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Greene et al.

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(54) **CORRECTION METHODS FOR BRIGHTNESS IN ELECTRONIC DISPLAY**

(75) Inventors: **Raymond G. Greene, Ovid; Robert H. Katyl, Vestal; J. Peter Krusius; Boris Yost, both of Ithaca, all of NY (US)**

(73) Assignee: **Rainbow Displays, Inc., Endicott, NY (US)**

(*) Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

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Related U.S. Application Data

(63) Continuation of application No. 08/636,604, filed on Apr. 23, 1996.

(51) **Int. Cl.⁷** **G09G 5/10**

(52) **U.S. Cl.** **345/147; 345/207; 345/89; 345/88**

(58) **Field of Search** 345/87, 103, 98, 345/100, 147, 1-2, 3, 92, 903, 207, 89, 88, 63, 431, 199; 348/383, 757, 687, 631, 607, 609; 382/167, 162

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,825,201 * 4/1989 Watanabe et al. 345/1

5,206,633	*	4/1993	Zalph	345/92
5,416,890	*	5/1995	Beretta	345/431
5,555,035	*	9/1996	Mead et al.	348/757
5,650,942	*	7/1997	Granger	358/500
5,805,117	*	9/1998	Mazurek et al.	345/1
6,005,968	*	12/1999	Granger	382/162
6,020,868	*	2/2000	Greene et al.	345/88

OTHER PUBLICATIONS

I. Gorog, "Displays for HDTV:Direct View CRTs and Projection Systems", Proceedings of the IEEE, vol. 82, No. 4, pp. 520-536, 1994.*

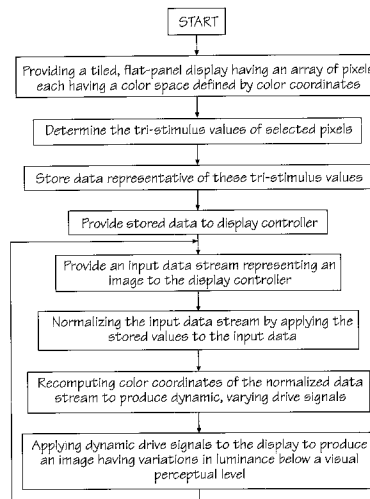
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Primary Examiner—Richard Hjerpe
Assistant Examiner—Francis Nguyen
(74) *Attorney, Agent, or Firm*—Salzman & Levy

(57) **ABSTRACT**

The present invention features methods and apparatus for the correction of spatial non-uniformities in brightness that arise from materials, manufacturing, operational and lighting parameter variations in electronic color, flat-panel displays. The methods apply both to gradual non-uniformities usually found in monolithic displays as well as to abrupt variations present in displays composed of a multitude of tiles. Corrections are performed on the electronic drive signals used to control the brightness of selected display pixels. Parameters required for these corrections are acquired via brightness measurements over selected pixels and stored after suitable transformations. The stored parameters are then used to scale and/or interpolate drive signals in real time. Corrections are performed such that any remaining gradual and abrupt brightness non-uniformities fall below the detectable threshold under the intended viewing conditions. The correction methods can also be used for correcting brightness non-uniformities arising from uneven aging of the display. Apparatus for an automatic self-calibrating function is also described.

26 Claims, 6 Drawing Sheets



OTHER PUBLICATIONS

H. Henck Van Leeuwen et al., “A Digital Column Driver IC for AMLCDs”, Euro-Display, pp. 453-456, 1993.*

H. Okada et al., “An 8-Bit Digital Data Driver for AMLCDs”, Society for Information Display International Symposium Digest of Technical Papers, vol. XXV, pp. 347-350, 1994.*

M. Hijikiwa et al., “Future Prospects of Large Area Direct View LCDs”, Society for Information Display International Symposium Digest of Technical Papers, vol. XXVI, pp. 147-149, 1995.*

N. Mazurek et al., A 51-in Diagonal Tiled LCD VGA Monitor; SID International Symposium, Digest of Technical Papers, vol. 24, pp. 614-617, 1993.*

D. Nickerson, “History of the Munsell System, Company and Foundation, 1-111”, Color Research Applications, vol. 1, pp. 7-10, 69-77, 121-135, 1976.*

S. Hecht, “The Visual Discrimination of Intensity and the Weber-Fechner Law”, Journal of General Physiology, vol. 7, p. 214, 1924*

K. B. Benson editor, Television Engineering Handbook Featuring HDTV Systems, McGraw-Hill, 1992.*

G. Wyszecki et al., Color Science, 2nd Edition Wiley, New York, 1982.*

* cited by examiner

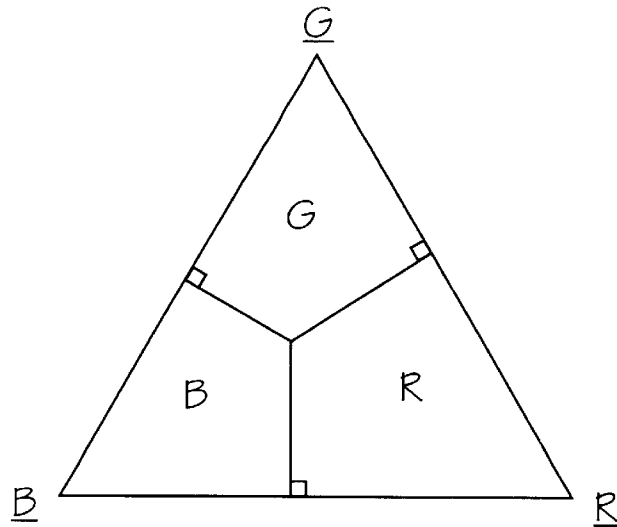


Figure 1

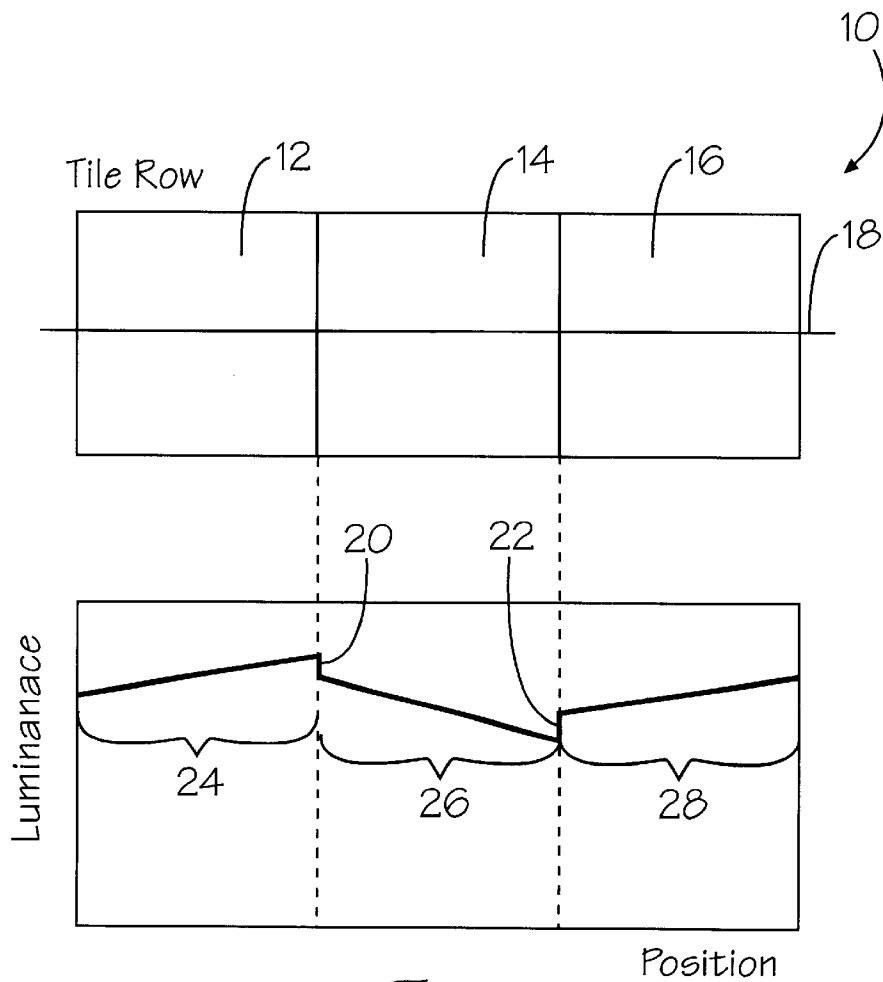


Figure 2

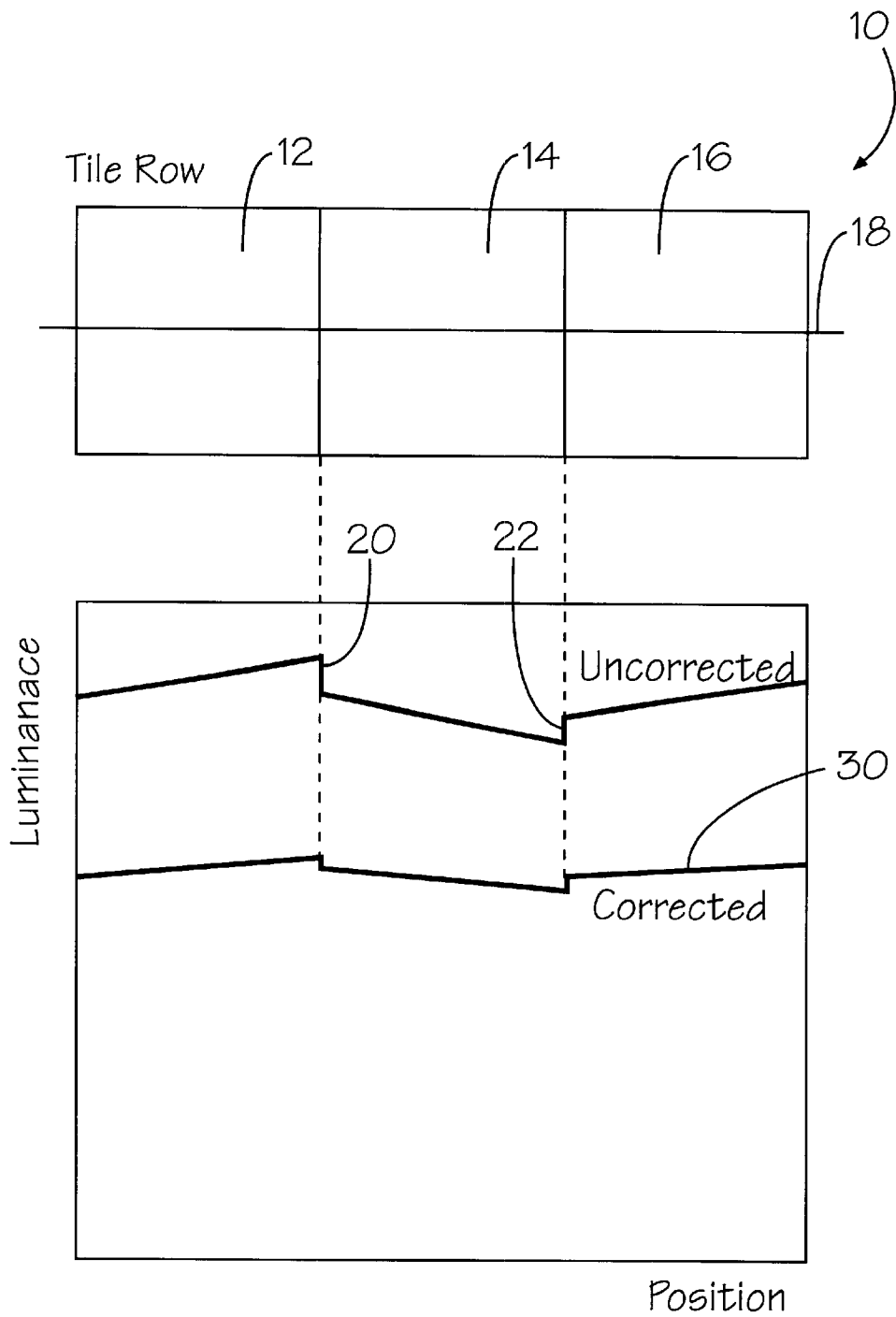


Figure 3

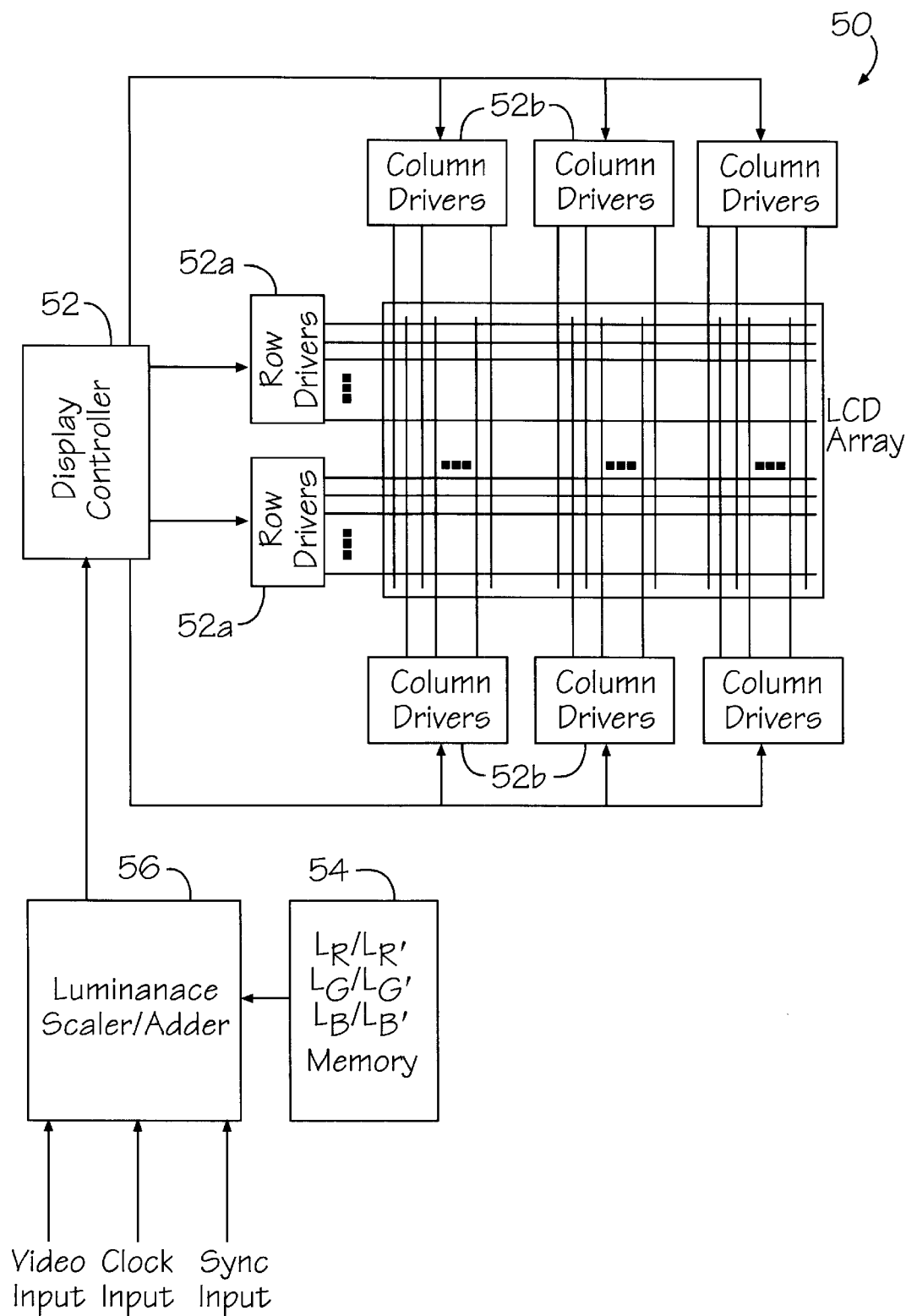


Figure 4

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