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Fogaroli et al.

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[54] **DIGITAL IMAGE SCANNING DEVICE HAVING AN AUTOMATIC BACKGROUND COMPENSATION CIRCUIT**

[75] Inventors: **Giuseppe Fogaroli**, Ivrea; **Ennio Sgreccia**, Banchette; **Giorgio Tadini**, Turin, all of Italy

[73] Assignee: **Ing. C. Olivetti & C., S.p.A.**, Ivrea, Italy

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[30] **Foreign Application Priority Data**

Mar. 18, 1988 [IT] Italy 67233 A/88

[51] **Int. Cl.**[5] **H04N 1/40**

[52] **U.S. Cl.** **358/461**; 358/464; 358/466

[58] **Field of Search** 358/464, 465, 466, 461

[56] **References Cited**

U.S. PATENT DOCUMENTS

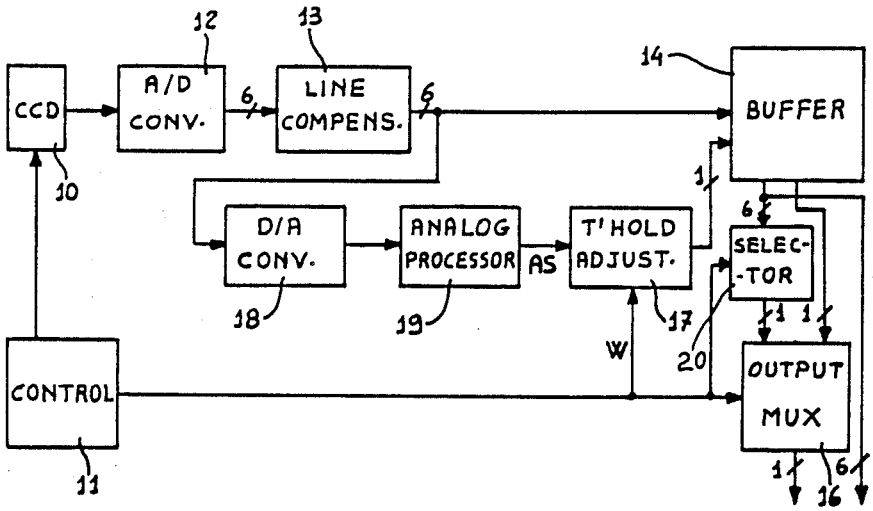
3,723,649	3/1973	Pitegoff et al.	358/465
3,790,706	2/1974	Gubala et al.	358/466
3,965,290	6/1976	Tisue	358/466
4,234,895	11/1980	Sommer et al.	358/466
4,468,704	8/1984	Stoffel et al.	358/466

Primary Examiner—Edward L. Coles, Sr.
Attorney, Agent, or Firm—Banner, Birch, McKie & Beckett

[57] **ABSTRACT**

The background compensation circuit defines a background threshold signal in dependence on an average value between the positive-peak and negative-peak signals previously received from the elements for scanning the pixels of the image, and in dependence on the analog signal (AS) of the pixel added to a reference signal. The circuit comprises two detectors (**21, 22**) for respectively detecting a positive peak and a negative peak and which each have a short charge time constant and a long discharge time constant. A summing circuit (**25**) generates a threshold signal (V_s) as a linear combination of the signals (V_{max}, V_{min}) of the detectors (**21, 22**) the analog signal (AS) of the pixel and a reference signal (V_r). Finally the threshold signal is compared (**26**) to the analog signal (AS) of the pixel to produce a binary reading signal which is at "one" level when the threshold signal is greater than the analog signal and is at "zero" level when the threshold signal is less than the analog signal.

8 Claims, 3 Drawing Sheets



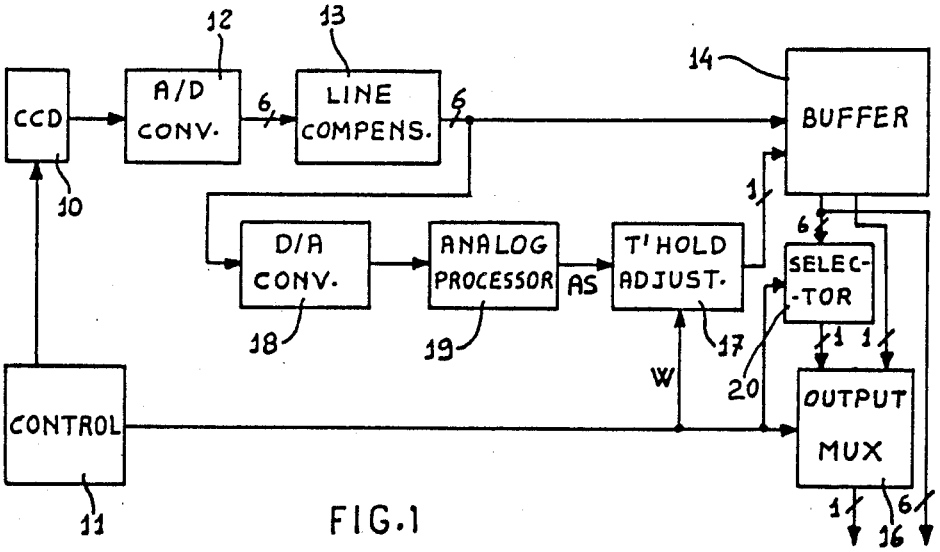


FIG.1

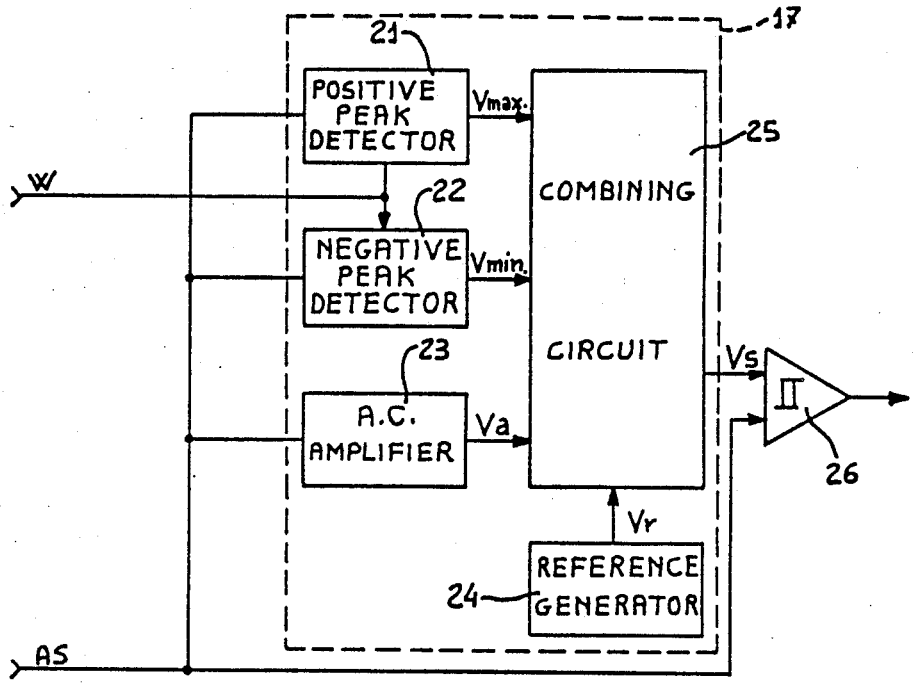


FIG.2

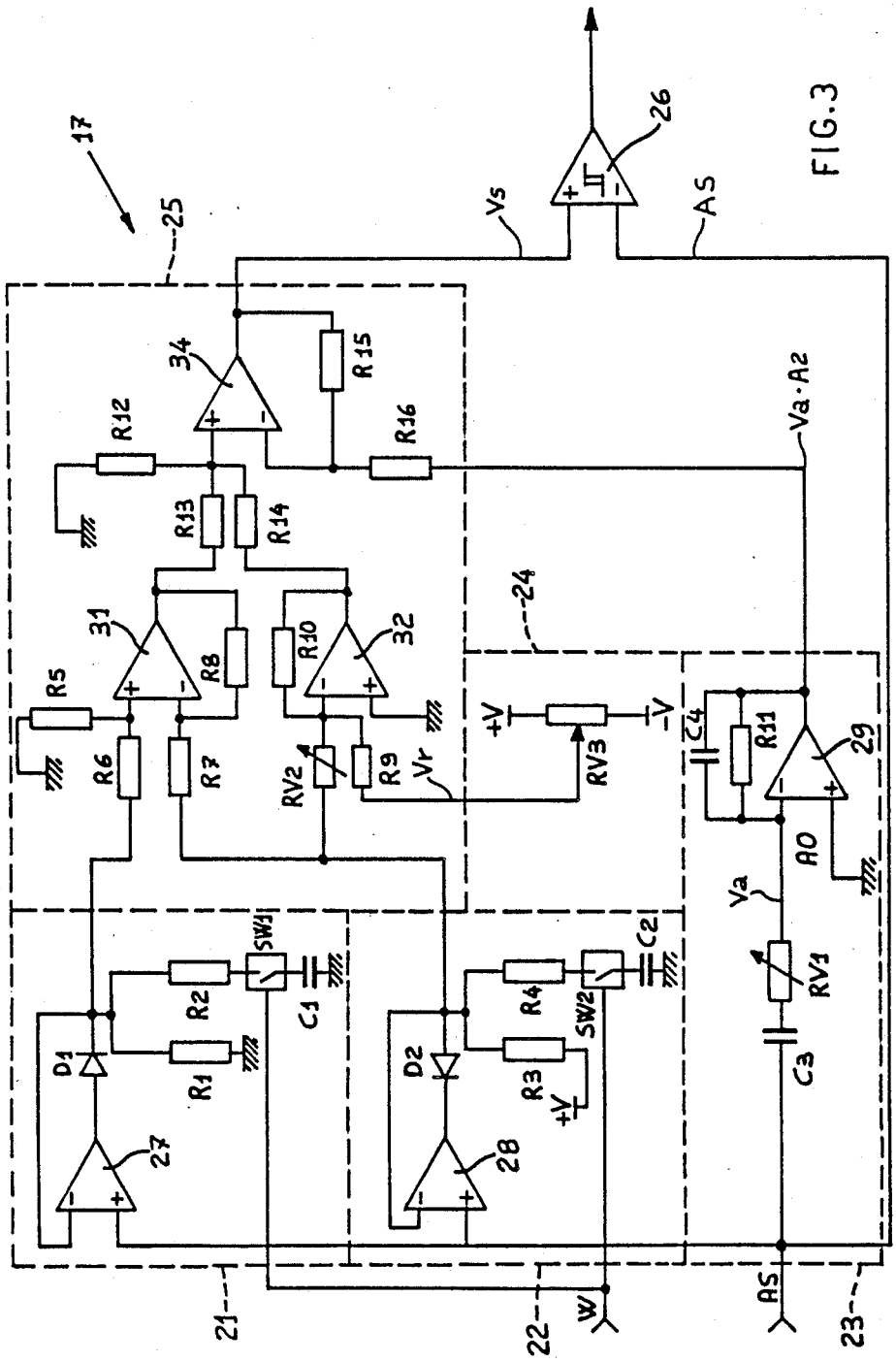


FIG.3

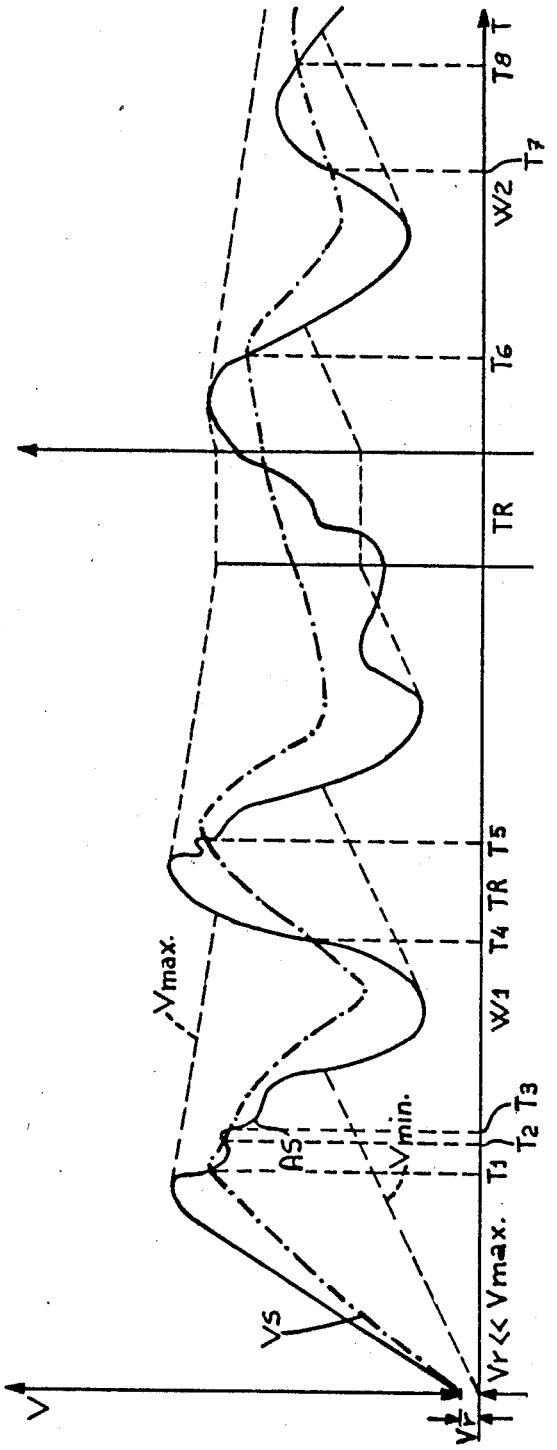


FIG.4

DIGITAL IMAGE SCANNING DEVICE HAVING AN AUTOMATIC BACKGROUND COMPENSATION CIRCUIT

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a circuit for automatically adjusting the background threshold of a reading signal for a digital image scanning device, comprising means for scanning the pixels, capable of generating corresponding electrical reading signals and transmitting them in series to the adjusting circuit and memory means controlled by the regulating circuit for storing digital values of the signal in binary code in dependence on the threshold, the adjusting circuit defining the threshold (V_s) of the signal in dependence on the positive-peak (V_{max}) and negative-peak (V_{min}) signals previously received from the scanning means.

2. Description of the Related Art.

In apparatus of the above indicated type wherein a signal produced by a photoelectric detector constituted of an array of image sensing elements such as a so called CCD device (Charge Coupled Device), an analog output signal produced by such a device must be compared against at least one threshold in order to derive therefrom a binary-type signal.

In order to obtain good performances from a scanning apparatus of this kind for scanning like office documents, it is necessary to adjust the level of the threshold which determines the digital conversion of the above said analog signal.

Several circuitries have been developed for rendering adaptive the level of the threshold in order to optimize the operation of the system.

For instance, the U.S. Pat. No. 4,251,837 discloses a circuit of the above-indicated type, which includes a switching circuit controlled by two comparators for comparing the threshold signals, in order to select three different thresholds. However that circuit is not capable of adapting the threshold to the type of image or to the background colour of the image.

U.S. Pat. No. 4,554,594 of the present assignee also discloses a variable threshold circuit for serial scanning and digital processing of images with various grey levels, in which a given threshold is selected only if it maintains a certain persistency defined by a counter. However that circuit is also not capable of adapting the threshold to the "background colour" of the image.

SUMMARY OF THE INVENTION

The object of the invention is to provide a circuit for automatically adjusting the threshold signal in dependence on a plurality of parameters including the background colour of the image.

The object of the invention is obtained by means of a circuit for automatically adjusting the background threshold of a reading signal for a digital scanning device, comprising means for scanning the pixels, capable of generating corresponding electrical reading signals and transmitting them in series to the adjusting circuit and memory means controlled by the regulating circuit for storing digital values of the signal in binary code in dependence on the threshold, the adjusting circuit defining the threshold of the signal in dependence on the positive-peak (V_{max}) and negative-peak (V_{min}) signals previously received from the scanning means.

These and others features of the invention will be more clearly apparent from the following description of a preferred embodiment of the invention given by way of non-limiting example with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** diagrammatically illustrates a digital image scanning device incorporating a threshold adjusting circuit according to the invention.

FIG. **2** is a block circuit diagram of the threshold adjusting circuit.

FIG. **3** is a detailed diagram of the threshold adjusting circuit shown in FIG. **2**, and

FIG. **4** is a diagram illustrating the signals which are processed in operation of the regulating circuit shown in FIG. **3**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. **1**, the scanning device comprises a series of elements **10** for reading a document, which are formed by the cells of a Charge Coupled Device, known as a CCD. For a reader for reading images in black and white, there may be provided a single series of cells of the CCD **10** which are spaced in such a way that each element can receive the light reflected from a small area of the document, referred to hereinafter as a 'pixel'.

The number of pixels per mm which is generally between 8 and 16 indicates the level of resolution of the document and may be varied under the control of a control unit **11** in per se known manner. By way of example, in the case of a document of A4 format with a level of resolution of eight pixels/mm, the CCD has a number of active cells equal to 1728.

For a reader for reading colour images, the CCD **10** is formed by three series of cells, for example associated with the three primary colours: green, red and blue, and which are capable of sending the associated signals in separate channels. In such a situation one of the CCDs **10**, for example the green CCD, may be designed for digital scanning of images to be recorded in monochrome mode (black and white).

The cells of the CCD **10** generate electrical signals which, suitably amplified and filtered, are passed serially to an A/D (analog/digital) converter **12** which converts the analog signals received into a group of bits, for example siX bits. Those bits represent the digital value of the signal which may therefore be at 64 different levels.

The signals emitted by the converter **12** are passed to a digital line compensation circuit **13**, for example, of the type described in the present assignee's Italian patent No. 1 183 816. The compensation circuit is operable to effect compensation in respect of the digital value of the amplitude of the signals on the basis of a digital value derived from the preliminary reading of a sample line, to take account of dust on the lamp and the errors of the sensor and the loss at the edges in respect of luminosity of the lens.

The output signals from the compensating circuit **13** are stored in the form of bytes in a buffer **14** which has the capacity to store two series of signals generated by the CCD **10**. Therefore the buffer **14** has a capacity of two bytes for each pixel of a line on the document, each byte having six bits for the digital signals of each pixel. The signals which are stored in the buffer **14** are then

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