United States Patent

Siegel

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[54] **VIDEO COLOR SYNTHESIZER**

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[51] **Int. Cl.** **H04n 9/02**
[58] **Field of Search** .... 178/6.8, 5.2, 5.4, 69.5 CB

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[57] **ABSTRACT**

An apparatus for synthesizing pseudocolor video signals from composite monochromatic video signals. Means are provided for producing a color burst signal on the back porch of the pseudocolor video signal from a monochromatic horizontal sync pulse. Such means includes a color subcarrier oscillator, a pulse generator which stretches the horizontal sync pulse to accommodate the proper period of the subcarrier frequency and slightly delay its occurrence, and a burst gate which produces the burst frequency from the subcarrier and stretched pulses. A pseudochrominance portion of the color video signal is produced by means which phase modulate the color subcarrier with the monochromatic video signal to produce a pseudohue signal and mix this hue signal with the video information portion of the monochromatic signal. An output mixer is also provided for mixing this pseudochrominance signal with the color burst and the monochromatic video signal to provide the pseudocolor video signal. Upon reception by a color video receiver, the monochromatic picture is reproduced in subjective color, the hues therein varying in accordance with the changes in the gray level of the monochromatic video information.

15 Claims, 3 Drawing Figures

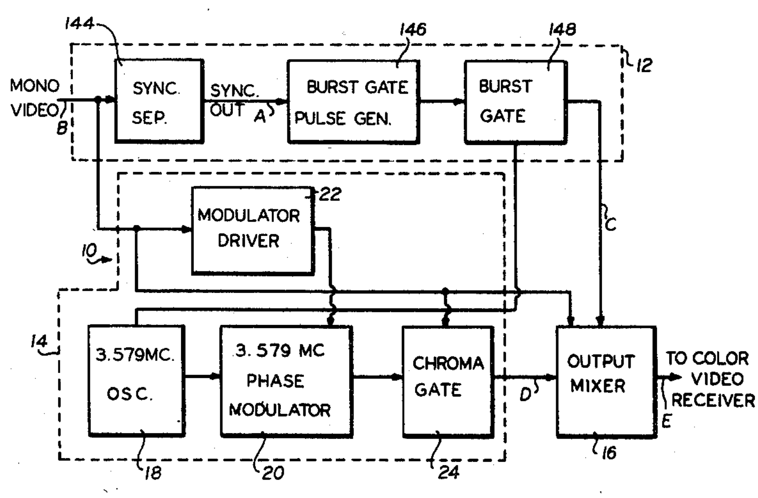

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FIG. 1.

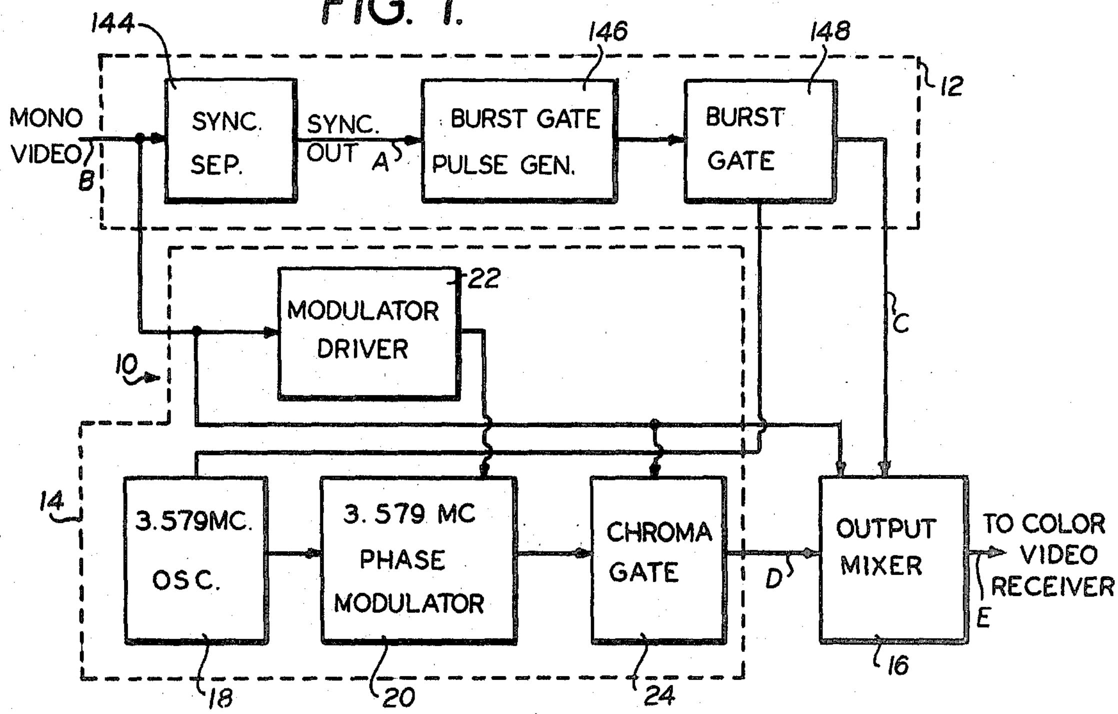

FIG. 2.

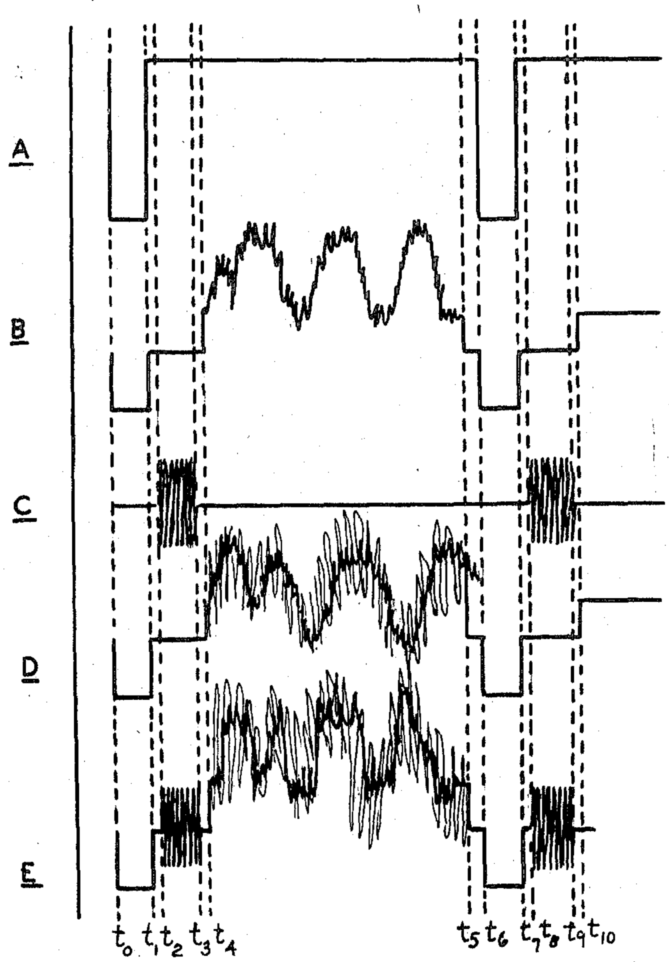

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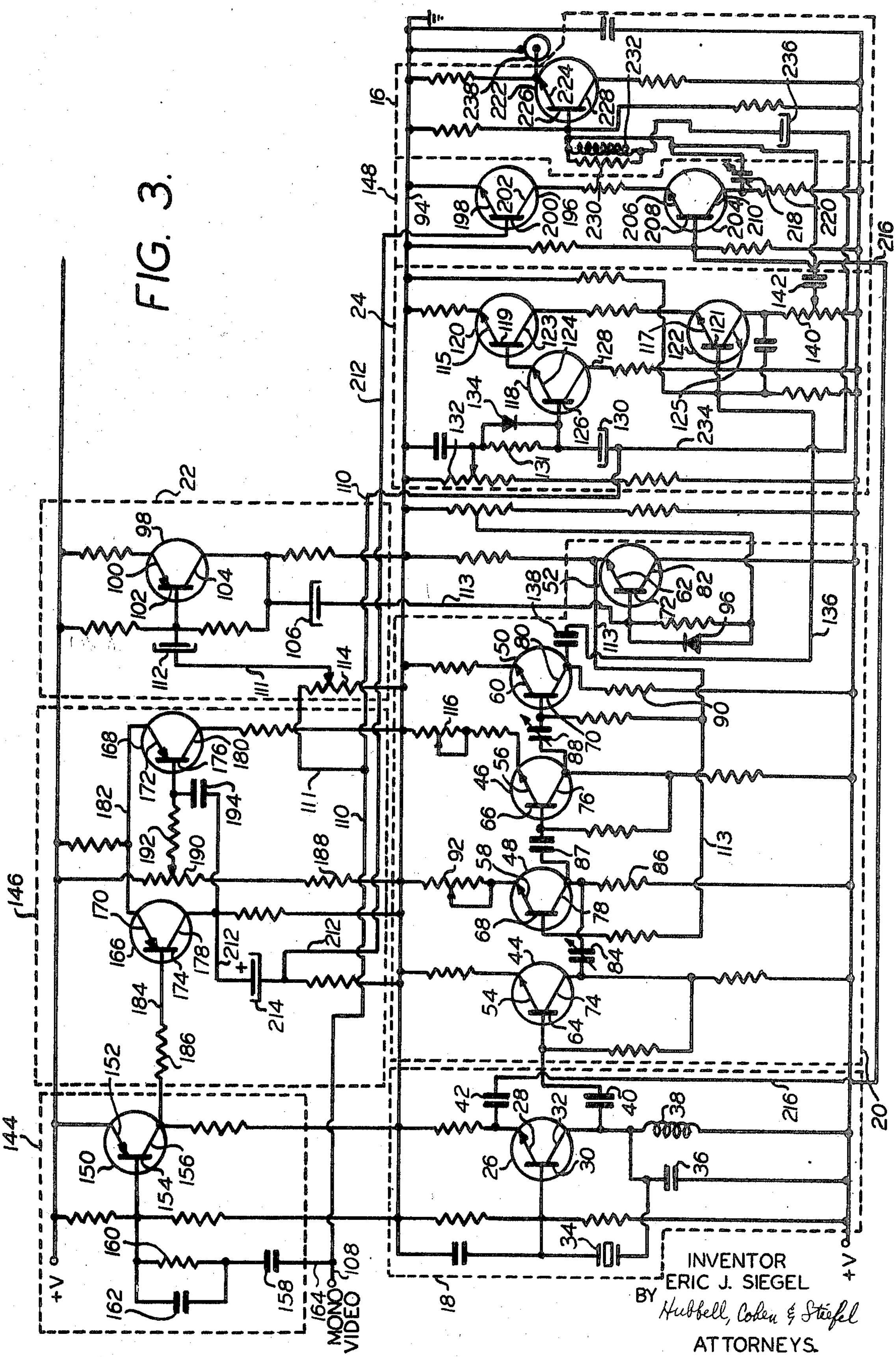
FIG. 3



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VIDEO COLOR SYNTHESIZER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an apparatus for producing from black and white video signals, video signals having portions which produce arbitrarily colored video pictures when applied to color video receiver.

2. Description of the Prior Art

Prior art subjective color systems, that is systems which do not reproduce the true color content of a scene, have utilized rotating discs, such as Benham discs, to produce subjective colors. The Benham disc is a disc having only black and white patterns thereon. When this disc is rotated, some of the patterns appear to the observer to be in color. The production of this color is wholly subjective, being solely dependent on the repetition of a certain sequence of dark and light areas, or lines. Prior art subjective color video systems have employed such discs to provide color pictures on black and white television receivers by encoding transmitted signal. These systems, however, require a special film in order to effect the desired transmission of signals which result in the subjective color phenomenon in the black and white receiver. In an attempt to overcome this deficiency of prior art subjective color systems, systems have been employed which utilize complementary color filters to convert colored light from a scanned scene into corresponding dark areas on a white background in combination with a major dark, or black area in a Benham disc-type color code. These patterns are caused to repeat in an established sequence by rotation of the disc so that the original colors are subjectively reproduced. In order to produce the subjective color phenomenon, however, the disc must be rotated at a frequency in the range of 2 to 100 revolutions per second which results in the production of a considerable flicker in the observed picture. Such flicker is disturbing to the viewer and elaborate means must be utilized to minimize this flicker. Other systems have utilized rotating drums to accomplish the same result as obtained by the use of a rotating disc. However, such drums also produce a disagreeable flicker. Furthermore, the use of these subjective color systems requires a modification to the television camera at the transmitting studio so that the subjective colors can be produced. This, therefore, requires that all persons receiving the broadcast receive the subjective color.

The production of a color video picture from a monochrome medium is another well-known phenomenon. However, these systems require that actual color information be encoded, by such means as a filter, and then recorded on a monochrome record medium. When the signal so recorded is played back on a color video receiver, the actual color content of the video signal is obtained. These systems require the initial transmission of a color video signal having a color burst portion, a luminance portion, and a chrominance portion which has hue and saturation characteristics. Hue represents a particular color and controls the phase of the chrominance portion, and saturation represents the degree to which the color is mixed with white, or in other words, the intensity thereof, and controls the amplitude of the chrominance portion. This color video signal must then be encoded so as to be recorded on the monochrome record medium for subsequent decoding by the color video receiver. These systems are not capable of converting a monochromatic video signal, which is a black and white television signal, into a subjective color video signal, as such a monochromatic video signal does not contain hue and saturation characteristics which are necessary for the color video receiver to reproduce colors.

SUMMARY OF THE INVENTION

An apparatus for synthesizing pseudocolor video signals, which are monochromatic video signals having characteristics which correspond to those of color video signals, from which composite monochromatic video signals containing synchronizing and information portions. The synthesizer includes a means for producing a synchronized color burst signal and a means for producing a pseudochrominance signal, which is a signal having characteristics corresponding to those of a true chrominance signal, from the composite monochromatic video signal. The color burst signal is produced from the monochromatic horizontal sync signal by means which include a color subcarrier oscillator, a pulse generator which stretches the horizontal sync pulse to accommodate the proper period of the subcarrier frequency and slightly delay its occurrence, and a burst gate which produces the burst frequency from the subcarrier and stretched pulses. The pulse generator provides a period for the burst pulse which is substantially equal to the period of the pseudocolor video signal so that the burst signal occurs on the back porch of the color video signal. The pseudochrominance signal producing means includes a phase modulator which is operatively connected to the subcarrier oscillator and the monochromatic video signal to phase modulate the color subcarrier with the monochromatic video signal to produce a pseudohue signal, which is a signal having a characteristic which corresponds to the hue portion of a chrominance signal. Mixing means are included to mix the phase modulated pseudohue signal with the video information portion of the monochromatic signal. This mixed signal corresponds to the pseudochrominance portion of the color video signal. Additional mixing means are provided for mixing the pseudochrominance signal with the color burst and the composite monochromatic video signal to produce the pseudocolor video signal.

BRIEF DESCRIPTION OF DRAWING

FIG. **1** is a block diagram of the preferred embodiment of the present invention;

FIG. **2** is a hypothetical graphical illustration of the signals present in various portions of the embodiment shown in FIG. **1**; and

FIG. **3** is a schematic diagram of the embodiment shown in FIG. **1**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the figures in detail, FIG. **1** is a block diagram of the color video synthesizer of the present invention, which synthesizer is generally referred to by the reference numeral **10**. The synthesizer **10** includes color burst generation circuitry, generally referred to by the reference numeral **12**, which will be explained in greater detail hereinafter; and circuitry, generally referred to by the reference numeral **14**, and which will be explained in greater detail hereinafter, for generating a pseudochrominance signal, which is a monochromatic video signal having the characteristics of a normal color video chrominance signal in that it contains hue and saturation signal characteristics, although these characteristics are preferably not directly related to actual or true color information. Furthermore, the synthesizer **10** preferably includes a combining means **16** for combining the pseudochrominance signal generated by the chrominance generation circuitry **14** with the color burst signal generated by the burst circuitry **12** and the input signal to the video synthesizer **10**, which is preferably a composite monochromatic standard black and white video signal having synchronizing and information portions, to produce a pseudocolor video signal in a manner to be described in greater detail hereinafter. The term pseudocolor video signal refers to a video signal having the signal characteristics of a color video signal, namely, burst, hue and saturation, although not containing any actual or true color information portions.

PSEUDOCHROMINANCE SIGNAL CIRCUITRY

The pseudochrominance signal circuitry **14**, whose operation will be described in greater detail hereinafter, preferably includes a subcarrier oscillator **18**; a phase modulator **20** and modulator driver **22** for phase modulating the subcarrier signal; and a chroma gate **24**, which is a gated mixer, to be described in greater detail hereinafter, for preferably mixing the phase modulated signal with the information portion of the monochromatic video signal.

As shown in FIG. 3, the subcarrier oscillator **18** is preferably a conventional crystal oscillator which includes a transistor **26** having an emitter **28**, a base **30**, and a collector **32**, and a piezoelectric crystal **34**, which is connected in the collector circuit between the collector **32** and the base **30** of transistor **26**. The crystal **34** is connected in the series-resonant mode and preferably has a resonant frequency equivalent to the standard color subcarrier frequency, which is 3.579 MegaHertz. A parallel tank circuit, consisting of capacitor **36** and inductor **38** is preferably connected between the collector **32** and the crystal **34**. Output capacitors **40** and **42** are each connected in parallel to the collector **32**, and emitter **28**, respectively, of transistor **26** of the oscillator **18**. The balance of the conventional circuitry associated with the oscillator **18** will not be explained in greater detail, as it will readily be understood by one of ordinary skill in the art.

The collector **32** of the subcarrier oscillator **18**, through output capacitor **40**, is connected to the phase modulator **20**, to be described in greater detail hereinafter. The phase modulator **20** preferably includes a transistor amplifier stage illustratively shown as two stages **44** and **46**; a transistor phase modulator stage, illustratively shown as two stages **48** and **50**, which are connected respectively to the outputs of amplifier stages **44** and **46**; and an emitter driver, or buffer stage **52** connected to transistor phase modulator stage **48** of the phase modulator **20**. Transistors **44, 46, 48, 50** and **52** have emitters **54, 56, 58, 60** and **62**, respectively; bases **64, 66, 68, 70** and **72**, respectively; and collectors **74, 76, 78, 80** and **82**, respectively. Connected to the collector **78** of the phase modulator stage **48** is a parallel R-C voltage dividing network preferably comprising a variable capacitor **84** and a resistor **86**, whose operation will be described in greater detail hereinafter. Similarly, a parallel R-C voltage dividing network preferably comprising a variable capacitor **88** and a resistor **90** is connected between the collector **80** and the base **70** of the output phase modulator stage **50**.

The base **64** of the first amplifier stage **44** is the point of connection of the collector **32** of transistor **26** of oscillator **18** through output capacitor **40** to the phase modulator **20**. The collector **74** of transistor **44** is connected in parallel to variable capacitor **84**. The balance of the amplifier stage **44** is conventional and will not be explained in greater detail as it will be readily understood by one of ordinary skill in the art.

The emitter **58** of input phase modulator stage **48** has a variable emitter bias resistor **92**, for a purpose to be described in greater detail hereinafter, connected between the emitter **58** and ground **94**. The base **68** of phase modulator stage **48** is connected to the emitter **62** of the buffer stage **52**, which is a conventional emitter driver circuit which will not be explained in greater detail hereinafter as it will readily be understood by one of ordinary skill in the art. The buffer stage **52** preferably includes a DC restorer diode **96** connected in parallel between the base **72** of transistor **52** and ground **94**. The base **72** of transistor buffer **52** is also connected in parallel to modulator driver **22**, to be explained in greater detail hereinafter.

The modulator driver **22** is preferably a conventional wide band, or video transistor amplifier including a transistor **98** having an emitter **100**, base **102**, and collector **104**. The circuitry associated therewith is conventional and will not be described in greater detail hereinafter as it will readily be understood by one of ordinary skill in the art. The collector **104** circuit of transistor **98** is connected in parallel to the base **72** of buffer stage **52** through a capacitor **106**, illustratively shown as being electrolytic, the symbol therefor being hereinafter used for all electrolytic capacitors illustratively shown in the synthesizer **10** schematic of FIG. 3. This is the point of connection between the modulator driver **22** and the buffer stage **52**. The base **102** of transistor **98** is connected in parallel to the monochromatic video signal input **108** via path **110** which preferably includes a capacitor **112**, illustratively shown as being electrolytic, and a potentiometer **114**.

The collector **78** circuit of the input phase modulator stage **48** is connected to the base **66** of the second amplifier stage **46**. The emitter **56** of the second amplifier stage **46** has a variable emitter bias resistor **116**, for a purpose to be described in greater detail hereinafter, connected between the emitter **56** and ground **94**. The balance of the circuitry associated with the amplifier stage **46** and the input phase modulator stage **48** is conventional and will not be explained in greater detail hereinafter as it will readily be understood by one of ordinary skill in the art. The collector **76** of the amplifier **46** is connected to the variable capacitor **88** associated with the output phase modulator stage **50** which is in turn connected to the base **70** of phase modulator stage **50**. The balance of the circuitry associated with phase modulator stage **50** is conventional and will not be explained in greater detail hereinafter as it too will be understood by one of ordinary skill in the art. The collector **80** circuit of the output phase modulator stage **50** is connected to the chroma gate **24**, to be described in greater detail hereinafter.

The chroma gate **24** circuit configuration is preferably a gated mixer circuit having a gating stage which comprises transistor **118**, having an emitter **124**, a base **126** and a collector **128**; and a mixing stage which comprises the series connected transistors **120** and **122**, each having an emitter **115** and **117**, respectively; a base **119** and **121**, respectively; and a collector **123** and **125**, respectively. The chroma gate **24** is so termed because it provides a pseudosaturation characteristic for the pseudochrominance signal in a manner to be described in greater detail hereinafter. The base **126** of transistor **118** is connected in parallel via path **110**, which preferably includes a capacitor **130**, illustratively shown as being electrolytic, to the monochromatic video signal input **108**. A bias resistor **131**, which preferably includes a variable resistor portion **132**, is connected in parallel to the base **126** of transistor **118** and is, preferably, adjustable to vary the bias of transistor **118** so that transistor **118** conducts, or in other words, in ON, only when the level of the monochromatic video signal is above the black level of the signal. This is the level below which synchronizing signals are transmitted and above which video information signals are transmitted. A DC restorer diode **134** is connected in parallel between the base **126** and ground **94**.

The emitter **124** of transistor **118** is connected directly to the base **119** of transistor **120** of the mixer stage whose emitter **115** is grounded. The collector **123** of transistor **120** is connected to the emitter **117** of the other transistor **122** of the mixer stage. The base **121** of transistor **122** of the mixer stage series connected pair **120** and **122** is the point of connection in the chroma gate circuit **24** from the collector **80** of the output phase modulator **50**. This connection is a parallel connection via path **136** which preferably includes a capacitor **138**. The balance of the mixer stage portion of the circuitry **24** is conventional and will not be described in greater detail hereinafter as it will readily be understood by one of ordinary skill in the art. The output circuit portion of the chroma gate **24** preferably comprises collector **121** of transistor **122**, potentiometer **140** and capacitor **142**.

COLOR BURST GENERATION CIRCUITRY

The color burst generation circuitry **12**, whose operation will be described in detail hereinafter, preferably includes a sync separator **144**, which is a conventional circuit whose purpose is to separate the sync pulses from a composite video signal having sync and information portions; a burst gate pulse generator **146** for stretching and delaying the sync pulses; and a burst gate **148** for passing the color burst signal. The sync separator **144** includes a transistor **150**, having an emitter **152**, a base **154**, and a collector **156**, which is connected in a typical clipper configuration which is conventional and will thus not be described in greater detail. Suffice it to say that the sync separator circuit preferably includes a capacitor **158** connected to a parallel R-C combination of a resistor **160** connected in parallel with a capacitor **162**, with the base **154** of transistor **152** connected in parallel with the composite monochromatic video signal input **108** via path **164** which includes the series-parallel combination of the capacitor **158** and the R-C combination **160–162**.

The collector **154** of transistor **150** of the sync separator circuit **144** is connected to the burst gate pulse generator **146**, to be described in greater detail hereinafter. The burst gate pulse generator **146** is, preferably, essentially a conventional Schmitt trigger type of pulse stretcher circuit for a negative input pulse, although a positive pulse stretcher could be substituted therefor if a positive sync pulse was to be stretched. This circuit **146** includes a pair of transistors **166** and **168**, each having an emitter **170** and **172**, respectively; a base **174** and **176**, respectively; and a collector **178** and **180**, respectively; which are emitter coupled **170–172** to provide a feedback path **182** therebetween. The collector **156** of transistor **152** is connected to the base **174** of transistor **166** via path **184** which preferably includes a resistor **186**. This is the point of connection between the sync separator **144** and the burst gate pulse generator **146**. The time constant provided by the R-C combination of resistor **186** and the internal capacitance of transistor **166** slightly delays the output signal from the collector **178** of transistor **166**, as will be explained in greater detail hereinafter. The collector **178** of transistor **166** is connected in parallel to the base **176** of transistor **168** through a parallel R-C combination which preferably includes a resistance portion comprising a resistor **188** and a potentiometer which includes resistors **190** and **192**, and a capacitance portion comprising capacitor **194**. As will be explained in greater detail hereinafter, this parallel R-C combination **188–190–192–194** together with transistor **168** provides the pulse stretching function for the burst gate pulse generator **146** so as to effectively increase the pulse width at the collector **178** of the input pulse present at the base **174** of transistor **166**. The potentiometer **190–192** provides a means for varying the R-C time constant for transistor **168**. The balance of the burst gate pulse generator circuitry **146** is conventional and will not be explained in greater detail hereinafter.

The collector **178** of transistor **166** of the burst gate pulse generator **146** is also connected in parallel to the burst gate **148**, to be described in greater detail hereinafter. The burst gate **148**, whose operation will be described in greater detail hereinafter, preferably includes a conventional overdriven transistor amplifier **196**, having an emitter **198**, a base **200**, and a collector **202**; and a transistor **204**, having an emitter **206**, a base **208**, and a collector **210**, connected in a series saturating gate configuration with the emitter **206** of transistor **204** connected to the collector **202** of transistor **196**. The base **200** of transistor **196** is connected in parallel to the collector **178** of transistor **166** via path **212** which includes capacitor **214**, which is shown and preferred as being electrolytic. This is the point of connection of burst gate **148** to burst gate pulse generator **146**. The emitter **198** of transistor **196** is connected to ground **94**. The base **208** of transistor **204** is connected in parallel via path **216**, which includes the output capacitor **42**, to the collector **28** of transistor **26** of the fixed frequency oscillator **18**, which is the point of connection between the oscillator **18** and the burst gate **148**. The output circuit for the burst gate **148** preferably includes a variable capacitor **218** connected in parallel with resistor **220** to the collector **210** of transistor **204**. The balance of burst gate circuitry **148** is conventional and will not be described in greater detail hereinafter.

OUTPUT MIXER CIRCUIT

The monochromatic video signal from input **108**, the burst gate **158**, and the chroma gate **24** are connected in parallel to the output mixer **16**, to be described in greater detail hereinafter. The output mixer circuit **16**, whose operation will be described in greater detail hereinafter, preferably is a conventional mixer including a transistor **222** having an emitter **224**, a base **226**, and a collector **228**. A resistor **230** and an inductor **232** are connected in parallel between the base **226** of transistor **222** and the monochromatic video signal input **108** via path **234** which includes capacitor **236**, shown and preferred to the electrolytic, and path **110**. This is the point of connection between the output mixer **16** and the monochromatic video input **108**. The base **224** of transistor **222** is also connected in parallel with the collector **210** of burst gate **148** via variable capacitor **218**, which is the point of connection between the output mixer **16** and burst gate **148**; and with the collector **125** of transistor **122** via capacitor **142** and resistor **140**. The latter is the point of connection between the output mixer **16** and the chroma gate **24**. The output portion of the output mixer circuit **16** preferably includes a coaxial cable **238** for connection to a color video receiver, not shown.

OPERATION

For ease in understanding the operation of the video color synthesizer **10** of the present invention, the operation of the associated circuitry to produce the color burst signal will be described first, then the production of the pseudochrominance signal, and lastly the production of the composite pseudocolor video signal. In a manner to be described in greater detail hereinafter, the composite monochromatic video signal is fed to the sync separator circuit **144** to produce the color burst signal; to the modulator driver circuit **122** and the chroma gate **24** to produce the pseudochrominance signal; and to the output mixer circuit **16** to produce the composite pseudocolor video signal.

The sync separator circuit **144** clips off all signals above the blanking level of the composite monochromatic video signal, shown illustratively in FIG. **2B**, which is the level that separates picture information from synchronizing information in a composite video signal and which coincides with the level of the base of the sync pulses, so that only the sync signals are permitted to pass. This produces a pulse train of sync pulses, illustratively shown in FIG. **2A**. The sync separator circuit **144** is adjusted so that the bias voltage applied to the base **154** of transistor **150** drives the transistor **150** to cut off at the blanking level. As a result the transistor **150** is cut off at all times, except when a negative sync pulse whose amplitude is lower than the blanking level is applied thereto. The occurrence of the sync pulses permit a momentary flow of collector current in transistor **150**. The synchronizing pulses are fed from transistor **150** via collector **156** along path **184** to the base **174** of transistor **166** of the burst gate pulse generator **146**.

The burst gate pulse generator **146** performs several functions. It is constructed preferably to operate responsive only to the horizontal synchronizing pulses of the synchronizing signal present on path **184**. As was previously mentioned, the burst gate pulse generator **146** is essentially a conventional pulse stretcher circuit for pulse-stretching a negative pulse. Emitter coupled transistors **166** and **168** are normally reverse-biased to be OFF. When an input pulse, which is the sync pulse, is supplied from the sync separator **144** through resistor **186** via path **184**, to the base **174** of transistor **166** of the burst gate pulse generator **146**, this overcomes the reverse bias of transistor **166** and forward biases transistor **166** to turn it ON. There is a slight delay in transition from the OFF condition to the ON condition of transistor **166** due to the time constant of the R-C combination of resistor **186** and the internal capacitance of transistor **166**. The leading edge of the output pulse from collector **176** of transistor **166** does not start coincidentally with the leading edge of the monochromatic video signal sync pulse due to this slight delay, for a purpose to be explained in greater detail hereinafter. The output of transistor **166** from collector **178**, which is a pulse whose width is determined by the parallel R-C combination **188–190–92–194**, is fed in parallel to the base **200** of transistor **196** of the burst gate **148**, whose operation will be described in greater detail hereinafter, and to the base **176** of transistor **168** through the parallel R-C combination **188–190–92–194**. The signal through the parallel R-C combination **188–190–192–194** is a trigger signal which overcomes the reverse bias of transistor **168** and turns transistor **168** ON. Transistor **168**, in the ON condition, through the emitter couple **172–170**, continues to forward bias transistor **166** to keep transistor **166** ON, even after the sync pulse present on path **184** goes to zero, until the decay of the signal present at the output of the parallel R-C combination **188–190–92–194** has reduced the signal level on the base **176** below the normal reverse bias potential so that transistor **168** is again reverse biased at which time it turns OFF. Since transistor **166** is no longer receiving an input pulse on base **174** nor a signal at emitter **170** which overcomes the normal reverse bias, transistor **166** is again reverse biased at which time it turns OFF and the trailing edge of the output pulse present on collector **178** occurs thereby terminating the pulse present on path **212**. The pulse width of this slightly delayed output pulse present on path **212**, which may be varied by varying the R-C time constant of the parallel R-C combination **188–190–92–194**, is preferably adjusted to permit 8 cycles of the 3.579 MegaHertz subcarrier signal to occur within the duration of this output pulse from the burst gate pulse generator **146**.

The subcarrier oscillator **18** operates as a conventional crystal fixed frequency oscillator having a piezoelectric crystal **56** tuned to the subcarrier frequency of 3.579 MegaHertz, and, provides a fixed output frequency of 3.579 MegaHertz via path **216** from the emitter **28** of transistor **26** to the base **208** of transistor **204** of the burst gate transistor pair **196** and **204** via path **171**. When no pulse stretched signal is present on path **212**, transistor **196**, which is the gating transistor, is OFF and effectively an open circuit is present between transistor **204** and ground. In this OFF condition, the 3.579 MegaHertz signal is not passed by burst gate **148** through the collector **210** of transistor **204** which is the output transistor of burst gate **148**. When the pulse stretched signal is present on path **212**, that is, when it has a value other than zero, transistor **196** is ON and the effective output of transistor **196** is substantially a short circuit as long as the collector **202** is in the saturation region, which is the preferable point of operation for this gating transistor. In this ON condition, transistor **196** is effectively short circuited to ground, and burst gate **148** passes the 3.579 MegaHertz signal via collector **210** to the parallel R-C combination of capacitor **218** and resistor **220** and therethrough in parallel to the base **226** of transistor **222** of the output mixer **16**. The switching levels of transistor **196** can, therefore, be described as OFF when no pulse is present on path **212** and ON when a pulse is present on path **212**.

The output of transistor **204** is equivalent to a standard color burst signal, illustratively shown in FIG. 2C, preferably having 8 cycles of the 3.579 MegaHertz signal each time a stretched pulse occurs. Since the horizontal sync pulses from which the burst gate pulse are derived occur in the region of the back porch of the composite video signal, which by definition is the portion of a composite video signal that follows the horizontal sync pulse and extends to the trailing edge of the corresponding blanking pulse, the color burst signal will also occur in the region of the back porch, and will be slightly delayed from the occurrence of the horizontal sync pulse, due to the slight delay present in the gating pulse on path **212**, as was previously explained. This color burst signal is equivalent to a standard color video color burst signal present in a composite color video signal.

Now that we have explained the derivation of the color burst signal, we shall describe the operation of the video color synthesizer **10** to produce the pseudochrominance portion of the composite pseudocolor video signal. The collector **32** output of the oscillator **18**, which is the 3.579 MegaHertz signal, is fed through capacitor **40** to the base **64** of transistor **44** of the phase modulator **20** where it is amplified. This signal is the carrier signal input of the phase modulator **20**. The monochromatic video signal is fed in parallel via path **110** and **111** to the modulator driver **22** where its signal level is boosted to the operating level of transistor **48** before being fed to the base **72** of the emitter driver **52**. This amplified signal via path **113** including emitter driver **52** is fed to the base **68** of phase modulator transistor **48**. The output of transistor **44**, which is the 3.579 MegaHertz subcarrier signal, is fed in parallel, via variable capacitor **82**, to the collector **78** output of transistor **48**. In this manner the output of the fixed subcarrier oscillator **18** is connected in parallel to the output of the phase modulator transistor **48** and provides a phase modulated output signal from the R-C voltage divider network of capacitor **84** and resistor **86**. Amplitude variations may also be present but they can be reduced by making the impedance of resistor **86** much greater than the impedance of capacitor **84**.

The output of the transistor **48** R-C network **84–86** is in turn fed through capacitor **87** to the base **66** of amplifier **46** where it is amplified. The amplified phase modulated signal is in turn fed to the output phase modulator **50** via capacitor **88**. The phase modulated output signal is fed from the collector **80** of transistor **50** via path **136** to the base **121** of transistor **122** of the chroma gate **24**. This phase modulated signal is one in which the phase of the carrier wave, which is the 3.579 MegaHertz subcarrier, varies linearly with the modulating signal, which is the monochromatic composite video signal.

This phase modulated output signal corresponds to a pseudohue signal in that a hue signal for a particular color causes phase modulation of the color subcarrier in a standard color video transmission system. The variations in pseudohue in this phase modulated signal are due to the differences in gray level of the video information portion of the signal. The variations in the gray level may be altered by changing the bias **92** and **116** of the transistors **48** and **46**, respectively, of the phase modulator circuitry **20**. The hue present in the pseudohue signal would thereby be changed due to these alterations in the gray level.

As previously mentioned, the other characteristic of the chrominance signal is saturation, which may be defined as a variation in intensity of the hue, and which controls the amplitude of the chrominance signal in a standard color video transmission system. The composite monochromatic video signal is fed in parallel via path **110** to the base **126** of transistor **118** of the chroma gate **24**. Transistor **118**, which is the gating transistor, is biased to conduct only when the signal on path **110** exceeds the black level of the video signal. When transistor **118** conducts, only the video information portion of the signal is passed to the base **119** of transistor **120**. When the signal on path **110** is below the black level, transistor **118** does not conduct and no signal is received by base **119** and mixing cannot occur between the monochromatic video signal input and the chroma gate **24** output signals. In this manner only the video information portion of the monochromatic video signal will be mixed with the phase modulated pseudohue signal so that the mixed output of the chroma gate **126** will be solely dependent on the amplitude of the video information portion of the monochromatic video signal. This effectively provides the pseudosaturation characteristic for the pseudochrominance signal, which is the mixed output signal present at the collector **210** of transistor **204** of the chroma gate **126**, and is illustratively shown in FIG. 2D. This pseudochrominance signal, having both pseudohue and pseudosaturation characteristics, is fed to the base **226** of transistor **222** of mixer circuit **16** in parallel via capacitor **218**, in parallel with the color burst signal via R-C network **140–142**.

A composite color video signal, as is well known, has a luminance portion, as well as a chrominance and color burst portion. To provide the luminance portion of the composite pseudocolor video signal, the composite monochromatic video signal is fed in parallel via paths **110** and **234** and R-C network **230–232**, to the base **226** of transistor **222** of the mixer circuit **16** in parallel with the color burst signal and the pseudochrominance signal. These three signals are mixed in a conventional manner to provide a mixed output having luminance and pseudochrominance superimposed thereon, as well as synchronizing and color burst signals present therein. Such a signal is illustratively shown in FIG. 2E. This mixed output is present at coaxial cable **238** and has all the characteristics of a composite color video signal, namely, chrominance, luminance, color burst, and synchronization, although not representing the true color content of the scene corresponding to the video information signal. This signal is therefore termed a pseudocolor video signal.

When this signal is fed to standard color receiver circuitry, not shown, the composite pseudocolor video signal is separated into monochromatic video and phase modulated signal portions. The phase modulated signal is equivalent to the chrominance signals of a true color video signal which are passed through the conventional color circuitry of the standard color receiver so as to produce a color picture. The presence of the color burst signal on the back porch prevents the chroma amplifier of the standard color receiver from producing a control signal to the color killer circuitry to shut off the color circuitry of the color receiver. Therefore, the color circuits stay ON and the pseudochrominance phase modulated signal is processed in the color circuitry in the same manner as a normal chrominance signal to produce a subjective color picture from the monochromatic video picture signal. The color, or hue, of the subjective color picture produced varies in accordance with the gray level of the monochromatic video information.

The present invention, as it is present and preferably contemplated to be used, produces arbitrarily colored video pictures on a color video receiver, which pictures are preferably not true color representations of the color content of the actual scene comprising the video information portion of a monochromatic video signal, so that various colorful, artistic and aesthetic effects may be produced on the color video receiver screen for this scene. Of course modifications might possibly be made to the circuitry of the present invention, if desired, to produce pictures which are truer representations of the color content of the actual scene if these artistic effects are not desired. Furthermore, by utilizing the present invention, these artistic effects may be produced by color designers from a standard black and white video transmission in a relatively easy manner without any modifications to the standard black and white video transmitting apparatus, or the standard color video receiving apparatus other than the passing of the received signal through the color video synthesizer before feeding the signal to the standard color receiver.

It is to be understood that the above-described embodiment of the invention is merely illustrative of the principles thereof and that numerous modifications and embodiments of the invention may be derived within the spirit and scope thereof.

What is claimed is:

1. An apparatus for synthesizing pseudocolor video signals from composite monochromatic video signals containing synchronizing and information portions, said pseudocolor video signals providing a subjective color display video presentation of said monochromatic video information portions, comprising:
   - means for producing a pseudochrominance signal having pseudohue and pseudosaturation characteristics from said composite monochromatic video signal, said pseudochrominance signal producing means including means for producing a color video subcarrier signal; and means for modulating said color subcarrier signal with said composite monochromatic video signal to produce a modulated signal having said pseudohue characteristic, said modulating means including means for varying the nature of the subjective display during a video presentation thereof so as to provide a varying subjective display of the monochromatic video information, said variations being controlled independently of said monochromatic video signal.

2. An apparatus in accordance with claim 1 wherein said pseudochrominance signal producing means further includes means for combining said modulated signal with said information portion of said composite monochromatic video signal to produce said pseudochrominance signal.

3. An apparatus in accordance with claim 1 wherein said apparatus includes
   - means for producing a color burst signal synchronized with said monochromatic video signal; and
   - means for combining said color burst signal with said pseudochrominance signal and said composite monochromatic video signal to produce said pseudocolor video signal.

4. An apparatus in accordance with claim 3 wherein said color burst signal producing means includes means for obtaining said synchronized color burst signal from said monochromatic synchronizing portion.

5. An apparatus in accordance with claim 4 wherein said obtaining means includes means for separating said synchronizing portion from said composite monochromatic signal.

6. An apparatus in accordance with claim 5 wherein said monochromatic synchronizing portion comprises synchronizing pulses, and said obtaining means further includes a burst pulse generator operatively connected to said separating means to produce a burst pulse signal from said monochromatic synchronizing portion pulse signal.

7. An apparatus in accordance with claim 6 wherein said burst pulse generator includes means for making the period of the burst pulse substantially equal to the period of the pseudocolor video signal so said color burst signal occurs on the back porch of the composite pseudocolor video signal.

8. An apparatus in accordance with claim 6 wherein said synchronizing portion includes vertical and horizontal synchronizing pulses, and said burst pulse generator includes means for obtaining said burst pulse solely from said horizontal synchronizing pulses.

9. An apparatus in accordance with claim 3 wherein said pseudocolor video signal includes a video information portion, a synchronizing portion and a color burst portion; and said color burst signal producing means includes means for making the period of occurrence of the color burst portion substantially equal to the period of the pseudocolor video signal so said color burst portion occurs on the back porch of the pseudocolor video signal spaced from said video information portion, and means for delaying the occurrence of said color burst portion with respect to said synchronizing portion so said color burst portion occurs after said synchronizing portion and spaced therefrom.

10. An apparatus in accordance with claim 1 wherein said modulating means includes a phase modulator, and means for driving said phase modulator.

11. An apparatus in accordance with claim 10 wherein said phase modulator driver includes means for increasing the signal level of said monochromatic video signal, said increased level signal being a driving signal for said phase modulator.

12. An apparatus in accordance with claim 1 wherein said means for varying the nature of the subjective display comprises means for varying the gray level of the monochromatic video signal information portion.

13. An apparatus in accordance with claim 1 wherein said pseudochrominance signal producing means further includes a means for combining said pseudohue signal with said monochromatic video signal.

14. An apparatus in accordance with claim 13 wherein said combining means includes means for combining said pseudohue signal with said monochromatic video signal information portion, said amplitude of said video information portion being a pseudosaturation signal, the output of said combining means being said pseudochrominance signal.

15. An apparatus in accordance with claim 14 wherein said combining means is a gated mixer means for mixing the pseudohue and monochromatic video signal only when the monochromatic video signal is above the black level for said monochromatic signal.

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