



US005461430A

**United States Patent** [19]**Hagerman**[11] **Patent Number:** **5,461,430**[45] **Date of Patent:** **Oct. 24, 1995**[54] **DYNAMIC GAMMA CORRECTION CIRCUIT FOR USE IN IMAGE PROJECTORS**[76] **Inventor:** **James G. Hagerman, 5137 Camino Playa Malaga, San Diego, Calif. 92124**[21] **Appl. No.:** **116,413**[22] **Filed:** **Sep. 3, 1993****Related U.S. Application Data**[63] **Continuation-in-part of Ser. No. 986,108, Dec. 4, 1992, abandoned.**[51] **Int. Cl.<sup>6</sup>** ..... **H04N 5/202**[52] **U.S. Cl.** ..... **348/674; 348/744**[58] **Field of Search** ..... **348/674, 254, 348/744, 745; 358/164, 32; H04N 5/20, 5/202**[56] **References Cited****U.S. PATENT DOCUMENTS**

3,708,693	1/1973	Ferrier et al.	358/164
4,847,524	7/1989	Van Roy et al.	358/164
4,868,668	9/1989	Tavernetti	358/237

**FOREIGN PATENT DOCUMENTS**

155884	9/1982	Japan	358/164
45775	3/1984	Japan	358/32
67784	4/1984	Japan	358/164
257674	12/1985	Japan	358/164
112479	5/1987	Japan	H04N 5/202
260976	10/1990	Japan	H04N 5/202
91375	4/1991	Japan	H04N 5/202
186071	8/1991	Japan	H04N 5/202
351071	12/1992	Japan	H04N 5/202

*Primary Examiner*—James I. Groody  
*Assistant Examiner*—Chris Grant[57] **ABSTRACT**

Apparatus that implements a nonlinear transfer function (gain) that provides for gamma correction of nonlinear image projectors. The nonlinearity of the transfer function is designed to compensate for the nonlinearity of a nonlinear light modulator, such as a liquid crystal light valve and cathode ray tube combination, for example, that is used in the image projector. The gamma correction circuit comprises a plurality of amplifiers that include current sources coupled together to sum their output currents, and each amplifier is adapted to implement a predetermined transfer function, and provide differing levels of current. An optional output resistor may be employed to convert the composite output current into a corresponding output voltage. Each of the plurality of amplifiers typically comprises first and second emitter coupled pair transistors plus their associated current sources. The present invention corrects the grey scale linearity of the image projector in which it is employed. The amplifier configuration of the circuit does not use feedback, so its processing bandwidth remains high. The present invention also produces "soft" breakpoints, creating a relatively smooth transfer function. The gamma correction circuit of the present invention is useful in any application using a nonlinear amplifier. The present gamma correction circuit may also be used in any image projector or display using liquid crystal or other nonlinear imaging technology. If gamma correction is used in conjunction with dynamic threshold correction then the gamma correction is made dynamic by adding the threshold correction signal to the base of one of the transistors in the gamma correction circuitry.

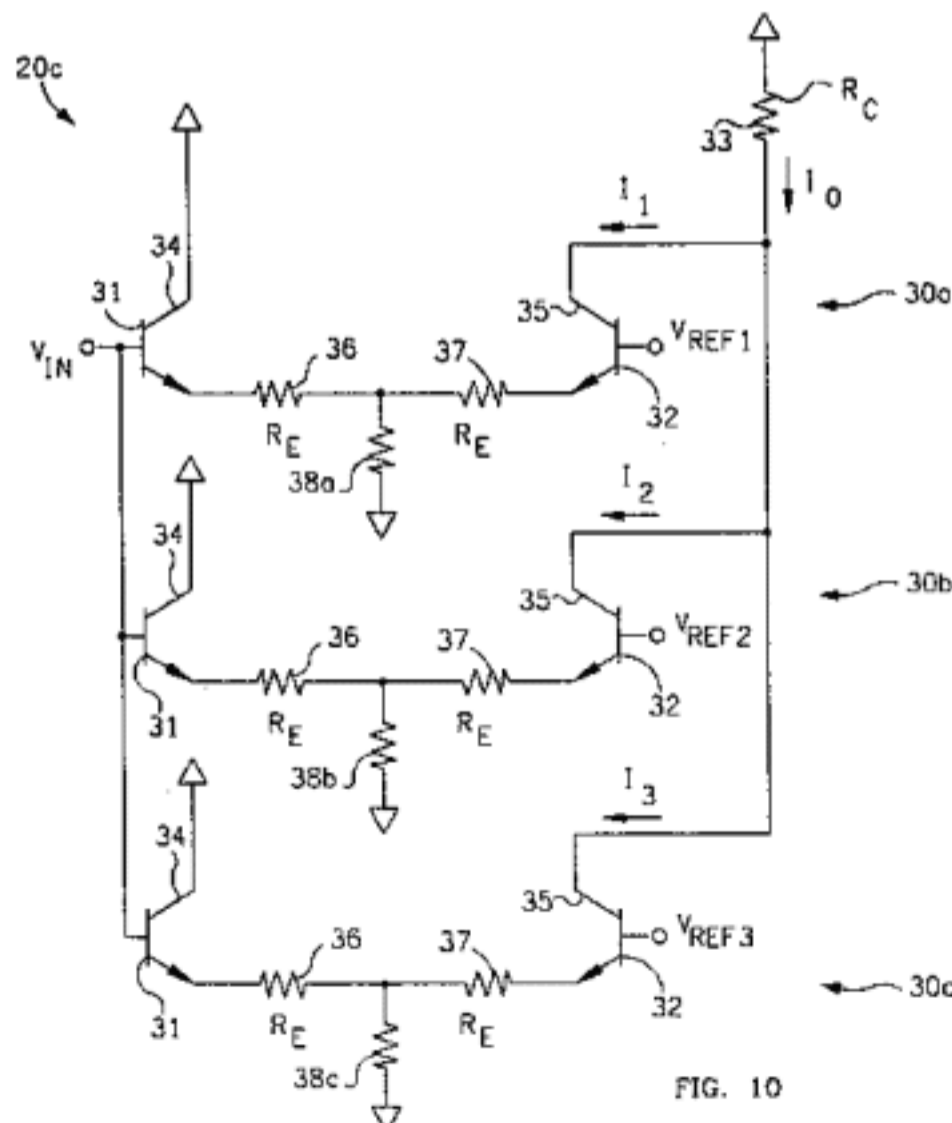
**19 Claims, 14 Drawing Sheets**

FIG. 10