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AUTOMATIC GAIN CONTROL CIRCUIT FOR VIDEO SIGNALS OF SCENES OF VARYING ILLUMINATION LEVELS

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A type of automatic gain control circuit useful for enhancement of video signals of scenes of varying light illumination levels is described. A DC voltage developed from the peak-to-peak input signal controls the effective gain of a video amplifier in a nonstandard method using a step-function control voltage.

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TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

INTRODUCTION

Increased emphasis on night operations by the US Army, especially within the aviation community, has resulted in numerous low-light-level (LLL) video systems and thermal imaging systems. Such systems are used to acquire, identify, and track targets, as well as to fly aircraft under various LLL conditions such as inclement weather and darkness.

LLL video systems utilize an image intensifier which, when actuated by a light image, can produce a similar image of increased contrast. With thermal imaging systems, a thermal detector transforms incident thermal energy into an electrical signal which produces a video image of the scene on a display. Typically, in both systems, a composite video signal is produced which is fed to one or more display monitors for observer interpretation. With LLL systems, as well as with standard video cameras, as the light level changes, continuous adjustment of the display's contrast and brightness is necessary to maintain an optimum image. The circuit described here was developed to provide a better signal-to-noise ratio under extreme LLL conditions and to reduce the need for display adjustments under varying scene-illumination conditions.

CIRCUIT DESCRIPTION

The circuit diagrammed in Figure 1 acts as an automatic gain control (AGC) for an input video signal, but its operation differs from the AGC operation in a standard video receiver. It has two modes of operation. Under normal or above normal ambient illumination, the AGC circuitry attenuates the amplifier circuit input. For signal levels associated with low ambient illumination, the AGC effectively is removed from the circuit operation, allowing amplification of the full input signal.

The input composite signal is applied to the inputs of IC1, a wideband video amplifier, and IC2, a 741 operational amplifier. The output of IC1 is controlled by IC2, IC3, and Q1. The composite video signal applied to IC2 is amplified and then rectified and filtered by diode D1 and capacitor C8, respectively. Resistor R9 determines the gain of IC2.

The resulting DC voltage, which is proportional to the input signal level, is applied to pins 4 and 13 of IC3, a quad bilateral switch, and to the base of transistor Q1. The gain of IC2 and the values of R12 and R13 are selected so that when an input video signal of 0.5 volts peak-to-peak is present, the voltage at the base of Q1 is +0.5 vdc or slightly less. If the peak-to-peak input signal exceeds 0.5 v, then the DC base voltage on Q1 will increase, turning on Q1 hard. This causes the Q1 collector voltage to go to

ground. This action also grounds pin 5 on IC3, opening the switch between pins 3 and 4 on IC3. Therefore, the DC voltage resulting from the input signal is fully applied to control pin 13 of the switch between pins 1 and 2 of IC3. This closes this switch, setting up a voltage divider consisting of resistor R6 and op-amp IC1. This reduces the signal applied directly to the input of IC1.

When the input signal level drops below 0.5 volts peak-to-peak, the AGC action is disabled, increasing the effective circuit gain. For this lower signal level, the DC voltage applied on the base of Q1 is not sufficient to turn on Q1. Therefore, the collector voltage, and hence the voltage on pin 5 of IC3, is equal to +Vcc. As a result, the switch between pins 3 and 4 (on IC3) is closed, shorting the DC level voltage to ground. This action also grounds control pin 13 of the switch between pins 1 and 2. This opens this switch, which causes the full input signal to be fed to IC1 for amplification.

DISCUSSION

The described circuit can be incorporated between the composite video source, such as a camera, and the display without modification of the circuitry of either. The response time of the circuit (less than 2 seconds) makes it capable of handling changes in scene illumination that might occur during the normal panning motion of a camera.

Actual circuit performance is illustrated in Figure 2. Figures 2a and 2c show the display imagery resulting from a standard video camera recording a high illumination and low illumination scene, respectively. The illumination levels for the high and low illumination scenes were 80.8 footcandles and 0.95 footcandles, respectively, measured parallel to the target surface. Figures 2b and 2d show the same scenes with the AGC circuit inserted. For high illumination, some contrast enhancement can be noted resulting in a slightly more detailed display picture. In the low illumination case, a marked improvement is attained with the AGC.

This circuit can enhance effectively the imagery produced by LLL, standard, and thermal imaging sources of video signals under varying levels of illumination. In contrast, at low illumination levels this enhancement lowers the threshold for target detection and recognition. For the user this means faster and more accurate identification of targets.

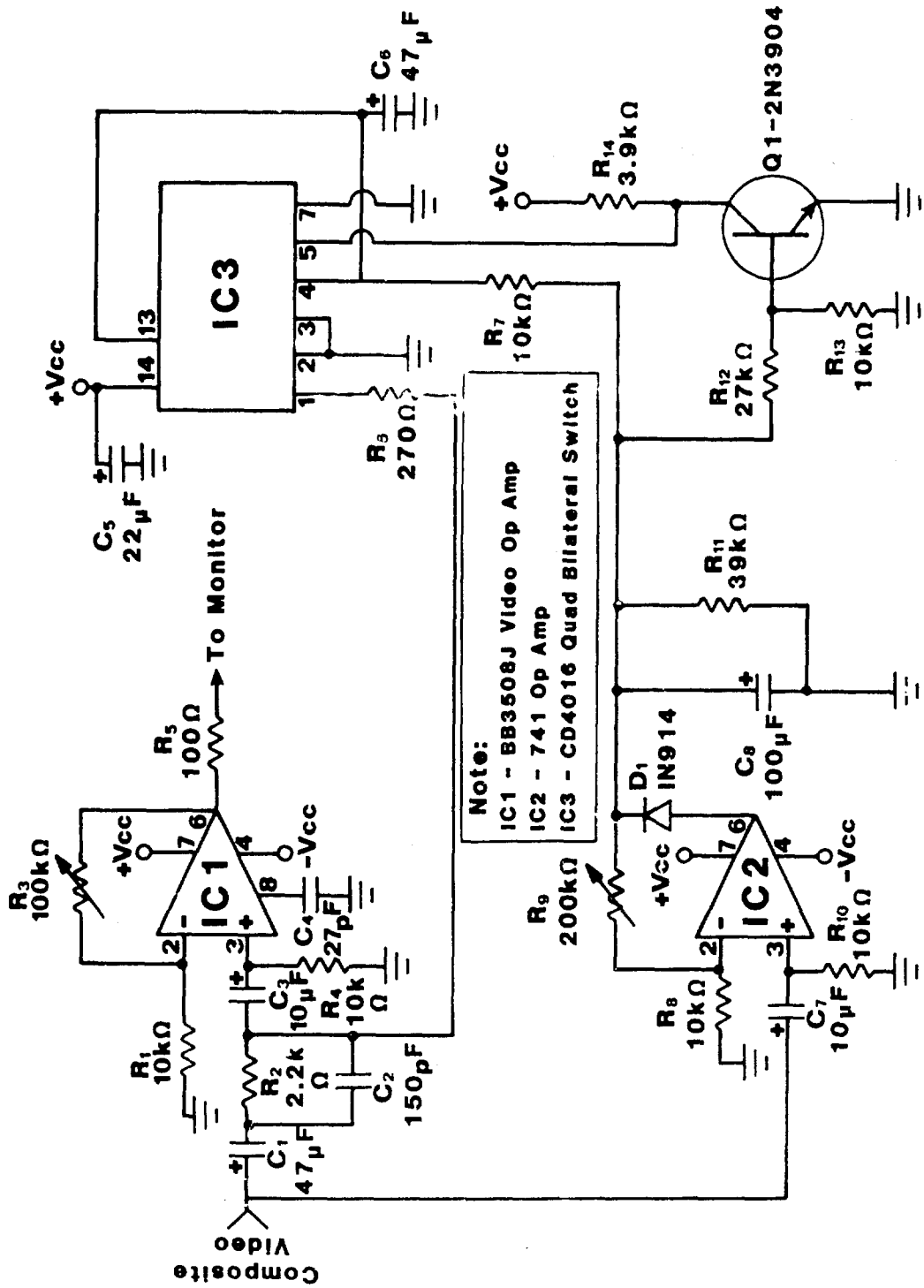

FIGURE 1. Scnematic for AGC circuit.

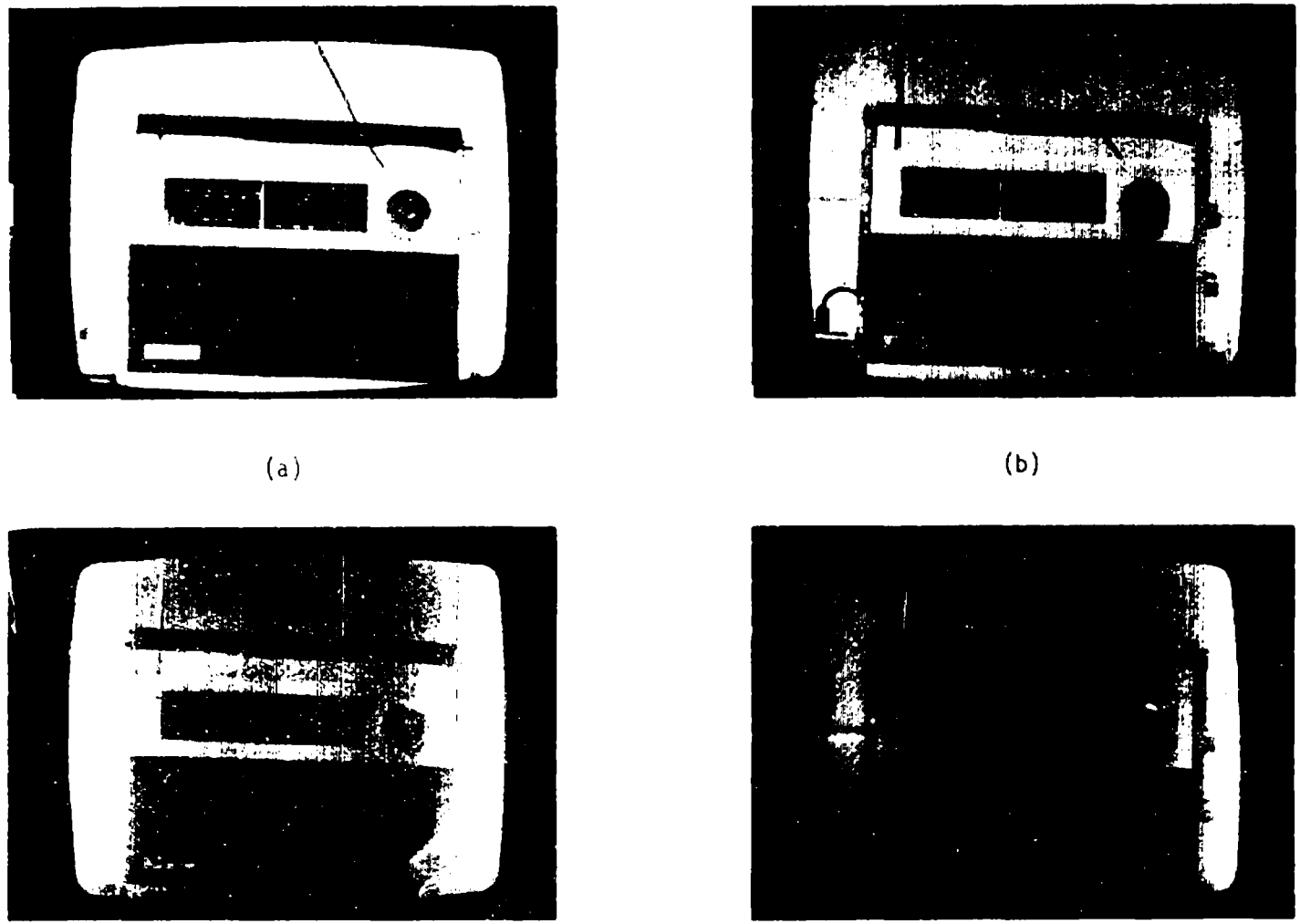

FIGURE 2. Photographs of display: High illumination scene (a) without new AGC circuit and (b) with new AGC circuit; low illumination scene (c) without new AGC circuit and (d) with new AGC circuit.

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