré effects. By virtue thereof, a substantial saving in costs can be achieved; in various types of display devices the same colour-cathode ray tube can be used. It is also possible to use the same colour selection electrode for different types of colour cathode ray tubes. The invention also provides a cathode ray tube which does not exhibit disturbing Moiré patterns when it is used for HDTV applications (double line frequencies).

Conventional colour cathode ray tubes for "standard applications" comprise colour selection electrodes the number of apertures of which ranges between approximately 500 and 600. In such colour cathode ray tubes the use of one and the same tube for different systems and applications inevitably leads to disturbing Moiré patterns.

Further it has been found that for the ranges $690 < N < 750$ (preferably $705 < N < 730$) in a PAL-HDTV system and $730 < N < 780$ (preferably $750 < N < 780$) in an NTSC-HDTV system substantially no disturbing Moiré patterns occur. This is remarkable because at first one would expect such a HDTV-system to exhibit the same Moiré effects as a "standard" PAL or NTSC system having half as many apertures, *i.e.* for PAL $345 < N < 375$ and for NTSC $365 < N < 385$. However, this is not the case. "Standard" PAL systems and NTSC systems having the number of apertures indicated in the previous line exhibit clearly visible Moiré patterns.

Table 1 above represents one aspect of the invention, which aspect relates to the number of apertures in one row.

Below, a description is given of a second aspect of the invention, which relates to the ratio between the number of apertures and the number of effectively scanned lines (the s/a_v ratio).

Table 2 below lists the ratios between the number of scanning lines and the number of apertures per row for the different ranges, the number of apertures per row and the different systems. This ratio is equal, within a 0.1% margin, to the ratio between the distance between the scanning lines (also referred to as scan pitch s) and the distance between the apertures in a row (also referred to as mask pitch a_v). The ratio s/a_v can be calculated from the number of apertures per row and the number of scanning lines. If N_0 is the number of apertures and N_s is the number of effective scanning lines, then s/a_v is defined by $(N_0 - 1)/(N_s - 1)$. Since both N_0 and N_s are very large, s/a_v is substantially equal to N_0/N_s. A few embodiments exhibiting exceptionally few Moiré effects are given in bold print. The s/a_v ratio is an important parameter for the occurrence of Moiré effects.

Table 2

Number of apertures per row	PAL SECAM	PAL-HDTV SECAM-HDTV	NTSC	NTSC-HDTV
690-770	1,285-1,434	0,643-0,717	1,524-1,708	0,762-0,854
705-730	**1,313-1,359**	**0,657-0,68**	1,557-1,612	0,779-0,806
730-750	1,359-1,397	0,68-0,699	1,612-1,657	0,806-0,829
750-780	1,397-1,434	0,699-0,717	**1,657-1,708**	**0,829-0,854**

An embodiment of the invention in accordance with the second aspect of the invention is characterized in that in interlaced systems the ratio s/a_v (which corresponds to the number of apertures divided by the number of lines in one field) is approximately 4/6 or 5/6.

In interlaced systems two fields are scanned, a first field having half the overall number of lines and the distance between successive lines being twice the scan pitch, followed by a second field, also having half the overall number of lines and the distance between two successive lines also being twice the scan pitch, with the lines of the second field extending between the lines of the first field. It has been found, both theoretically and in practice, that in such systems the Moiré effect is substantially reduced and is minimal for the indicated value. In the PAL (SECAM) system the ratio is preferably approximately 4/6 and in the NTSC system the ratio is approximately 5/6 (see Table 2, third column, third row (PAL-SECAM-HDTV) and Table 2, fifth column, fifth row (NTSC-HDTV)). In the above Table these ranges are given in bold print (for a 7% overscan). "Approximately" is to be understood to mean in this connection that the difference between the s/a_v ratio and the ideal ratio is less than approximately 2% of said ideal ratio (4/6 or 5/6).

A frame can also be scanned by means of the so-called progressive scanning method, *i.e.* all lines of the complete frame are successively scanned. In such systems the ratio s/a_v is preferably approximately equal to 4/3 or 5/3. In the case of a progressive scan the overall number of lines in each frame is scanned.

Table 2 above lists in bold print s/a_v ranges for PAL and NTSC systems which do not overlap, *i.e.* under the given conditions the number of apertures of an "ideal" PAL system do not correspond to the number of apertures of an "ideal" NTSC system. Table 3 below shows that such an overlap is possible.

Table 3

Number of apertures per row	PAL SECAM 4% overscan	PAL-HDTV SECAM-HDTV 4% overscan	NTSC 10% overscan	NTSC-HDTV 10% overscan
690-770	1,285-1,434	0,643-0,717	1,524-1,708	0,762-0,854
705-730	1,313-1,359	0,657-0,68	1,557-1,612	0,779-0,806
730-750	**1,359-1,397**	**0,68 0,699**	**1,612-1,657**	**0,806-0,829**
750-770	1,397-1,434	0,699-0,717	1,657-1,708	0,829-0,854

In Table 3 the preferred ranges are given in bold print. The difference between Table 2 and Table 3 is that in Table 2 the overscan is 7% for each system, whereas in Table 3 a distinction is made between a PAL (SECAM) system and an NTSC system. In a PAL system the overscan is 4%, while in an NTSC system the overscan is 10%. A change in overscan causes a change of the scan pitch s and hence of the ratio s/a_v. By making the overscan dependent on the signal to be received, it becomes possible to design a system which exhibits a substantially improved Moiré effect for both a PAL (SECAM) signal and an NTSC signal. It will be obvious that this optimum range is somewhat variable. A 2% (or 6%) overscan of a PAL system in combination with an 8% (or 12%) overscan of an NTSC system causes the "ideal" number of apertures to change from approximately 737 to 751 or 723. The "ideal" number of apertures can be varied slightly further if the difference in overscan is also changed. For example, if a difference in overscan of 5% is used, a combination of 7% (PAL) and 12% (NTSC) can be used. The "ideal" number of apertures then amounts to 717.

Table 3 above deals with a third aspect of the invention. This aspect of the invention relates to the ratio s/a_v in combination with a manipulation of this ratio which is governed by the incoming signal.

An embodiment of the invention in accordance with the third aspect of the invention relates to a display device comprising a colour cathode ray tube having an electron gun for generating at least one electron beam, a colour selection electrode having rows of apertures, a display screen and means for deflecting the electron beam across the colour selection electrode in a line-deflection direction transverse to the rows of apertures, and comprising means for receiving a picture signal and means for controlling the overscan as a function of the incoming signal.

As shown above, this makes it possible to attain a reduced Moiré effect for two systems having a different number of scanned lines. The two systems presently in use are PAL and NTSC. Preferably, the number of apertures per row ranges between 710 and 760. Within this range, it is possible to maximally reduce the Moiré effect for the two systems presently in use. Preferably, the difference in overscan is 5-7%.

For this purpose, the receiving means 15 (Fig. 1) comprises a means for influencing the overscan as a function of the incoming signal. This results in an adaptation of the scan pitch s and hence the ratio s/a_v.

It will be obvious that within the scope of the above-described invention many variations are possible to those skilled in the art.

In this example, the electron gun simultaneously generates three electron beams, each electron beam generating an image in red, green or blue. This is not to be interpreted in a limiting sense, the electron gun may alternatively generate a single electron beam which sequentially generates the three different colour images. In this example each row has an equal number of apertures. Small variations, within the indicated range, in the number of apertures may however occur, for example to improve the edges of the image displayed. Besides, at its periphery, the colour selection electrode may have a small number (fewer than five) of rows having a smaller number of apertures than indicated in the claims.

Claims

1. A colour cathode ray tube comprising an electron gun for generating at least one electron beam, a colour selection electrode having rows of apertures, a display screen and means for deflecting the electron beam(s) across the colour selection electrode in a line deflection direction transverse to the rows of apertures, characterized in that the number of apertures per row ranges between 690 and 780.

2. A colour display tube as claimed in Claim 1, characterized in that the number of apertures per row ranges between 730 and 750.

3. A colour display device of the PAL or SECAM type comprising a colour cathode ray tube having an electron gun for generating at least one electron beam, a colour selection electrode having rows of apertures, a display screen and means for deflecting the electron beam across the colour selection electrode in a line deflection direction transverse to the rows of apertures, characterized in that the number of apertures per row ranges between 705 and 750.

4. A colour display device of the NTSC type comprising a colour cathode ray tube having an electron gun for generating at least one electron beam, a colour selection electrode having rows of apertures, a display screen and means for deflecting the electron beams across the colour selection electrode in a line deflection direction transverse to the rows, characterized in that the number of apertures per row ranges between 730 and 780.

5. A display device comprising a colour cathode ray tube having an electron beam, a colour selection electrode having rows of apertures, a display screen and means for deflecting the electron beam across the colour selection electrode in a line deflection direction transverse to the rows of apertures, characterized in that, in operation, the lines are subjected to interlaced scanning and the ratio between the number of apertures and the number of lines scanned across the apertures (s/a_v) is approximately 4/6 or 5/6.

6. A display device comprising a colour cathode ray tube having an electron gun for generating at least one electron beam, a colour selection electrode having rows of apertures, a display screen and means for deflecting the electron beam across the colour selection electrode in a line deflection direction transverse to the rows of apertures, characterized in that, in operation, the lines are progressively scanned and the ratio between the number of apertures and the number of lines scanned across the apertures (s/a_v) is approximately 4/3 or 5/3.

7. A display device comprising a colour cathode ray tube having an electron gun for generating at least one electron beam, a colour selection electrode having rows of apertures, a display screen and means for deflecting the electron beam across the colour selection electrode in a line deflection direction transverse to the rows of apertures, and comprising means for receiving a picture signal and means for controlling the overscan as a function of the incoming signal.

8. A display device as claimed in Claim 7, characterized in that the number of apertures per row ranges between 710 and 760.

9. A display device as claimed in Claim 7 or 8, characterized in that the difference in overscan ranges between 5% and 7%.

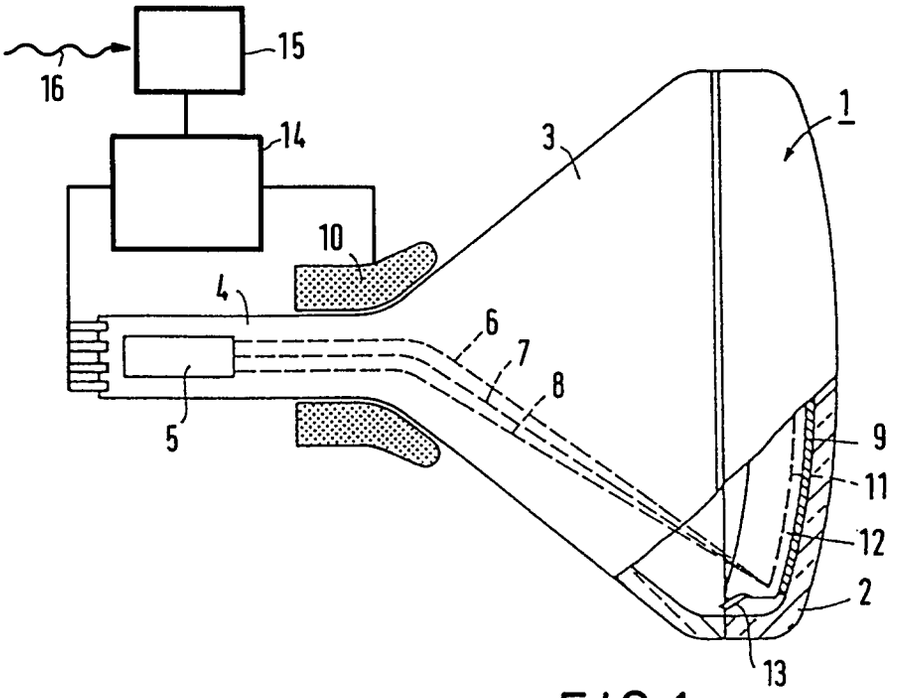

FIG.1

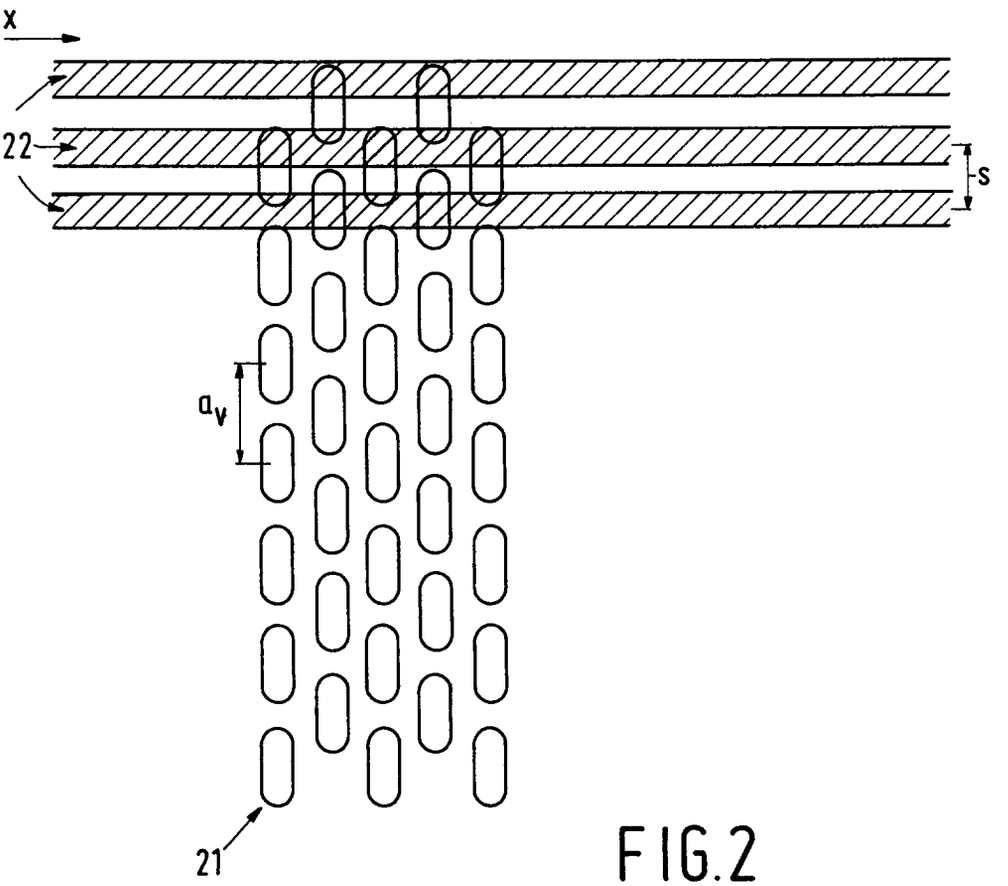

FIG.2

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EUROPEAN SEARCH REPORT

Application Number
EP 94 20 2200

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	EP-A-0 321 202 (MITSUBISHI) * column 2, line 42 - line 46 * * column 3, line 3 - line 38 * * column 6, line 56 - column 7, line 34 * * column 7, line 49 - column 8, line 30 * * figure 3 *	1,3-7	H01J29/07
A	US-A-4 326 147 (T. NAKAYAMA ET AL.) * the whole document *	1,3,4	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			H01J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23 November 1994	Daman, M

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