



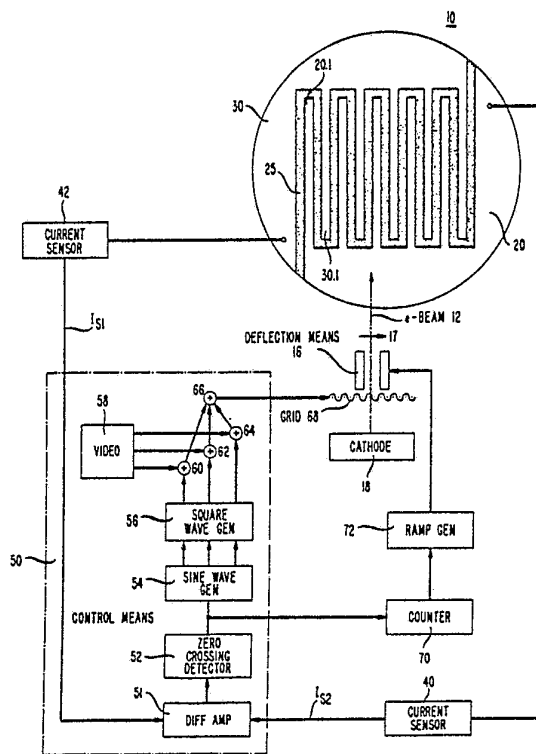
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(54) Title: SINGLE BEAM COLOR CRT

(57) Abstract

The target (10) of a CRT comprises a substrate (14) on which are formed a plurality of color stripe triads. Each stripe triad has three epitaxial layers (R, G, B) in a staircase geometry and is overlaid with a metal stripe (20.1, 30.1). The metal stripes are the fingers of a pair of interdigitated electrodes (20, 30). A single e-beam (12) scans the stripes horizontally, and a sequence of current pulses (I_{S1} , I_{S2}) generated in the electrodes precisely defines the horizontal position of the beam relative to the triads. The sequence of current pulses is used to precisely time the beam modulation for introducing color signals.



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SINGLE BEAM COLOR CRT

Background of the Invention

This invention relates to color cathode ray tubes
5 (CRTs) and, more particularly, to color CRTs in which the
target is addressed by a single electron beam (e-beam).
These CRTs are suitable for projection display systems.

In a single electron beam CRT, different color
10 producing phosphors are arranged in groups of three, or
"triads", and a single electron beam sweeps across each
phosphor of the triads to generate each primary color; the
electron beam being modulated by a video signal to obtain
the proper color mix at each triad. Essential to proper
15 operation of such CRTs is the need to synchronize the beam
movement with the video signal; this, in turn, requiring a
continuous accurate determination of the position of the
beam relative to each triad. In one prior art CRT, for
example, the electron gun contains a single cathode and
20 means for splitting up the electrons into two beams. The
primary beam generates color in the usual fashion, and the
pilot beam is used to determine the position of the primary
beam. The color phosphors are parallel stripes, and behind
the red phosphor stripes are secondary emission index
25 stripes. A particular frequency mixing scheme is used to
determine when the primary color beam is at the red
phosphor stripe, with the other colors coming at fixed
periods in relation to that time. The system, however,
imposes too many severe requirements on the structure of
the CRT to be practical and has been abandoned after
30 several years of intense development. Other approaches are
similarly excessively complex.

Summary of the Invention

In accordance with one aspect of our invention,
the target for a CRT includes a plurality of color stripe
35 triads, each triad being overlaid with a metal stripe.
The metal stripes are the fingers of a pair of



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interdigitated electrodes. A single e-beam scans the stripes, and a sequence of current pulses generated in the electrodes is used to precisely define the position of the beam relative to the triads. This information is used to
5 time the beam modulation for introducing color signals.

Brief Description of the Drawings

FIG. 1 is a schematic of CRT apparatus in accordance with one embodiment of our invention;

FIG. 2 is a cross-sectional view (without cross-hatching) of a preferred target for use in the CRT of
10 FIG. 1; and

FIG. 3 illustrates signal waveforms generated by the apparatus of FIG. 1.

Detailed Description

15 With reference now to FIG. 1, there is shown CRT apparatus in accordance with one aspect of our invention including a color target 10 which is scanned by a single e-beam 12. The target, as shown in FIG. 2, comprises a plurality of color phosphor stripe triads: R for
20 generating red light, G for generating green light, and B for generating blue light. These stripes are arranged on a substrate 14 in a staircase geometry so that, as viewed by the e-beam 12, they appear as side-by-side color stripes. The particular arrangement with the red stripe on top and
25 the blue stripe on the bottom is illustrative only - any sequence of the three primary colors is suitable.

Overlaying each stripe triad is a metal layer. Two metal layers designated 20.1 and 30.1 are depicted in FIG. 2 as overlaying adjacent triads. The plurality of
30 such metal layers form the fingers of a pair of interdigitated electrodes 20 and 30 as shown in FIG. 1. Note that a serpentine gap 25 is depicted in FIG. 1 for clarity of illustration only. In practice, the top view of the target might not show such a gap because, as shown in
35 FIG. 2, the only separation between adjacent fingers is in the direction perpendicular to substrate 12.



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In another embodiment of the invention, all of the stripes are in a side by side relationship in a single plane, i.e., not in a staircase geometry as illustrated in FIG. 2. In such arrangement, the metal layers overlying the various triads are also in a single plane, and a small gap (such as that shown in FIG. 1) is provided between each metal layer to electrically separate the metal layers.

By means described later, the e-beam 12 is modulated with video (color) information and made to scan horizontally (i.e., transversely) across the fingers of electrodes 20 and 30 in the direction, for example, of arrow 17. The metal layers do not stop the electrons. The e-beam energy is chosen, however, so that the electrons are absorbed in only the uppermost color stripe. Thus, the beam produces only a single primary color at a time (i.e., in a given beam position). For example, in FIG. 2 for the beam position shown, the electrons are absorbed in the green stripe G and generate light of wavelength λ_G , but they do not have enough energy to penetrate into the underlying blue stripe B. The light intensity is modulated by modulating the e-beam current as is well known in the art.

The substrate 14 is electrically insulating and the electrons instantly leak back to the overlying metal layer (layer 20.1 for the illustrative beam position of FIG. 2). By monitoring this leakage current to the interdigitated electrodes 20 and 30, current sensors 40 and 42 generate a sequence of current pulses. Control means 50 (FIG. 1) is responsive to these current pulses for precisely defining the horizontal position of e-beam 12 relative to the triads. An important feature of this aspect of our invention is that the sensor outputs are used to generate a zero-crossing signal which is independent of the level of the beam current and hence independent of the video signal. The zero-crossing signal, in turn, is used to time beam modulation for introducing color signals.



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More specifically, as the e-beam 12 scans across the interdigitated electrodes, it generates a current I_{S1} from electrode 30 and I_{S2} from electrode 20. The waveforms for I_{S1} and I_{S2} are shown, respectively, in parts (a) and (b) of FIG. 3. Note that these waveforms constitute pulse trains which are 180° out of phase with one another. The sum of these currents equals the beam current less the secondary electron emission current, which is typically small at the relatively high beam voltages employed (e.g., 25 kV). However, only when the beam is precisely centered on the interface 19 (FIG. 2) between adjacent fingers is the beam current in each of those fingers identical. This fact is exploited by feeding the currents I_{S1} and I_{S2} into a balanced difference amplifier 51. The output of amplifier 51 is a zero-crossing signal $I_{S1} - I_{S2}$ shown in part (c) of FIG. 3. This difference signal is applied to a zero-crossing detector 52 which generates a train of timing pulses shown in part (d) of FIG. 3. These pulses have a period T and correspond precisely to the instants at which the beam crosses from one triad to the next. Importantly, this timing signal is derived only from the zero-crossing of the difference signal and is independent of the amplitude level (i.e., video modulation) of the beam current.

The timing pulses at the output of the zero-crossing detector 52 are fed into a sine wave generator 54 in order to generate within each interval T three sine waves which are 120° out of phase with one another and which have a period equal to T , as shown in part (e) of FIG. 3. In practice, the timing pulses could, for example, serve as the input to a phase delay circuit in generator 54. These phase delayed sine waves are then converted by square wave generator 56 into trains of sampling pulses on three parallel output lines of generator 56. As shown in part (f) of FIG. 3, there are three sampling pulses in each period T and, as with sine waves, the pulse trains are 120° out of phase with one



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another.

These sampling pulses are used to sample the red, green and blue analog color signals supplied by video circuit 58. Sampling circuits are well known in the art and are illustratively depicted in FIG. 1 as multipliers 60, 62, and 64 used, respectively, to sample the red, green, and blue video signals. The three primary color samples retain the 120° phase delay and are combined by means of adder circuit 66 to supply an analog modulation signal to the grid 68 of the CRT. Of course, this modulation signal varies the beam current which, in turn, varies the intensity of the light output.

The output of the zero-crossing detector 52 is also used to control the horizontal deflection means 16. The timing pulses at the output of detector 52 are counted in counter 70 and used to control the duration of the sawtooth output waveform of ramp generator 72 as is well known in the art.

In one embodiment of our invention, a high brightness, miniature CRT is provided which is useful, for example, in a projection CRT system. The target 10 comprises a yttrium-aluminum-garnet (YAG) substrate 14 on which are epitaxially grown three YAG layers, each one producing a primary color for use in color display. These layers are then etched, or otherwise suitably shaped, to form the staircase configuration of FIG. 2. Finally, the interdigitated electrodes 20 and 30 are deposited so that the fingers of electrodes cover the triads as in FIG. 2. Aluminum is a suitable material for the electrodes. To generate primary colors the following compositions are illustrative: the R layer comprises Eu:YAG, the G layer comprises Ce:YAG, and the B layer comprises Tm:YAG all of which may be grown on an undoped YAG substrate by the epitaxial technique generally described in H. J. Levinstein, S. J. Licht, R. W. Landorf, and S. L. Blank, Applied Physics Letters, Vol. 19, p. 486 (1971). Although this paper describes the growth of a



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different material, essentially the same method is used to fabricate YAG. See also, U.S. Patent 3,790,405.



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CLAIMS

1. A single beam color CRT comprising
a target including a plurality of triads each
including three adjacent stripes of material for generating
5 primary colors of light when excited by an electron beam,
and
means for scanning a single electron beam across
the triads to generate said light,
CHARACTERIZED BY
10 a pair of interdigitated electrodes (20, 30)
having fingers (20.1, 30.1) which overlay said triads, said
beam generating trains of current pulses from said
electrodes,
control means (50) responsive to said current
15 pulse trains for modulating said electron beam so as to
modulate the intensity of said light.
2. The apparatus of claim 1 wherein each of said
triads comprises adjacent stripes of single crystal YAG
material.
- 20 3. The apparatus of claim 2 wherein said triads
have a staircase geometry.
4. The apparatus of claim 1 wherein said control
means includes
sensing means (42) for generating a pair of
25 current pulse trains which are 180° out of phase with one
another,
comparator means (51) for generating a signal
corresponding to the difference between said pulse trains,
detector means (52) for generating a train of
30 timing pulses of periodicity T corresponding to the zero-
crossings of said difference signal,
means (54, 56) responsive to said timing pulses
for generating in each period T three sampling pulses 120°
out of phase with one another,
35 sampling means (60, 62, 64) responsive to said
sampling pulses for generating analog samples of three
primary color video signals, and

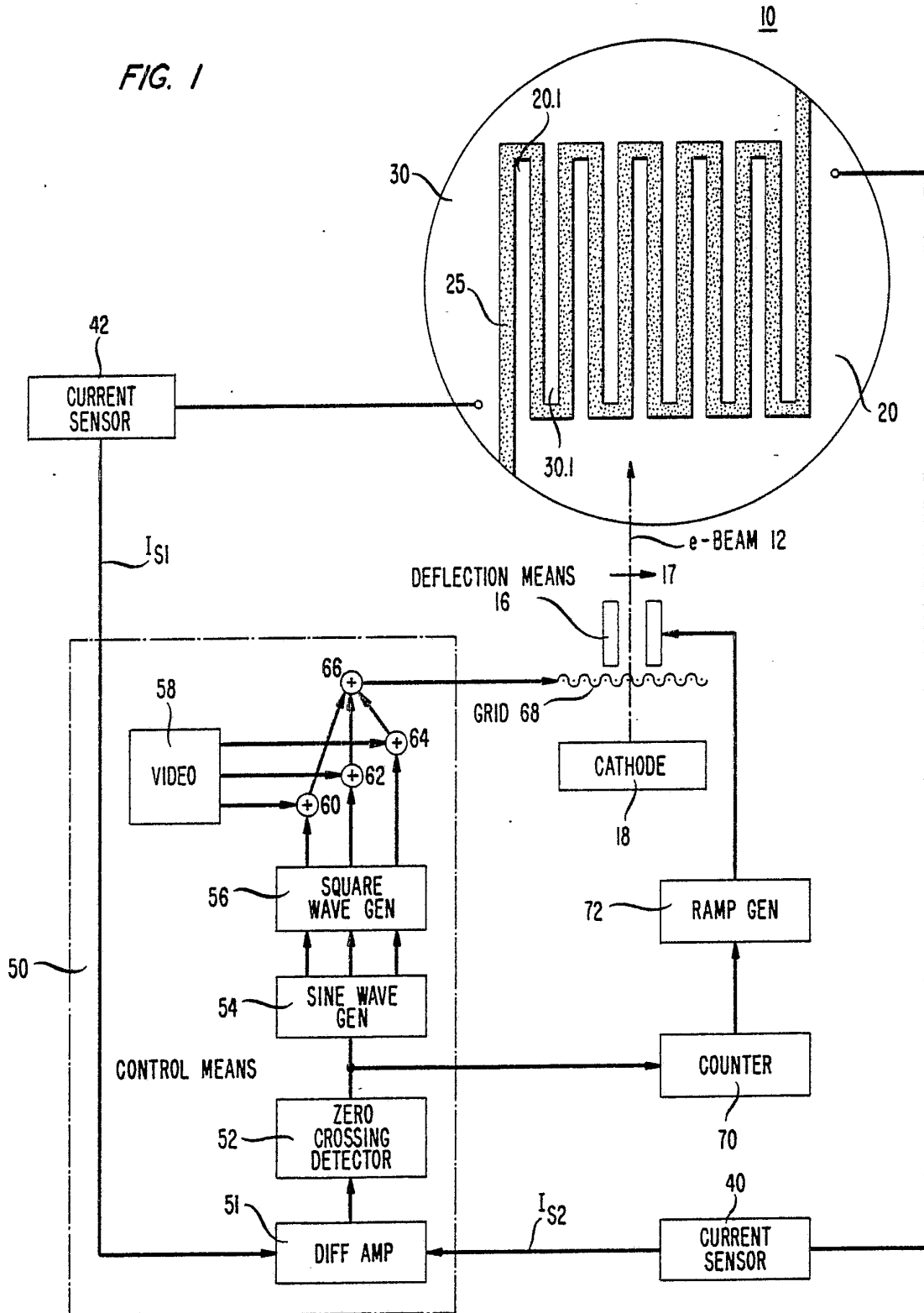


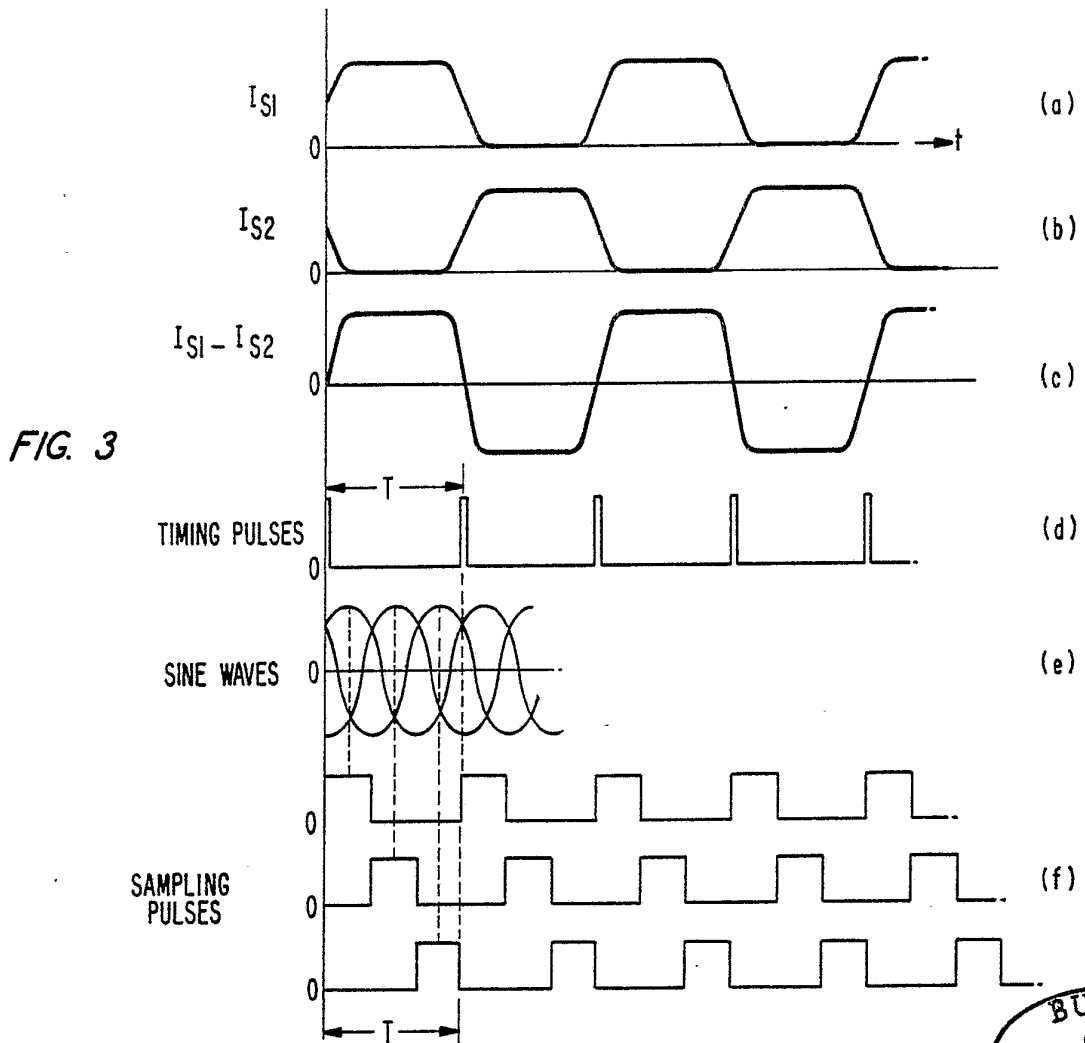
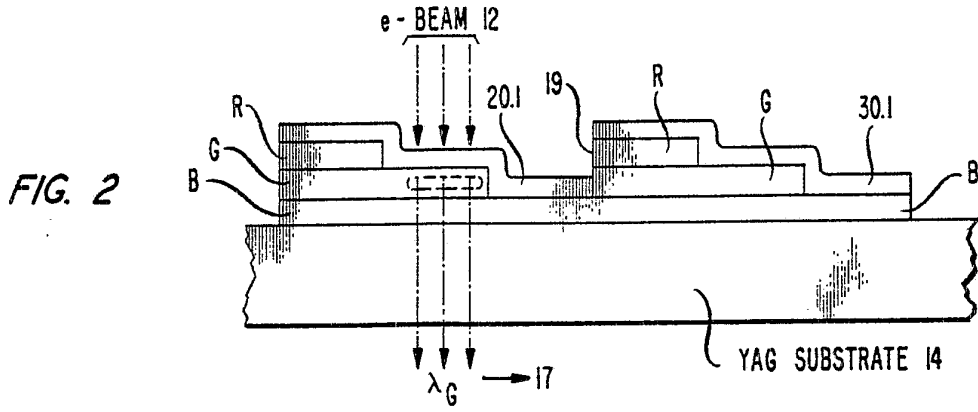
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means (66) responsive to said samples for modulating said electron beam so as to modulate the intensity of said light.



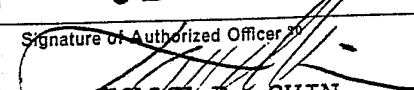
FIG. 1





INTERNATIONAL SEARCH REPORT

International Application No **PCT/US84/00102**

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ³		
According to International Patent Classification (IPC) or to both National Classification and IPC		
INT. CL ³ H04N 9/22, H04N 9/24; HOLJ 29/52		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁴		
Classification System	Classification Symbols	
U.S. CL.	358/43, 46, 66, 67, 68, 69, 72, 73, 74; 350/167; 315/30, 369, 383	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁵		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴		
Category *	Citation of Document, ¹⁶ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No. ¹⁸
X	U.K. A, 800,641 27 AUGUST 1958 (MANNERS, J.)	1
Y	U.K. A, 800,641 27 AUGUST 1958 (MANNERS, J.)	2,3
Y	U.S. A, 4,183,053 08 JANUARY 1980 (TOMII, K.)	1
Y	U.K. A, 999,649 28 JULY 1965 (THACKER, W.)	3
Y	JP, A, 75,226 24 JUNE 1977 (KISHIMOTO, S.)	1-3
Y	U.S. A, 3,851,093 26 NOVEMBER 1974 (SUNSTEIN, D.)	1-3
A	U.K. A, 800,641 27 AUGUST 1958 (MANNERS, J.)	4
A	U.S. A, #3,781,465 25 December 1973 (Ernstoff)	
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IV. CERTIFICATION		
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