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IX The Mark IX Coder

Summary

The coder module for the Mark IX camera family is described. Alternative versions, for PAL or NTSC, are fitted within the CCU. The two coders employ similar designs and each includes a new facility – Dynamic Gain. This allows adjustment of the video gain in sympathy with the scene illumination. By this means it is possible to restructure the contrast range of the televised scene on an element-by-element basis. Areas of low scene brightness can be enhanced or those nearing the whites can be reduced in brightness. It is therefore possible, particularly on outside broadcasts, to produce more acceptable pictures in difficult lighting conditions. The technique employed operates upon the fully encoded signal, as a contrast control, thus colorimetry is fully preserved.

The article further describes new circuit techniques employed to guarantee precise quadrature of the inphase and quadrature components of the chrominance channel. Also a new V modulator system for PAL is described. This employs two oppositely-phased modulators which are alternately brought into operation on successive lines. Axis switching is thus implemented without interference to either modulating or subcarrier paths.

The complete coder with dynamic gain facility is housed in one module space. The colour bar generator is separately fitted on the pulses module where all the necessary timing waveforms are available. Bars are produced to all recognized standards and split-field is available on all.

Introduction

The coder for the Mark IX family of cameras, which has been described in previous articles,[1, 2] is a simple module contained within the CCU (figure 1). It is produced in two versions, PAL and NTSC. The coder carries all coding functions in addition to a new facility, Dynamic Gain. The bar generator is, however, mounted separately on the CCU pulses module where all the required timing waveforms are available. SECAM is provided for by an external coder which can be driven by G, R and B video outputs available at the rear of the CCU. This article will not dwell upon the principles of coding which are well known. It will highlight some of the novel features employed to reduce set-up time and provide further facilities.

The PAL coder

The signal path of the PAL coder is shown in figure 2. Dynamic Gain is omitted for clarity, but will be dealt with later. The system will be recognized as fairly conventional. The luminance signal is generated by a summing amplifier taking appropriate proportions of the G, R and B inputs. Prior to the addition of sync, the luminance signal is passed through an optional filter which reduces luminance energy in the chrominance spectrum. This reduces cross-colour effects from the high definition luminance signal. After passing through a delay line to equalize the chrominance path delay, the luminance is added to the chrominance at the output amplifier. Differential amplifiers produce U and –V modulating signal voltages. The choice of –V, which results from Y–R instead of the more conventional R–Y is simply to enable a single source of burst gate pulses to be resistively mixed into U and V channels. This eliminates the need for accurately matched antiphase burst gate pulses. The U and V modulating voltages with the added burst pulses are then filtered to control the chrominance bandwidth. After further amplification, not shown, the signals are clamped and fed to the modulators at high level to minimize balance drift. The modulated carriers produced are then simply added and passed via a filter to remove unwanted harmonics of subcarrier frequency before addition to the luminance signal.

Two V modulators

In the PAL system it is required to reverse the phase of the modulated V signal on alternate lines. Often this is done by inverting either the modulating or the carrier voltages. Both these processes require very precise implementation to achieve an accurate 180° switch. In the Mark IX coder a much simpler approach is used, employing two modulators, with input, carrier and output terminals connected in parallel (figure 3a). However the balanced carrier inputs are cross-connected so that one modulator functions in opposite phase to the other. Precise axis switching occurs as a result of enabling the modulators on alternate lines. The enable signals switch the d.c operating current of the integrated circuit modulators without disturbance to either modulating or carrier signal paths. The means for switching the modulators are shown in figure 3b. Sync is fed to a multivibrator timed for three-quarters of a line. Twice-line frequency information in the field period is therefore ignored by the multivibrator. The following divider produces the steady PAL switching waveform at half line frequency. A characteristic of the PAL system is that the first burst in each field is of uniform

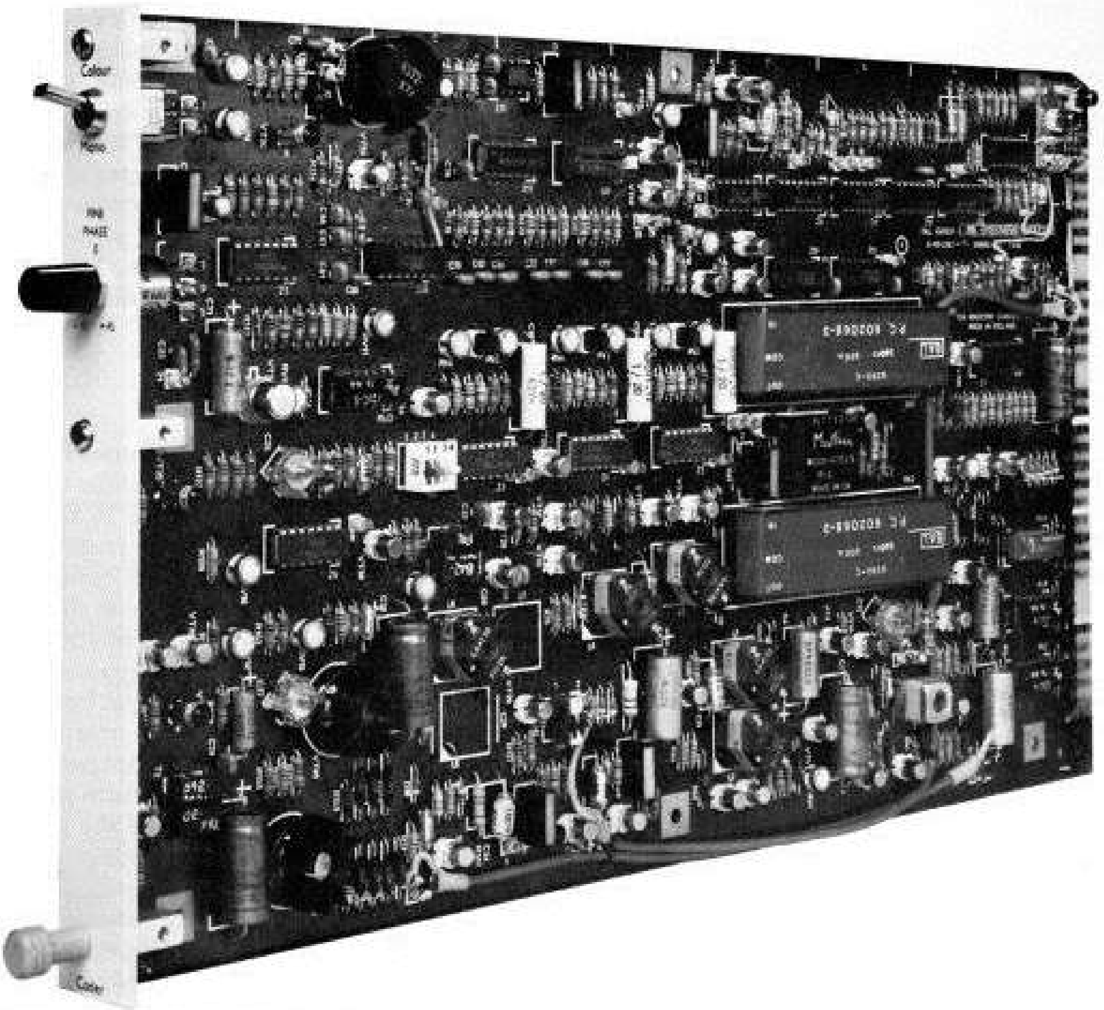

Figure 1. The coder module of the Mark IX camera system

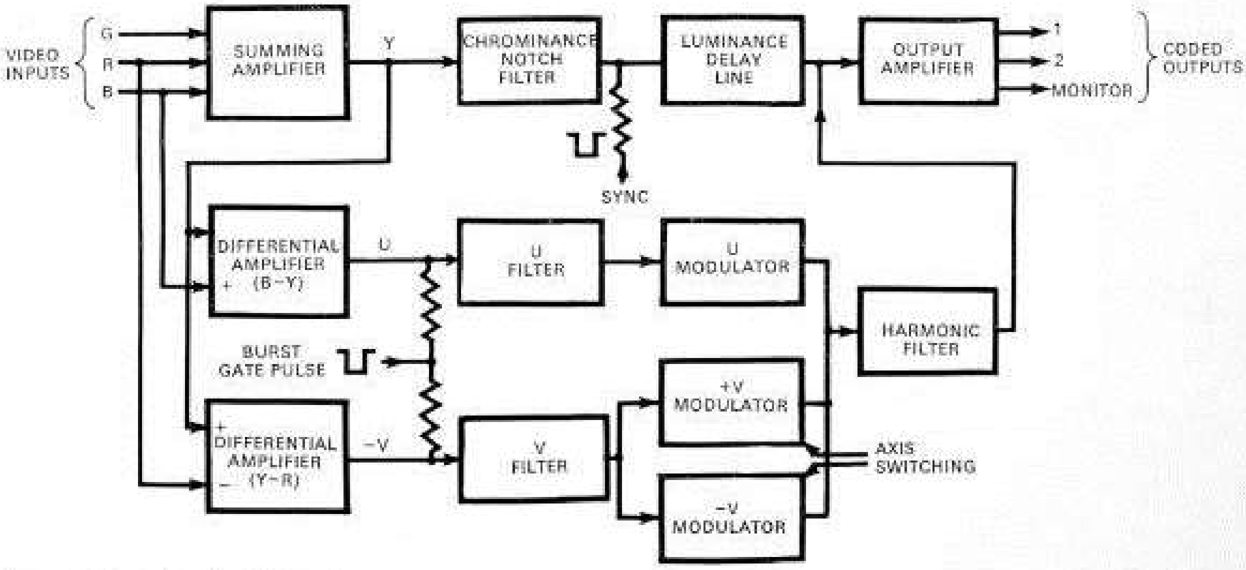

Figure 2. Signal path, PAL coder

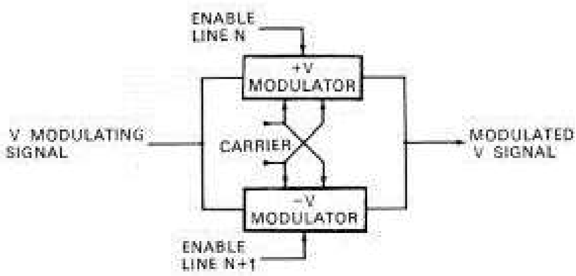

Figure 3a. V-axis switching system

polarity, thus simple means can be employed to guarantee the phase of the PAL switching waveform at this point. In the circuit, a D-type flip-flop senses, via a first gate, the polarity of the sync waveform at a point three-quarters through each line. When a broad pulse occurs the flip-flop is set and is then held by feed back to the second input of this gate. The first equalizing pulse of the field then clears the flip-flop for the remainder of the field, producing a brief pulse output from the second gate which establishes the PAL phase of in the divider.

Sub-carrier system

To complement the precise axis switching system and burst-forming methods described, a new sub-carrier system is employed. To eliminate the need for quadrature adjustment, locally generated sub-carrier at four times sub-carrier frequency is used to drive a divide-by-four Johnson counter. This counter has a unique characteristic in that the two stages provide complementary outputs in precise quadrature at sub-carrier frequency. The system is shown in figure 4a, with the counter waveforms in figure 4b. The 4 f.s.c oscillator is crystal-controlled and is maintained in lock with the system sub-carrier by a phase locked loop. A switch in the feedback path selects one of the four counter phases to provide a coarse calibrated phase adjustment. Fine phase adjustment is implemented by a potentiometer providing an offset voltage to the calibrated phase comparator. Together the coarse and fine phase controls provide a 360° sub-carrier phase adjustment range. In the event of a failure of system sub-carrier an input detector shuts down the buffer stage driving the counter to prevent chrominance generation with a non-synchronous sub-carrier.

Dynamic gain

A new feature of the camera is dynamic gain. This system allows adjustment of the video gain in sympathy with the scene illumination. By this means it is possible to restructure the contrast range of the televised scene on an element-by-element basis. Areas of low scene brightness can be enhanced or those nearing the whites can be reduced in brightness. It is therefore possible, particularly on outside broadcasts, to produce more acceptable pictures in difficult lighting conditions. Controls for dynamic gain are provided on the CCU control panel and remote control panel.

With a monochrome camera such an effect could be obtained by adjustment of the gamma correction circuit. In a colour camera this is not possible since any deviation from optimum gamma produces chromatic errors. A high gamma moves the reproduced colour towards the strongest primary, whilst too low a gamma produces a shift to the weakest primary.[3] To produce the required effect it is necessary to vary the gains in the three primary paths in unison. This is equivalent to variation of the camera lens aperture or the contrast

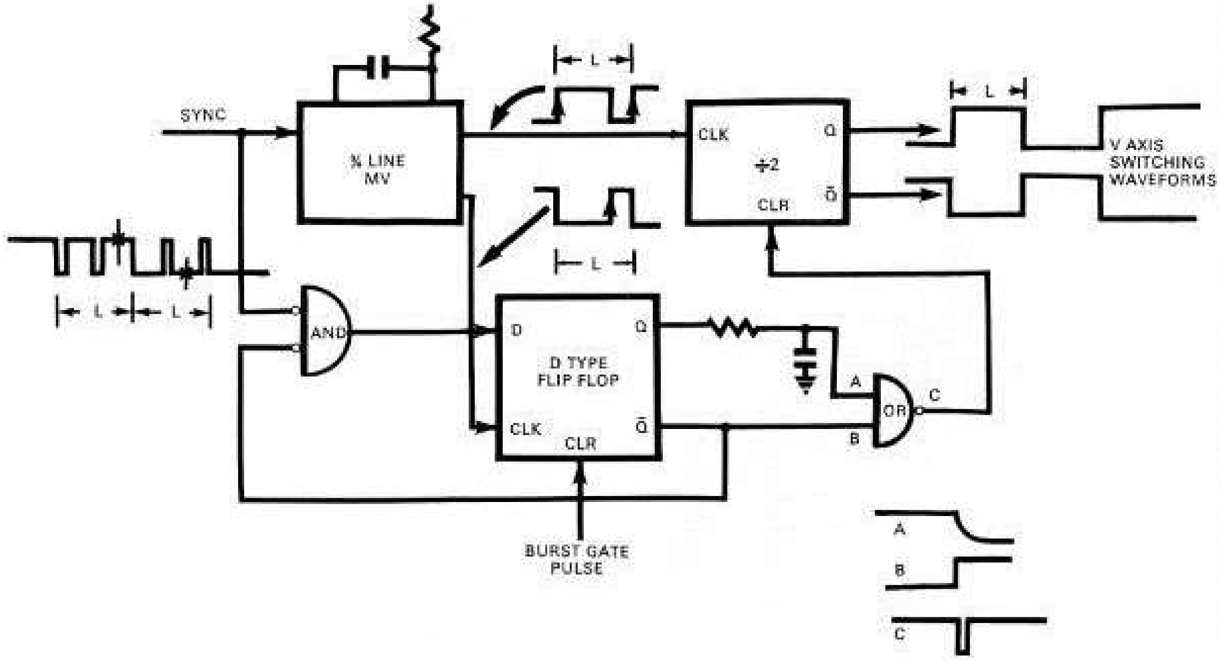

Figure 3b. Axis switch control

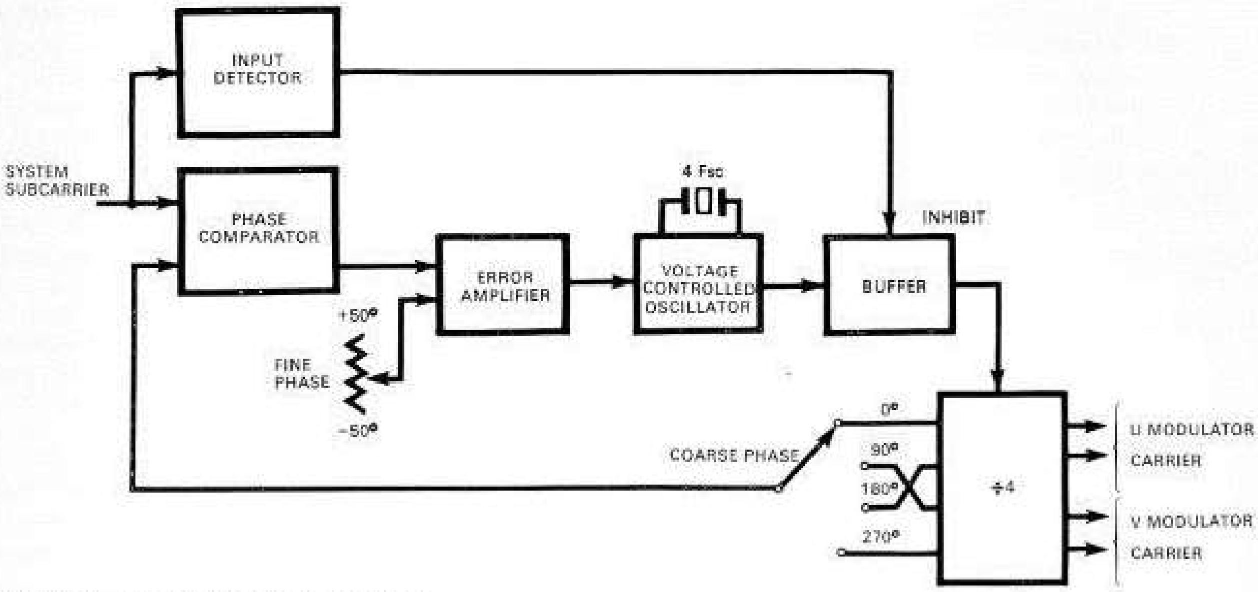

Figure 4a. Quadrature carrier generation

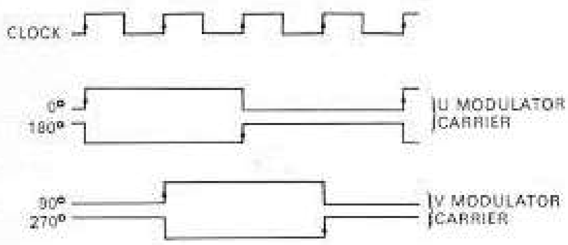

Figure 4b. Counter operation

control of a monitor. Two methods may readily be employed to do this, the first possibility being to vary as one the gains of the three processing amplifiers. In this case, very accurate dynamic tracking of these gain adjustments would be necessary to eliminate chromatic errors. The second possibility, that employed in the Mark IX coder,[4] is to operate upon the fully-encoded signal, since the structure of both the PAL and NTSC signals is such that variation of the path gain affects only contrast and not colorimetry.

Implementation

A block diagram, figure 5, illustrates the main elements of the dynamic gain system incorporated in the coder

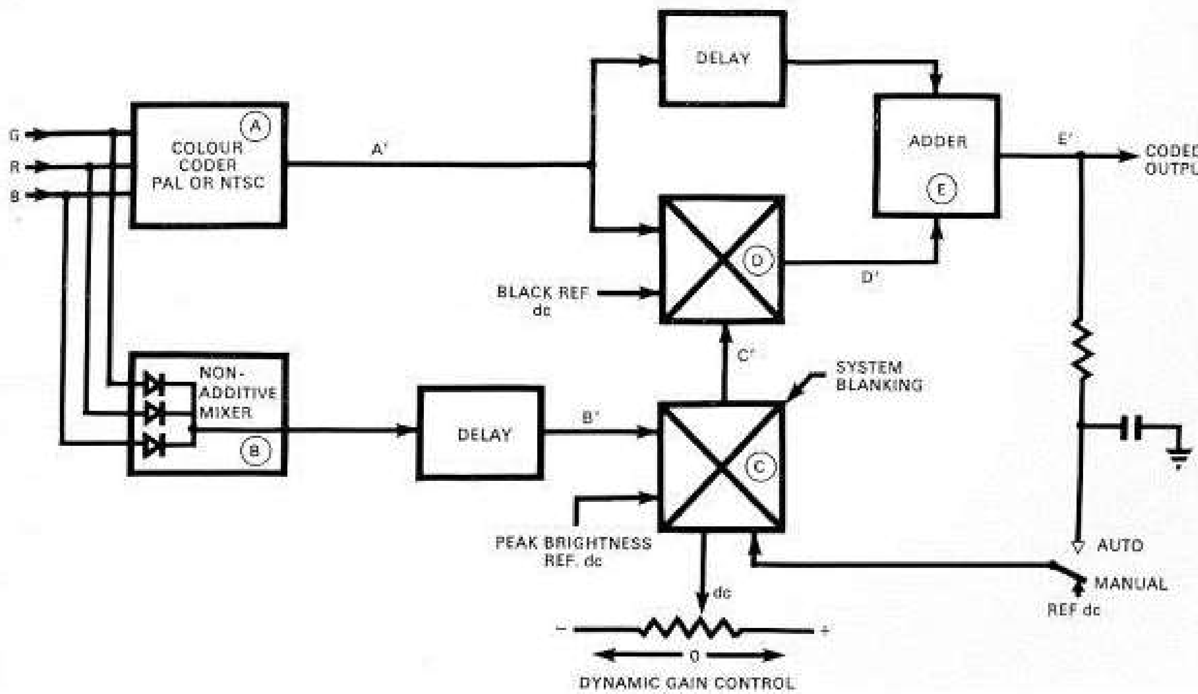

Figure 5. Block diagram of dynamic gain system

module of the camera. The PAL or NTSC coded signal is formed in the coder A, producing a composite coded output A′. Scene brightness is measured by the non-additive mixer B. The output signal B′, after passing through a delay line to equalize coding delay, represents scene brightness irrespective of chromatic content. This signal is referenced to a d.c voltage representing peak brightness and is multiplied by a d.c signal fed from the dynamic gain control knob. The multiplication takes place in a wideband multiplier circuit C. This produces an output C′, whose sign and magnitude is the product of the departure of the brightness signal from peak value and the d.c component set by the control knob. Thus it will be seen that if the brightness is at peak, no departure occurs, or the control is centred at zero volts d.c, no product results. However, when peak brightness is not achieved a product C′ results, which, depending on the control setting, may be of either polarity, or zero with the control centred.

In order to vary the transmission in the encoded signal path a second wideband multiplier circuit D is employed. This produces an output D′ which represents a modification signal whose sign and magnitude depends on the derived control signal C′. The coded output signal E′ results from the summation in adder E of A′, delayed to match the timing of D′, and the modification signal D′.

To prevent any modification of sync and burst, the first multiplier C is inhibited by system blanking. The video signal input A′ to multiplier D is referenced to a d.c level corresponding to black. Thus at black no input is effective and irrespective of the value of C′ no product and hence no black level shift is produced.

Circuit operation

The waveforms shown in figure 6 illustrate how the circuit works and make use, for the purpose of illustration, of a monochrome greyscale wedge as the camera signal. Waveforms are shown for positive and negative settings of the dynamic gain control and for the central position at which no correction is applied.

Signal B′ is shown departing from peak brightness towards the black part of the wedge. This generates the derived control signal C′ whose sign and magnitude is adjusted by the dynamic gain knob. In turn this produces signal D′, a video signal which also varies in sympathy with the control knob. This signal, by virtue of the system blanking fed to multiplier C has no sync and burst content and hence when added to the original coded waveform produces only a modification of contrast law.

Automatic dynamic gain

Scenes which most require modification tend to be such that, after the application of dynamic gain, their average picture level (APL) is near to 50%, and thus automatic control of dynamic gain can be achieved on a basis of the output APL. In the Mark IX a switch facility is included, enabling either Auto or Manual control to be selected.

In the auto mode (see figure 5), the encoded output signal E′ is integrated and fed back to multiplier C

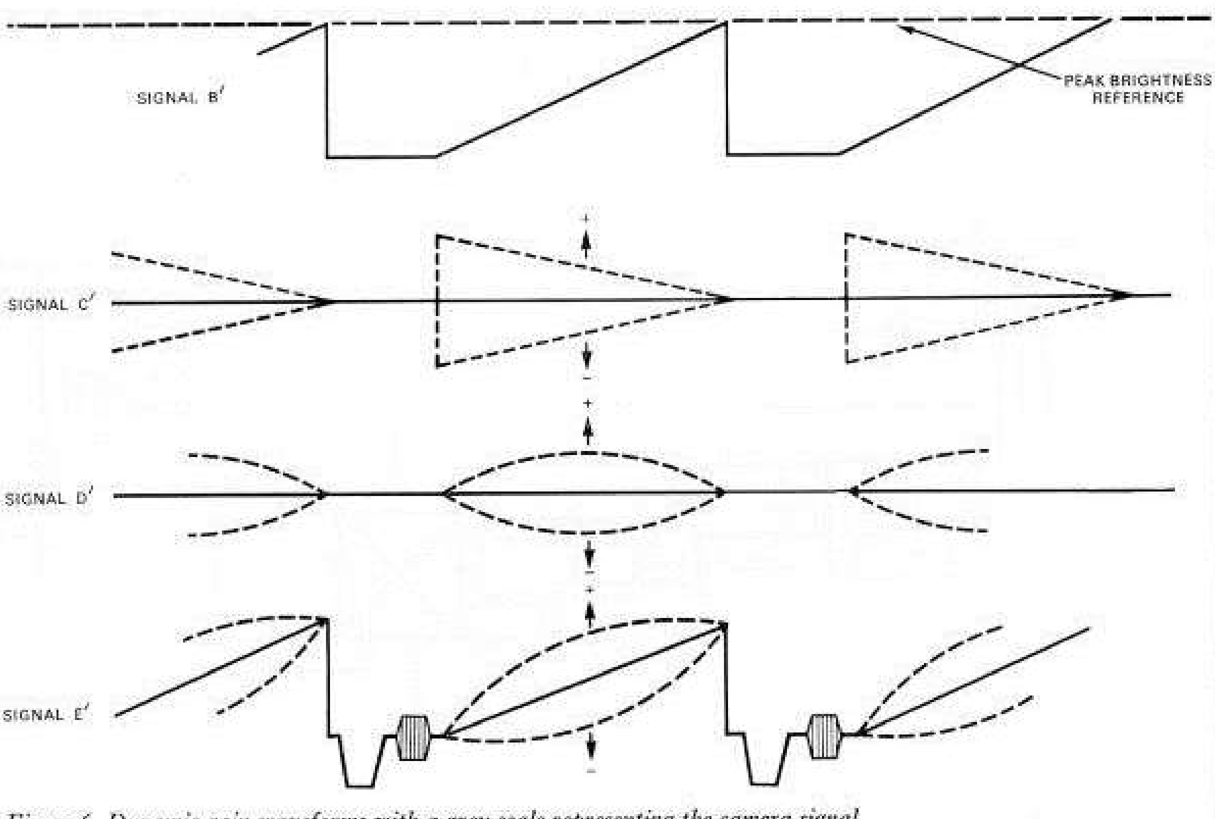

Figure 6. Dynamic gain waveforms with a grey scale representing the camera signal

where it adjusts automatically the derived correction signal C' to tend to produce 50% APL and hence optimal dynamic gain correction. In this case the manual control knob is left in circuit but with reduced effect to enable a trim of APL for scene matching.

Conclusion

The coder employing the new techniques described satisfies the trend towards simplified setting-up procedures. The NTSC coder is very closely based upon the PAL design and also includes dynamic gain. This facility provides a new dimension in camera operation; high contrast scenes may be restructured without loss of colour fidelity. The bar generator, separately housed, provides all recognized bar formats both in full-field and split-field versions.

References

[1] N. N. PARKER-SMITH: 'The Mark IX – a camera system for the 80's, *Communication & Broadcasting*, Vol.4, No.2 (Spring 1978), pp.4–9.
[2] J. R. CROOK AND I. E. GIBSON: 'A new studio outside broadcast camera channel', *Communication & Broadcasting*, Vol.4, No.2 (Spring 1978), pp.10–15.
[3] A. N. HEIGHTMAN: 'Gamma in television', *Sound & Vision Broadcasting*, Vol.12, No.2 (Summer 1971), pp.26–30.
[4] R. W. FENTON: British Patent Application No.38498/76.