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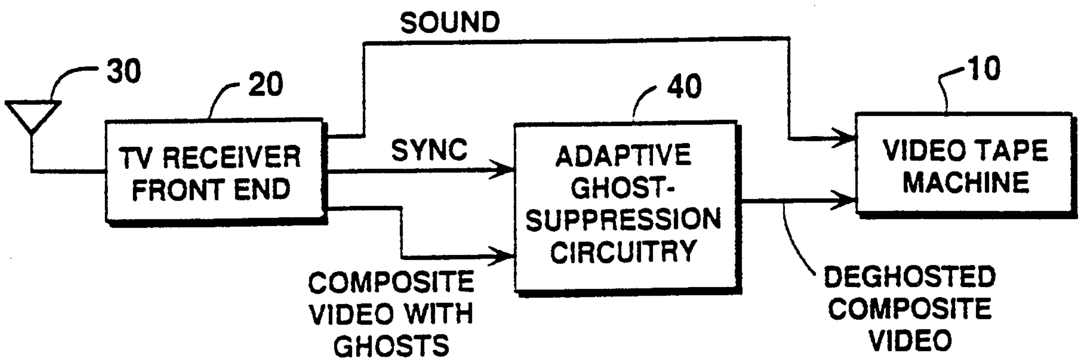

(57) Abstract

Ghost-suppression circuitry is connected for receiving composite video signal from the video detector of a television receiver front-end. The response to that composite video signal, in which response at least one ghost is suppressed, is supplied to the recording electronics of a video tape machine, which uses helical scanning to record that response together with a sound signal supplied from the sound detector of the television receiver front-end. This is done instead of supplying the recording electronics of the video tape machine with the composite video signal as taken directly from the video detector of the television receiver front end. This deghosts the images on the viewing screen of a television receiver producing television images in response to television signal supplied from the video tape machine during playback from the recorded video tape, without having to rely on ghost-suppression circuitry in this television receiver. This obviates the problem that the performance of any ghost-suppression circuitry in this television receiver will be impaired because the time-base stability of the ghost cancelation reference signal in the composite video signal reproduced during playback from the recorded video tape is poor, owing to headswitching during helical scan.

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VIDEO TAPE RECORDER WITH TV RECEIVER FRONT END & GHOST-SUPPRESSION CIRCUITRY

The invention relates to video tape recorders and players, especially cassette types using helical-scan recording and playback.

Background of the Invention

Television engineers have given considerable thought to ghostcancelation circuitry for inclusion in television receivers that also include a display device for reproducing the television image in a form suitable for viewing by humans. Ghost images, caused by multipath reception and commonly referred to as "ghosts", are a common occurrence in television pictures that have been broadcast over the air or have been transmitted by cable.

The signal to which the television receiver synchronizes is called the reference signal, and the reference signal is usually the direct signal received over the shortest transmission path. The multipath signals received over other paths are thus usually delayed with respect to the reference signal and appear as trailing ghost images. It is possible, however, that the direct or shortest path signal is not the signal to which the receiver synchronizes. Where the receiver synchronizes to a reflected (longer path) signal, there will be a leading ghost image caused by the direct signal, or there will a plurality of leading ghosts caused by the direct signal and other reflected signals of lesser delay than the reflected signal to which the receiver synchronizes. The multipath signals vary in number, amplitude and delay time from location to location and from channel to channel at a given location. The parameters of a ghost signal may also be time-varying.

The visual effects of multipath distortion can be broadly classified in two categories: multiple images and distortion of the frequency response characteristic of the channel. Both effects occur due to the time and amplitude variations among the multipath signals arriving at the reception site. When the relative delays of the multipath signals with respect to the reference signal are sufficiently large, the visual effect is observed as multiple copies of the same image on the television display displaced horizontally from each other. These copies are sometimes referred to as "macroghosts" to distinguish them from "microghosts", which will be presently described. Usually, the direct signal predominates, and a receiver is synchronized to the direct signal. In such case the ghost images are displaced to the right at varying position, intensity and polarity. These are known as trailing ghosts or "post-ghost" images. In the less frequently encountered case where the receiver synchronizes to a reflected signal, there will be one or more ghost images displaced to the left of the reference image. These are known as leading ghosts or "pre-ghost" images.

Multipath signals of relatively short delay with respect to the reference signal do not cause separately discernible copies of the predominant image, but do introduce distortion into the frequency response characteristic of the channel. The visual effect in this case is observed as increased or decreased sharpness of the image and iii some cases loss of some image information. These short-delay or close-in ghosts are most commonly caused by unterminated or incorrectly terminated radio-frequency transmission lines such as antenna lead-ins or cable television drop cables. In a cable television environment, it is possible to have multiple close-in ghosts caused by multiple taps having improperly terminated drop cables of varying lengths. Such multiple close-in ghosts are frequently referred to as micro-ghosts".

Long multipath effects, or macroghosts, are typically reduced by cancelation schemes. Short multipath effects, or microghosts, are typically alleviated by waveform equalization, generally by peaking and/or group-delay compensation of the high frequency video response.

Since the characteristics of a transmitted television signal are known a priori, it is possible, at least in theory, to utilize such characteristics in a system of ghost signal detection and cancelation. Nevertheless, various problems limit this approach. Instead, it has been found desirable to transmit repeatedly a reference signal situated, for example, in a section of the TV signal that is currently unused for video purposes and to utilize this reference signal for detection and cancelation of ghost signals. Typically, lines in the vertical blanking interval (VBI) are utilized. Such a signal is herein referred to as a Ghost Canceling Reference (GCR) signal.

The strategy for eliminating ghosts in a television receiver relies on the transmitted GCR signal suffering the same multipath distortions as the rest of the television signal. Circuitry in the receiver can then examine the distorted GCR signal received and, with a priori knowledge of the waveform of a distortion-free GCR signal, can configure an adaptive filter to cancel, or at least significantly attenuate, the multipath distortion. A GCR signal should not take up too much time in the VBI (preferably no more than one TV line), but should still contain sufficient information to permit circuitry in the receiver to analyze the multipath distortion and configure an compensating filter to cancel the distortion.

The GCR signals are used in the television receiver for calculating the adjustable weighting coefficients of a ghost-cancelation filter through which the composite video signals from the video detector are passed to supply a response in which ghosts are suppressed. The weighting coefficients of this ghost-cancelation filter are adjusted so it ha-s a filter characteristic complementary to that of the transmission medium giving rise to the ghosts. The GCR signals can be further used for calculating the adjustable weighting coefficients of an equalization filter connected in cascade with the ghost-cancelation filter, for providing an essentially flat frequency spectrum response over the complete transmission path through the transmitter vestigial-sideband amplitude-modulator, the transmission medium, the television receiver front-end and the cascaded ghost-cancelation and equalization filters.

W. Ciciora *et alii* in "A Tutorial on Ghost Canceling in Television Receivers", IEEE Transactions on Consumer Electronics, vol. CE25, 2/79, pp. 9-43, indicates that a GCR signal may appropriately exhibit a (sin x)/x waveform. Such a waveform, suitably windowed, exhibits a relatively constant spectral energy density over a frequency band of interest. Ghost locations can then be determined so a filters can be configured for ghost signal cancelation to reduce the effects of long multipaths and for waveform equalization to reduce the effects of short multipaths.

In U.S. Patent No. 4,897,725 issued 30 January 1990 to Tanaka *et alii* and entitled "GHOST CANCELLING CIRCUIT" a transmitted reference or GCR signal is used that is substantially the proposed BTA (Japanese) GCR signal and that utilizes as the main reference or deghosting signal a (sin x)/x waveform. This (sin x)/x waveform as received together with ghosts thereof is Fourier transformed to provide a set of Fourier coefficients. The Fourier transform of the ghosted GCR signal is then processed with an available Fourier transform of an unimpaired GCR to compute the deghosting filter parameters, that is, tap gain information for both an infinite-impulse-response (IIR) deghosting filter and a finite-impulse-response (FIR) waveform equalization filter.

U.S. Patent No. 4,896,213 issued 23 January 1990 to Kobo *et alii* and entitled "GHOST CANCELLING REFERENCE SIGNAL TRANSMISSION/RECEPTION SYSTEM" discloses a system with a built-in ghost cancelling device for reducing or eliminating ghost components attributable to group-delay distortion and frequency-versus-amplitude characteristic distortion generated in a signal transmission path. A digital signal composed of frame synchronizing signals, clock synchronizing signals, and data signals is generated and superposed on a television signal to be transmitted, during a VBI scan line thereof. At the receiving end, the digital signal is utilized as a ghosted CGR signal in an arrangement that correlates that signal with its known non-ghosted CGR signal to control adaptive filtering of the video signal to reduce the ghost phenomenon.

Bessel pulse chirp signals are the de facto standard

GCR signal for television broadcasting in the United States of America. The distribution of energy in the Bessel pulse chirp signal has a frequency spectrum extending continuously across the video frequency band. The chirp starts at the lowest frequency and sweeps upward in frequency therefrom to the 4.1 MHz highest frequency. The chirps are inserted into the first halves of selected VBI lines, the 19th line of each field currently being preferred. The chirps, which are on +30 IRE pedestals, swing from -10 to +70 IRE and begin at a prescribed time after the trailing edges of the preceding horizontal synchronizing pulses. The chirp signals appear in an eight-field cycle in which the first, third, fifth and seventh fields have a polarity of burst defined as being positive and the second, fourth, sixth and eighth fields have another polarity of burst defined as being negative. The initial lobe of a chirp signal ETP that appears in the first, third, sixth and eighth fields of an eight-field cycle swings upward from the +30 IRE pedestal to +70 IRE level. The initial lobe of a chirp signal ETR that appears in the second, fourth, fifth and seventh fields of the eight- field cycle swings downward from the +30 IRE pedestal to -10 IRE level and is the complement of the ETP chirp signal.

U. S. patent No. 4,864,403 issued 5 September 1989 to Chao *et alii* and entitled "ADAPTIVE TELEVISION GHOST CANCELLATION SYSTEM INCLUDING FILTER CIRCUITRY WITH NON-INTEGER SAMPLE DELAY" describes the use of an IIR deghosting filter using interpolative techniques.

U. S. patent No. 4,864,403 issued 10 September 1991 to Koo and entitled "METHOD AND APPARATUS FOR COMMUNICATION CHANNEL IDENTIFICATION AND SIGNAL RESTORATION" describes method and apparatus for calculating ghost-suppression-filter parameters in a television receiver.

U. S. patent No. 4,044,381 issued 23 August 1977 to Shimano *et alii* and entitled "AUTOMATIC WAVEFORM EQUALIZING SYSTEM FOR TELEVISION RECEIVER" describes a waveform equalizer filter as may be used to suppress microghosts.

U. S. patent No. 5,032,916 issued 16 July 1991 to

Matsura *et alii* and entitled "METHOD OF DETECTING SIGNAL WAVEFORM DISTURBANCE IN RECEIVED TELEVISION SIGNAL" describes the pairwise combination of VBI intervals containing antiphase GCR signals and in-phase other reference signals, in order to suppress longer-delayed macroghosts.

Since the known ghost-cancelation schemes rely to a high degree on cancelation procedures, the time-base stability of the GCR signal in the received television signal is critical in order for the procedure of determining the weights for the ghost cancelation and equalizing filters by analyzing the GCR signal to work well. The theoretical validity of a ghost-cancelation procedure using weighted summation of differentially delayed video signals depends on the same signal with different delays having given rise to the ghosted signal. If the length of scan lines is different during the GCR signal transmission than during other portions of the video signal, then the weights determined for generating ghost-free GCR signal by weighted summation of variously delayed GCR signals will not be appropriate for generating ghost-free video at other times by weighted summation of variously delayed video signals. In a television receiver with included display device and ghost cancelation circuitry, the problem of time-base stability of the detected video signals is hot a problem when receiving -off-the-air broadcast signals or when receiving such signals as relayed by cable broadcasting or community antenna systems.

A problem that has not been appreciated by television receiver designers, who are the persons working in the field of ghost cancelation for television, is that such a television receiver with included display device and ghost-cancelation circuitry often will not perform its ghost-cancelation procedures satisfactorily when the receiver receives its radio frequency (r-f) signals from a home video cassette recorder (VCR) that has recorded a television signal containing ghosts. In the prior art the location for ghost-cancelation circuitry is after the video detector in the television receiver with the display device, where the ghost-cancelation circuitry supposedly can be used for r-f signals received from off-the-air, cable or a video recording medium.

The term "television set" is used in this specification to describe a television receiver front end with accompanying kinescope, power supply for a kinescope, deflection circuitry for a kinescope, portions of a television receiver associated with converting the composite video signal to the color signals for driving a kinescope, loudspeaker(s), stereophonic sound detector or audio amplication circuitry. The conventional video cassette recorder (VCR) includes a television receiver front end without those accompanying further items, which are termed a "television monitor" in this specification and the accompanying drawing. If in a VCR and TV-set combined into a single piece of apparatus called a "combo" one desires the capability simultaneously to record a program received on one channel and to display a program received on a different channel, two television receiver front ends have to be provided, one for the video tape machine with recording capability and one for the television receiver with image displaying capability.

Suppose one were to consider locating ghost-cancelation circuitry after the video detector in the television receiver front end used for supplying composite video signal and sound signal for recording on an electromagnetic storage medium. Ghost suppression circuitry is estimated to cost US$50 as a portion of manufacturing price, which appears as an increase of about US$150 in the retail price of the instrument including that circuitry. The average service life in terms of years of actual use is longer for a television set than it is for a VCR, which is an underlying reason why separate VCRs and television sets are commercially more popular than TV/VCR combos.

Since ghost-suppression circuitry is quite expensive, it would seem better economics to include the ghost-cancelation circuitry in the instrument having longer service life. Since ghost-suppression circuitry will be required after the video detector in the television receiver with the display device in any case, in order to be able to deghost composite video signals received over a cable TV distribution system or off-the-air with an antenna, the prospect of raising the price of the VCR or TV/VCR combo by perhaps US$150 strongly pushes the designer of such devices towards abandoning any consideration of locating ghost-cancelation circuitry after the video detector in the television receiver front end used for supplying composite video signal for recording.

The inventor has discerned that the belief commonly held by television design engineers that ghost-suppression circuitry should only be placed in the television receiver including the display device is incorrect. Those unfamiliar with home video recording design are unlikely to give thought to the problem of time-base stability of the signals being subjected to ghost-cancelation, especially since the situation does not arise when using laboratory generators or off-the-air broadcast signals as the r-f signals to the television receiver, as has been the practice in developing ghost-suppression procedures and circuitry. Home VCRs use helical scanning of the electromagnetic tape, with head switching taking place shortly before the vertical retrace interval. There is time-base instability in the video signal recorded from the electromagnetic tape during playback, which time-base instability unfortunately under practical circumstances often persists throughout the vertical retrace interval and to some extent in the first few active lines of video signal, which are used to generate the topmost portion of the picture on the display device of the television receiver. Thus, the ghost-suppression circuitry in a television receiver receiving the r-f signal modulated in accordance with the played-back video signal will tend not to operate properly. The weighing coefficients chosen in response to an evaluation of the GCR signal occurring in one scan line will not be correct for the active video signal in other scan lines, because the scan lines of active video do not have the same actual time duration as the scan line in which GCR signal occurs. Good time-base stability is essential also where the 19th scan lines of several fields are differentially delayed thereafter to be linearly combined in order to separate a GCR signal component from accompanying horizontal sync pulse, front porch, back porch including color burst and +30 IRE GCR signal pedestal components. These accompanying components will not cancel out well if there be errors in the timing of the samples of the 19th scan lines when those lines are digitized to facilitate their being differentially delayed using temporary digital memory. Home VCRs generally are not capable of providing the requisite time-base stability for separating GCR signal this way.

Summary of the Invention

A basic precept taught by the inventors is that, when relatively unsophisticated video tape recording and playback apparatus are used, the satisfactory suppression of ghosts, particularly macroghosts, in composite video signal retrieved from recorded video tape is not possible in practice. Ghost cancelation must be done before the tape recording and playback procedures that give rise to time-base instabilities that interfere with ghost cancelation. Otherwise, when a television signal with ghosts is recorded, a video tape results that when played back to supply television signals to a television set will result in ghosts appearing in the reproduced image, even if that set includes ghost cancelation circuitry that satisfactorily suppresses ghosts when receiving television signals off-the-air or off-cable.

Ghost cancelation done before recording the tape, in accordance with an aspect of the invention, results in a tape that can be played back to supply deghosted signals to a television set. The reproduced image will be ghost free even if the television set is one without ghost suppression circuitry. This aspect of the invention is embodied in a combination of:

a television receiver front-end, including elements up to and including the sound detector and video detector;

a video tape machine including at least recording electronics, to which signals from said sound detector and said video detector are supplied for recording;

and the improvement wherein ghost-suppression circuitry is connected for receiving composite video signal from the video detector of said television receiver front-end and is connected for supplying its response to that composite video signal, in which response at least one ghost is suppressed, to the recording electronics of said video tape machine instead of supplying the recording electronics of said video tape machine with the composite video signal as taken directly from the video detector of said television receiver front end.

A further aspect of the invention is that in a combination of a television receiver and video tape machine (called a "combo") although ghost suppression circuitry is needed after the video detector in the television receiver front end used for supplying composite video signal for recording, in addition to the ghost suppression circuitry needed after the video detector in the television receiver with the display device, a single computer can be used for calculating the parameters for the filters in both sets of ghost suppression circuitry.

Brief Description of the Drawing

FIGURE I is a schematic diagram of a video tape machine with recording capability, in combination with a television receiver front end up to and including the sound detector and video detector used for supplying sound signal and composite video signal for recording, which combination in accordance with the invention includes ghostsuppression circuitry through which the composite video signal is passed before being supplied to the video tape recorder.

FIGURE 2 is a schematic diagram of ghost-suppression circuitry suitable for inclusion in the FIGURE I combination.

FIGURE 3 is a schematic diagram of circuitry for resetting a modulo-eight field counter in the FIGURE 2 ghost-suppression circuitry.

FIGURE 4 is a flow diagram of a deghosting method used with the FIGURE 2 deghosting circuitry.

Each of FIGURES 5, 6 and 7 is a schematic diagram of a combination of television receiver and video tape machine, which combination is called a "combo" and is constructed in accordance with the principles of the invention.

Detailed Description

FIGURE I shows a video tape machine 10 having recording capability, which by way of example may be a video cassette recorder (VCR) of VHS, super-VHS or Betamax type. The video tape machine 10 may also be an improved VHS recorder of the type described in U. S. patent No. 5,113,262 issued12 May1992 to C. H. Strolle *et alii* and entitled "VIDEO SIGNAL RECORDING SYSTEM ENABLING LIMITED BANDWIDTH RECORDING AND PLAYBACK.

A television receiver front end 20, in response to a radio-frequency television signal received thereby, supplies a sound signal and a composite video signal for recording by the video tape machine 10. The radio-frequency television signal may be broadcast over the air and then captured by an aerial television antenna 30, as shown by way of example. Alternatively, the radio-frequency television signal can be provided over cable by community-antenna or other television cable service. The television receiver front end 20 includes the portions of a conventional television receiver normally employed in combination with a video tape machine having recording capability. These portions generally include a radio-frequency amplifier, a down converter or "first detector", at least one intermediate-frequency amplifier, a video detector or " second detector", and a sound demodulator (frequently of intercarrier type). The television receiver front end 20 further includes separation circuitry for horizontal synchronizing pulses and for vertical synchronizing pulses.

The sound signal from the sound demodulator in the television receiver front end 20 is demodulated from a frequency-modulated sound carrier, as heterodyned to intermediate frequency by the down converter. Before its demodulation the frequency-modulated sound carrier is limited to remove amplitude variations therein, and the capture phenomenon suppresses responses to ghosts in the sound signal from the sound demodulator. Accordingly, the sound signal from the sound demodulator in the television receiver front end 20 is supplied directly to the video tape machine 10, there to be recorded in the conventional manner.

The composite video signal from the video detector in the television receiver front end 20 is supplied to ghost-suppression circuitry 40 to have the accompanying ghosts removed or suppressed. The resulting "deghosted" composite video signal is supplied from the ghost-suppression circuitry 40 to the video tape machine 10, there to be recorded in the conventional manner. The ghost-suppression circuitry 40 can be any one of the types known to the art.

FIGURE 2 illustrates one form the ghost-suppression circuitry 40 can take, which is suited for use with the Bessel-chirp GCR signals being inserted into the first halves of the 19th VBI lines of each field. Composite video signal, supplied to the FIGURE 2 ghost-suppression circuitry from the television receiver front end 20, is digitized by an analog-to-digital converter 50. The ADC 50 typically will supply eight-parallel-bit samples of digitized composite video signal. The digitized composite video signal is applied as input signal to a cascade connection of a post-ghost cancelation filter 51, which is an adaptive filter of IIR type; a preghost cancelation filter 52, which is an adaptive filter of FIR type; and an equalization filter 53, which is an adaptive filter of FIR type.

The output signal of the filter cascade is a digital deghosted composite video signal, which is converted to an analog deghosted composite video signal by a digital-to-analog converter 54. The analog deghosted composite video signal is supplied to the video tape machine 10 for recording using VHS, super-VHS or Betamax standard, by way of example. The digital-to-analog converter 54 is dispensed with in advanced designs where the video tape machine 10 does digital recording, rather than recording analog signals.

A filter coefficient computer 55 computes the weighting coefficients for the adaptive filters 51,52 and 53. These weighting coefficients are binary numbers, which the filter-coefficient computer 55 writes into registers within the digital filters 51, 2 and 53. In the IIR filter 51 the weighting coefficients stored in registers thereof are used as multiplier signals for digital multipliers receiving the filter output signal with various amounts of delay as multiplicand signals. The product signals from the digital multipliers are combined by addition and subtraction in digital adder/subtractor circuitry to generate the IIR filter response. In each of the FIR filters 52 and 53 the weighting coefficients stored in registers thereof are used as multiplier signals for digital multipliers receiving the filter input signal with various amounts of delay as multiplicand signals. In each of the FIR filters 52 and 53 the product signals from the digital multipliers are combined by addition and subtraction in digital adder/subtractor circuitry to generate the weighted summation response characteristic of an FIR filter.

Pre-ghosts occurring in off-the-air reception can be displaced as much as 6 microseconds displacement from the direct signal, but typically displacements are no longer than 2 microseconds. In cable reception direct off-the-air pick-up can precede the cable-supplied signal as much as 30 microseconds. The in-band video response can be rolled off as much as 20 dB at 3.6 MHz, but roll-off at 3.6 MHz is usually less than 10 dB. The number of taps in the FIR filters 52 and 53 depends on the range over which ghost suppression is sought; to keep filter costs within commercial constraints, typically the FIR filter 52 has around 64 taps for suppressing ghosts with as much as 6 microseconds displacement from the direct signal. The FIR filter 53 used for frequency equalization need only have 32 taps or so. The cascaded FIR filters 52 and 53 are replaced in some designs by a single FIR filter having about 80 taps.

Typically, the range for post-ghosts extends to 40 microseconds displacement from the direct signal, with 70% or so of post-ghosts occuring in a subrange that extends to 10 microseconds. The IIR post-ghost cancelation filter 51 required for suppressing post-ghosts over the full range can be as many as 600 taps long. However, since post-ghosts occur at discrete displacements, the weighting coefficients for many of these taps of the filter 51 will be zero-valued or nearly so. The taps requiring weighting coefficients of value significantly more than zero are usually clumped together in groups of ten or less. It is desirable, from the standpoint of economy of hardware, to use only as many digital multipliers as there are expected to be weighting coefficients of value significantly more than zero. Accordingly, the tapped delay line in the IIR filter 51 is usually designed as a cascade connection of ten-tap-or-so delay lines interspersed with programmable delay devices, making filter 51 what is sometimes termed a "sparse-weighting" filter. The ten-tap-or-so delay lines furnish signals to the digital multipliers for weighting. The programmable bulk delay devices comprise various length delay lines the chaining together of which can be controlled in response to control signals expressed as binary numbers. Such a sparse-weighting filter will include registers for the binary numbers specifying the delays of the programmable delay devices, the contents of which registers are also controlled by the filter-coefficient computer 55.

Consider now the means by which the filter-coefficient computer 55 is supplied ghosted GCR signals from the television receiver front end 20. Horizontal and vertical synchronizing pulses are received from the front end 20. The horizontal sync pulses are counted by a nine-stage digital counter 56, denominated "scan line counter", periodically reset by vertical sync pulses; and the vertical sync pulses are counted modulo-8 by a three-stage digital counter 57, denominated "field counter". These counts are available to the filter-coefficient computer 55 for use in timing its operations, although connections for furnishing these counts to the computer 55 are left out of FIGURE 2 to reduce its complexity. A decoder 58 responds to the scan line count from the line counter 56 being nineteen, corresponding to the scan line in each field containing GCR signal, to condition the output signal of a multiplexer 59 to correspond to the digitized composite video signal from ADC 50 supplied as a first input signal thereto, rather than to a wired zero supplied as a zeroeth input signal thereto.

A random-access memory with read-then-write capability provides a temporary (scan) line store 60 in FIGURE 2, which store 60 may be replaced by serial memory in alternative embodiments of the ghost-suppression circuitry. This temporary line store 60 is connected in an arrangement for accumulating the 19th-VBI-line GCR signals on a per pixel basis for eight successive fields, in a temporal filtering operation that separates the Bessel-chirp information from other information occurring during those 19th VBI scan lines. This temporal filtering operation correlates the Bessel-chirp information occurring during those 19th VBI scan lines to provide improved signal-to-noise ratio, as compared to using gating simply to separate the Bessel-chirp information from 19th VBI scan lines as it occurs. When the corresponding pixels of the eight GCR signals have been accumulated during the 19th line of FIELD 000, the eighth and last field of the eight-field sequence, the separated Bessel-chirp information is serially loaded one pixel at a time into a register of the filter-coefficient computer 55 during any line of FIELD 000 after its lath and before the line store 60 is cleared of data. In FIGURE 2 the line store 60 is cleared of data during the last line of the last field of the eight-field sequence, but this clearance can take place during any line of FIELD 000 after the separated Bessel-chirp information is written into a register of the filter-coefficient computer 55. The transfer of accumulated data from the line store 60 to the computer 55 and the subsequent clearing of the accumulated data from the line store 60 can also take place during any two of the 1st through 18th scan lines of FIELD 001.

More particularly, the temporary line store 60 has to have the capability of storing a full scan line of sixteen-parallel-bit samples, assuming that it is to accumulate on a signed basis eight lines of eight-parallel-bit samples of digitized composite video signal supplied from the ADC 50. The signed arithmetic is preferably two's complement arithmetic. In partial implementation of the arrangement for operating the temporary line store 60 as a signed accumulator for GCR signals, a digital adder/subtractor 61 supplies a sixteen-parallel-bit output signal to the temporary line store 60 as its write input signal. The digital adder/subtractor 61 receives as a first input thereto the output signal of a multiplexer 62, which normally corresponds to the readout from the temporary line store 60 received as the zeroeth input of the multiplexer 62. The digital adder/subtractor 61 receives as a second input thereto the eight-parallel-bit output signal of the multiplexer 59 together with eight wired ZEROs as a sign-bit extension.

A decoder 80 decodes the modulo-eight field count being one, three, six, or zero (i. e., eight) to furnish a logic ZERO to the digital adder/subtractor 61 to condition it to add its input signals. The decoder 80 decodes the modulo-eight field count being two, four, five, or seven to furnish a logic ONE to the digital adder/subtractor 61 to condition it subtract its second input signal (supplied from the multiplexer 59) from its first input signal (supplied from the multiplexer 62). This arrangement accumulates in the temporary line store 60 the following function: FIELD 001 line nineteen FIELD 010 line nineteen + FIELD 011 line nineteen - FIELD 100 line nineteen - FIELD 101 line nineteen + FIELD 110 line nineteen FIELD Ill line nineteen + FIELD 000 line nineteen.

During the last line of the eighth of each sequence of eight fields, the normally ZERO control signal to' the multiplexer 62 is caused to be a ONE. This ONE conditions the multiplexer 62 to furnish an output signal corresponding to a first input thereto, which is an arithmetic zero comprising sixteen parallel bits of wired ZEROS. This results in the resetting of the accumulation result in the temporary line store 60 to arithmetic zero. The control signal for the multiplexer 62 is shown in FIGURE 2 as being generated by a two-input AND gate 63. A decoder 64 decodes the count from the scan line counter 56 corresponding to the last line of the current field to generate one of the input signals to the AND gate 63. A decoder 65 decodes the modulo-eight field count from the counter 57 to generate the other of the input signals to the AND gate 63. The eighth of each sequence of eight fields generates a 000 modulo-eight count from the field counter 57. Both the input signals to the AND gate 63 are ONE only during the last line of the eighth of each sequence of eight fields, during which line the AND gate 63 supplies a ONE to the multiplexer 62 as its control signal, causing the accumulation result stored in the temporary line store 60 to be reset to arithmetic zero.

A two-input AND gate 66 supplies a ONE to the filter-coefficient computer 55 when the accumulation result stored in the temporary line store 60 is available for transfer into a ghosted Bessel-chirp register within the internal memory of the computer 55. The output signal of the decoder 65 is one of the input signals to the AND gate 66 and is ONE only during the eighth of each sequence of eight fields. A two-input NOR gate 67 generates the other of the input signals to the AND gate 66. The NOR gate 67 responds to the output signal of the decoder 64, which detects the last line of a field in the count from line counter 56, and to the output signal of a decoder 68, which detects the vertical blanking interval proceeding from the count from line counter 56. Accordingly, the NOR gate 67 output signal is ONE except during the vertical blanking interval or the last line of a field. So, the accumulation result in the temporary line store 60 is available for transfer into the internal memory of the computer 55 any time during the eighth of each sequence of eight fields except during its last line or during vertical blanking interval.

The clocking for timing pixel sampling by the analog-to-digital converter 50 and the addressing of the temporary line store 60 will now be considered. An oscillator 70 that has automatic frequency and phase control (AFPC) generates sinusoidal oscillations at the second harmonic of color subcarrier frequency as a primary clocking signal. A zero-crossing detector 71 detects average axis crossings of the sinusoidal oscillations to generate pulses at a rate four times color subcarrier frequency. These pulses time the sampling of the composite video signal for digitization by the ADC 50; and they would time the advance of data in the temporary line store 60 if it were a serial memory. In the FIGURE 2 ghost-suppression circuitry the temporary line store 60 is a random-access memory arranged for read-then-write operation as each of its storage locations is addressed. The addresses of its storage locations are recurrently scanned in accordance with the count of pixels supplied from a ten-stage digital counter 72 denominated as "pixel counter", which counts the pulses from the zero-crossing detector 71. These same addresses are supplied to the filter-coefficient computer 55 to be used to address a line storage register therein when separated GCR signal is transfered thereto from the temporary line store 60.

Generally, if it exists, the color burst signal is the most stable frequency reference in a composite video signal and is the preferred reference signal for AFPC of the oscillator 70. The overflow signal from the second stage of the pixel counter 72 is presumably a 3.58 MHz square wave and is supplied as a feedback signal to a first AFPC detector 73 for comparison to a separated burst signal, in order to generate an error signal an AFPC signal multiplexer 74 selectively applies to the pixel counter 72 for controlling the frequency and phase of its oscillations. A burst gate 75 responds to pulses from a burst gate control signal generator 76 to separate from the analog composite video signal supplied from the TV receiver front end 20 a color burst signal to be supplied to the first AFPC detector 73. The horizontal sync pulses from the television receiver front end 20 are supplied to the burst gate control signal generator 76 and their trailing edges are used to time the pulses that the generator 76 generates during color burst intervals. A cascade of astable flip-flops or "one-shots" are customarily employed in the generation of these pulses.

The decoder circuitry 68 responds to the scan line counts that the line counter 56 provides which correspond to the VBI lines in each field to generate an inhibitory signal. This inhibitory signal is applied to the burst gate control signal generator 76 to inhibit its generating pulses, so that the burst gate 75 will select only those backporch intervals during a field which can have color burst. (In a variant embodiment the burst gate control signal generator 76 is not inhibited from generating burst gate pulses during the vertical blanking interval and the time constant of the first AFPC detector is made longer than necessary in the FIGURE 2 circuitry.)

An amplitude detector 77 denominated the "color burst presence detector" detects when burst is present in the output signal from the burst gate 75 to supply a ONE that conditions the AFPC signal multiplexer 74 to select the output signal from the first AFPC detector 73 as a first error signal, for application to the controlled oscillator 70 as its AFPC signal. Preferably, from the standpoint of immunity to noise, the amplitude detector 77 comprises a synchronous detector stage followed by a threshold detector stage followed by a short-pulse eliminator. Arrangements of the pixel counter 72 can be made for providing a pair of 3.58 MHz square waves in quadrature phase relationship with each other for application to the synchronous detection portions of the detectors 73 and 77. Arrangements of counters to provide square waves in quadrature phase relationship with each other are familiar to television circuit designers, being commonly used in television stereophonic sound decoders. Short-pulse eliminators are known from radar and are commonly constructed using circuitry for ANDing differentially delayed input signal thereto thereby to generate output signal therefrom.

When black and white television signals are received without attendant color burst, the reference signal for AFPC of the oscillator 70 will have to be the separated horizontal sync pulses supplied to the AFPC circuitry from the TV receiver front end 20. The color burst presence detector 77 will supply a ZERO when the composite video signal supplied from the TV receiver front end 20 has no attendant color burst, conditioning the AFPC signal multiplexer 74 to select the output signal from a second AFPC detector 78 to controlled oscillator 70 as its AFPC signal. A sync decoder 79 responds with a ONE to the count(s) of the pixel counter 72 theoretically corresponding to the occurence of the horizontal sync pulse or a prescribed portion thereof, such as an edge thereof. The output signal from the sync decoder 79 is supplied as feedback signal to the second AFPC detector 78, which compares that feedback pulse to an input reference signal taken from the horizontal sync pulses supplied from the horizontal sync separator in the TV receiver front end 20 and generates a second error signal for being selectively applied by the AFPC signal multiplexer 74 to controlled oscillator 70 as its AFPC signal. This AFPC arrangement is called "line-locked-clock" by television engineers.

Stability of the oscillations of the controlled oscillator 70 is required over the number of fields from which the 19th scan lines are taken for accumulation in the temporary line store 60, in order that the accumulation procedure by which the Bessel chirp is separated from those lines' adequately suppresses horizontal sync pulse, front porch, back porch including color burst and +30 IRE pedestal. Crystal control of the frequency of the oscillations is a practical necessity; and the automatic phase control (APC) aspect of the AFPC should predominate, with the automatic frequency control (APC) aspect of the AFPC having a very long time constant -- i. e., several fields long.

The circuits for resetting the counters 56, 57 and 72 are omitted from FIGURE 2 to avoid undue complexity. The scan line counter 56 can be simply reset by the leading edges of vertical sync pulses supplied from the vertical sync separator in the TV receiver front end 20.

The pixel count from the pixel counter 72 is reset when necessary in order to re-synchronize it with the scan lines in the composite video signal supplied from the video detector of the TV receiver front end 20. The leading and trailing edges of the horizontal sync pulses supplied from the horizontal sync separator of the TV receiver front end 20 are detected, using a differentiator followed by a appropriate level comparators. The leading edge detector result is used to command the loading of a temporary storage register with the current pixel count. The pixel count is applied to a window comparator to determine if it is within its expected range and to generate an indication of error if it is not. The count of the pixel counter 72 is conditionally reset to zero responsive to the trailing edge detector result. The condition for reset may be a single indication of pixel count error. However, better noise immunity is obtained by counting the errors in an up/down counter configured so a given number of consecutive errors must be counted before pixel count is corrected.

FIGURE 3 shows circuitry for resetting the modulo-eight field counter 57 so its count either is correctly phased or is misphased by four fields. The temporary line store 31 is shown as being a random-access memory addressed by the pixel count supplied from the pixel counter 72. The line store 31 is arranged for read-then-write operation. The logic ONE issued by the decoder 58 only during the 19th scan line of each field is furnished to a multiplexer 310 to condition the updating of the temporary line store 31 with digitized 19th scan line samples supplied from the ADC 50. During other scan lines the logic ZERO issued by the decoder 58 conditions the multiplexer 310 to apply the data read from the temporary line store 31 for writing back thereinto.

The temporary line store 31 is provided with pixel latches 32 and 33 clocked by the output signal from,the zero-crossing detector 71. The pixel latches 32 and 33 are used for temporily storing the last pixel written into the temporary line store 31 and the last pixel read out of the temporary line store 31, respectively, aligning those samples in time to be respective ones of the subtrahend and minuend input signals of a digital subtractor 34. The pixel samples of the difference signal from the subtractor 34 will all be zero valued except during 19th scan lines. The difference signal from the subtractor 34 is furnished to an absolute-value circuit 35, which can comprise a battery of two-input exclusive-OR gates each receiving the sign bit of the difference signal as a first input and receiving a respective other bit of the difference signal for selectively complementing, and which can then further comprise a digital adder for adding the sign bit of the difference signal to the selectively complemented remaining bits of the difference signal to generate as a sum output signal the absolute value of the difference signal.

An accumulator 36 for successive samples of the absolute-value circuit 35 output signal includes an output latch 361 for temporarily storing successive values of the accumulation result, a digital adder 362 for adding the successive samples of the output signal of the absolute-value circuit 35 to the accumulation result to augment its value, and a multiplexer 363 for selectively supplying the augmented accumulation result to the output latch 361 for updating its contents. The multiplexer 363 is wired for inserting arithmetic zero into the output latch 361 whenever the decoder 58 does not detect the counter 56 supplying a scan line count of nineteen. A decoder 364 responds to the pixel count from the counter 72 being descriptive of those portions of a scan line as may contain Bessel chirp information to furnish a ONE, which is ANDed with the output signal from the zero-crossing detector 71 in an AND gate 365. The output latch 361 is clocked to receive input data responsive only to a ONE being received from the AND gate 365.

The successive samples of the absolute value of the difference of the nineteen lines of the current and previous fields, as supplied serially from the absolute-value circuit 35, are accumulated using the accumulator 36. The accumulation result should have appreciable value if the current field is not FIELD 001 or FIELD 101. The 19th lines of FIELD 000 and of FIELD 001 both contain ETP signal, so their difference is zero-valued except for noise. The 19th lines of FIELD 100 and of FIELD 101 both contain ETR signal, so their difference is zero-valued except for noise. The output signal of a threshold detector 37, which is a ONE when the accumulation result is substantially more than arithmetic zero and is otherwise a ZERO, is complemented by a NOT gate 38 to supply one of the four input signals of an AND gate 39. A decoder 41 detects the field count from the counter 57 being other than 001 or 101 to furnish a ONE to the AND gate, which ONE is indicative that the field count is misphased and enables the resetting of the counter 57. The output signal of the decoder 58, which detects the occurence of the 19th line of a field, and the output signal of a decoder 42, which responds to the pixel count from the counter 72 to detect the end of a scan line, are the other two input signals to the AND gate 39. Providing that the field count is not 001 or 101, the AND gate 39 generates a ONE to reset the counter 57 to 001 field count at the end of the 19th line of a FIELD 000 or of a FIELD 100 in the television signal received by the TV receiver front end 20. Alternatively, the counter 57 could be reset to 101; or provision can be made for resetting only the two least significant bits of the field count, resetting them to 01.

Returning to FIGURE 3, if the modulo-eight field count provided by the field counter 57 is correctly phased, the accumulation result attained in the temporary line store 60 during FIELD 000, the last field in the cycle of accumulation, will be eight times the ETP Bessel chirp signal devoid of accompanying horizontal sync pulse, front porch, back porch including color burst and +30 IRE pedestal. On the other hand,if the modulo-eight field count provided by the field counter 57 is misphased by four fields, the accumulation result attained in the temporary line store 60 during FIELD 000, the last field in the cycle of accumulation will be eight times the ETR Bessel chirp signal devoid of accompanying horizontal sync pulse, front porch, back porch including color burst and +30 IRE pedestal. A wired three binary place shift in the direction towards reduced magnitude divides the accumulation results attained in the temporary line store 60 during FIELD 000 by eight, and the resulting quotients are supplied as the ETP or ETR signal to the filter-coefficient computer 55.

The filter-coefficient computer 55, which is well-adapted to performing correlations against a ghost-free Bessel chirp function ETP or ETR stored in an internal register thereof, is programmed to perform a correlation substep that determines whether the input it receives from the temporary line store 60 during FIELD 000 is ETP signal, is ETR signal, or is unrelated to the ETP or ETR signal. This procedure enables the filter-coefficient computer 55 to determine when no GCR signals are included in the television signal received by the TV receiver front end 20. The computer 55 may then apply predetermined weighting coefficients as stored in registers therewithin to the filters 51, 52 and 53. Alternatively, the computer 55 may be arranged to compute weighting coefficients for the filters 51, 52 and 53 proceeding from data concerning received ghosts supplied by means that do not rely on GCR signals being included in the television signal received by the TV receiver front end 20.

In other variations of the FIGURE 3 circuitry, circuitry external to the computer 55 is provided for analyzing the GCR signal stored in the temporary line store 31 (during the scan line following its acquisition, for example) to determine whether it is an ET P or ET R signal and this determination is used to determine whether the most significant bit of the reset condition for the field counter 57 is a ZERO so reset is to 001 field count or is a ONE so reset is to 101 field count. The contents of the temporary line store 31 are scanned in accordance with the pixel count from the counter 72 during the analysis procedure.

In an exemplary analysis procedure, the portions of the pixel count corresponding to the initial lobe of the Bessel chirp are decoded to selectively generate a ONE that is used to enable accumulation by either of two accumulators. One accumulator further requires that the sign bit of the current GCR signal be ZERO in order to accumulate its magnitude (absolute-value) in excess of a threshold value T. The other accumulator further requires that the sign bit of the current GCR signal be ONE in order to accumulate its magnitude (absolute-value) in excess of a threshold value T. After the portion of the pixel count corresponding to the initial lobe of the Bessel chirp is scanned, the magnitudes of the accumulator contents are each compared in respective comparators to a threshold value T that is almost as large as the integral of the absolute value of the initial lobe of the Bessel chirp. If the contents of the accumulator that requires that the sign bit of the current GCR signal be ZERO in order to accumulate exceeds this threshold T after the initial lobe of the Bessel chirp, the associated comparator furnishes a ONE to the filter-coefficient computer 55, which identifies the presence of an ETP signal. Conversely, if the contents of the accumulator that requires that the sign bit of the current GCR signal be ONE in order to accumulate exceeds this threshold T after the initial lobe of the Bessel chirp, the associated comparator furnishes a ONE to the computer 55, which identifies the presence of an ETR signal. If this threshold T is not exceeded by the contents of either of these accumulators after the initial lobe of the Bessel chirp, the associated comparators furnish ZEROs to the computer 55, which determines that neither an ETP or an ETR signal exists in the television signal which the FIGURE 2 apparatus is attempting to deghost. In further refinements of this scheme the threshold value T is adjusted responsive to noise and GCR signal amplitude conditions.

Variations of the FIGURE 2 ghost-suppression circuitry are possible wherein, when data is being transferred from the temporary line store 60 to a line storage register in the filter-coefficient computer 55, the addressing of the temporary line store 60 and of the line storage register being transfered to is generated within the, computer 55, instead of by the pixel counter 72. A multiplexer under control of decoder 58 or of the computer 55 can apply addresses to the temporary line store 60, selecting them from the pixel counter 72 during the 19th line of each field and otherwise selecting them from those provided by the computer 55. Variations of the FIGURE 2 ghost-suppression circuitry are also possible wherein a plurality of temporary line stores are used, instead of a single temporary line store 60, enabling the computer 55 to update the coefficients of the filters 51, 52 and 53 more often than on an eight-field cycle.

In still other variations of the FIGURE 2 ghost-suppression circuitry the temporary single-scan-line store 60 may be replaced by a temporary two-scan-line store and the decoder 58 may be replaced by a decoder for detecting the presence of the 19th - 20th scan lines to condition the multiplexer 59 for loading the temporary two-scan-line store. Or the temporary single-scan-line store 60 may be replaced by a temporary three-scan-line store and the decoder 58 may be replaced by a decoder for detecting the presence of the 19th through 21st scan lines to condition the multiplexer 59 for loading the temporary three-scan-line store. These arrangements facilitate the pairwise combination of VBI intervals containing antiphase GCR signals and in-phase other reference signals, in order to suppress longer-delayed macroghosts.

Another modification that can be made to the FIGURE 2 ghost-suppression circuitry is the accumulation in the temporary line store 60 of the 19th scan lines from 16 consecutive fields, rather than S. This further correlates the separated Bessel chirp information, which significantly improves its signal-to-noise ratio as supplied to the filter-coefficient computer 55. In such modification the modulo-8 field counter 57 is replaced by a modulo-16 field counter. Further accumulation -- e.g., of the 19th scan lines from 24 consecutive fields -- provides little more improvement in the signal-to-noise ratio of the separated Bessel chirp information supplied to the filter-coefficient computer 55.

FIGURE 4 shows the flow diagram of a procedure for establishing the operating parameters of the filters 51, 52 and 53, which procedure is carried out by the filter-coefficient computer 55. Entry to the START condition 81 of the procedure is at the time power is turned on in the television receiver, when a new channel is tuned, or when a prescribed time has elapsed since the last deghosting procedure. A RESET ALL DEGHOST FILTERS step 82 preferably sets the filter coefficients in the filters 51, 52 and 53 to values previously determined for the channel to which the TV receiver front end 20 is tuned and stored in a channel-addressed memory. Alternatively, during power up or retuning the filter coefficients in the filters 51, 52 and 53 can be to values associated with a ghost-free signal; and during periodic deghosting previous values of the filter coefficients are retained during "reset".

An ACQUIRE DATA step 83 then follows, which step 83 is completed after the number of fields elapse that the computer 55 must wait for accumulation in the temporary line store 60 to be completed, in order to generate a separated GCR signal that is suitable input data for the computer 55. The ACQUIRE DATA step 83 includes a correlation substep not shown in FIGURE 4 which substep determines whether the input the computer 55 receives from the temporary line store 60 during FIELD 000 is ETP signal, is ETR signal, or is unrelated to the ETP or ETR signal.

A CHANNEL CHARACTERIZATION step 84 then takes place.

The location in time of the predominant response in the data supplied the computer 55 is detected, then the respective location in time of each successively smaller one of the significantly large ghost responses, up to the number of post-ghosts that can be suppressed by the filter 5 1 and up to the number of pre-ghosts that can be suppressed by the filter 52. The respective locations in time of the predominant response and multipath responses in the data supplied the computer 55 are calculated to be used as the basis for programming the bulk delay lines interspersed between the clumps of taps in the IIR filter 51. The relative strengths of the predominant response and multipath responses in the data supplied to the computer 55 are calculated to be used as the basis for assigning weights to the clumped taps of IIR filter 51 and to the taps of FIR filter 52.

An UPDATE IIR COEFFICIENTS step 85 is performed after the CHANNEL CHARACTERIZATION step 84 is performed, in which step 85 the programmable delays and the non-zero weighting coeffients of the IIR filter 51 are updated.

An UPDATE FIR COEFFICIENTS step 86 is performed after the UPDATE IIR COEFFICIENTS step 85. The non-zero weighting coeffients of the FIR filter 52 are updated. After the UPDATE IIR COEFFICIENTS and UPDATE FIR COEFFICIENTS steps 85 and 86 are performed, a decision step 87 of GHOSTS BELOW THRESHOLD? is reached. If the decision is NO, not all significant ghosts have been canceled although the filters 51 and 52 have the capability to be further adjusted so as either to suppress at least one more ghost or to improve the cancellation of the ghosts already suppressed, the procedure loops back to the ACQUIRE DATA step 83. A threshold 30 dB down from the predominant image has been used in step 87. If the decision is YES, all significant ghosts have been canceled or the filters 51 and 52 do not have the capability to be further adjusted to cancel at least one more ghost, the procedure goes on to an EQUALIZATION step 88 in which weighting coefficients for the amplitude-equalization filter 53 are calculated.

The updating of the initial one of the cascaded ghost cancelation filters, here the post-ghost filter 51, gives rise to spurious ghosts of the type that cannot be suppressed by the final one of these filters. Since the weighting coefficients calculated in the channel characterization step 84 normally do not take these spurious ghosts into account, the weighting coefficients of the initial one of the cascaded ghost cancelation filters should be recalculated to introduce compensatory ghosts that will reduce the spurious ghosts in the initial filter response. Since this reduction may not be complete, recalculation of the weighting coefficients of the final one of the cascaded ghost cancelation filters is advisable. The decision loop around steps 83-86 implements these recalculations.

The EQUALIZATION step 88 can be performed by taking the discrete Fourier transform (DFT) of the response of the cascade connection of the filters 51, 52 and 53 to the correlator response, then dividing it by the DFT of the ideal correlator response as stored in the memory of the computer 55, thereby to obtain the basis for calculating the adjustments necessary in the tap weights of the FIR filter 53. Since the number of taps for the FIR filter 53 is typically no more than thirty-two, the number of spectral bins in the DFT is reasonably small; however, the DFT calculations tend to be lengthy.

An alternative, more rapid way to calculate equalization filter coefficients is to use a least-means-squares method to adjust the filter 53 weighting coefficients so that the response of the cascade connection of filters 51-53 accumulated in the temporary line store 60 best fits an ideal response stored in the memory of the computer 55.

Following the EQUALIZATION step 88 the FIGURE 3 procedure reaches the condition 89, DONE. It is preferred that the UPDATE FIR COEFFICIENTS step 85 and the EQUALIZATION step 88 be performed after the UPDATE IIR COEFFICIENTS step 85 is performed, because the higher-order ghosts generated in the IIR filtering can be accounted for before the FIR filtering coefficients are computed. Then, the FIR filtering coefficients can be computed so as to suppress those higher-order ghosts

The FIGURE 5 combo includes the video tape machine 10, the television receiver front end 20 for that machine, and the television antenna 30 of FIGURE I together with adaptive ghost-suppression circuitry similar to the adaptive ghost-suppression circuitry 40 of FIGURE 1. This ghost-suppression circuitry consists of a filter--coefficient computer 90; GCR signal acquisition circuitry 91, which acquires a GCR signal for the computer 90 from the television receiver front end 20; and a ghost-suppression filter 92, which deghosts the composite video signal from the television receiver front end 20 for application to the video tape machine 10 as a deghosted composite video signal for recording. The video tape machine 10 sound signal for recording from the sound detector in the television receiver front end 20.

The FIGURE 5 combo further includes another television receiver front end 93 to which the television antenna 30 is selectively connected by an input selection switch 94; further GCR signal acquisition circuitry 95, which acquires a GCR signal for the computer 90 from the television receiver front end 93; and another ghost-suppression filter 96, which deghosts the composite video signal from the television receiver front end 93. The further GCR signal acquisition circuitry 95 is similar to the GCR signal acquisition circuitry 91, which can be similar to that formed by the elements 56-78. The ghost-suppression filters 92 and 96 can each comprise a respective cascade connection of filters similar to the cascade connection of filters 51-53 shown in FIGURE 2.

The deghosted composite video from the ghost-suppression filter 96 is supplied to a luma/chroma separator 97, which responds to the deghosted composite video to generate separated luminance and chrominance signals. Chroma demodulator circuitry 98 responds to the separated chrominance signal to generate a pair of color-difference signals --e. g., the well-known. I and Q color-difference signals -- for application to color matrix circuitry 99 together with the separated luminance signal. The color-matrix circuitry 99 generates red (R), green (G) and blue (B) color signals for application to a television monitor 100. The television monitor 100 responds to the R, G and B signals from the color-matrix circuitry 99 and to sound signal, horizontal synchronizing signal and vertical synchronizing signal from the television receiver front end 93 to generate television images with accompanying sound for a human observer.

A feature of the FIGURE 5 combo is that the single filter-coefficient computer 90 performs a dual function, computing on a time-division multiplexed basis the filter coefficients both for the ghost-suppression filter 92 and for the ghost-suppression filter 96. There is a significant cost saving realized by not using separate computers for computing the filter coefficients for the filters 92 and 96. There are some technical advantages as well, as saving in power consumption being one of them.

The combos of FIGURES 5, 6 and 7 are similar, each computing on a time-division multiplexed basis the filter coefficients for both of the ghost-suppression filters 92 and 96. The differences between these combos is in the way that playback sound and video are routed to the television monitor 100.

In the FIGURE 5 combo, the color-under signal recovered from a recorded video tape is up-converted in the playback electronics of the video tape machine 10 to generate a quadrature amplitude-modulated(QAM) playback chrominance signal. A circuit 101 additively combines this chrominance signal with a playback luminance signal recovered from the recorded video tape, to generate a playback composite video signal, which composite video signal is modulated onto a low-power radio-frequency picture carrier in the amplitude-modulator 102. The sound signal recovered from the recorded video tape is modulated onto a low-power radio-frequency sound carrier in the frequency modulator 103. A circuit 104 additively combines the output signals from the modulators 102 and 103 to generate a low-level television signal, which signal the input selection switch. 94 can select as input signal to the front end 93 rather than signal from the television antenna 30 when playing back from a recorded video tape, and which is available for application to another television receiver.

In the FIGURE 6 combo the television receiver front end 93 is partitioned into a leading portion, including a radio-frequency amplifier 105 and down converter 106, and a trailing portion, including a plural-stage intermediate-frequency amplifier 107, a sound detector 108, a video detector 109, and sync separation circuitry 110. A selector switch 111 selects the input signal for the intermediate-frequency amplifier 107, with the output signal from the down converter 106 being selected when the television monitor 100 is used for viewing signals received via antenna 30 or a cable substitute therefor. The color-under signal recovered from a recorded video tape is up-converted in the playback electronics of the video tape machine 10 to generate a quadrature amplitude-modulated(QAM) playback chrominance signal. The circuit 101 additively combines this chrominance signal with a playback luminance signal recovered from the recorded video tape, to generate a playback composite video signal, which composite video signal is modulated onto a low-power intermediate-frequency picture carrier in the amplitude-modulator 112. The sound signal recovered from the recorded video tape is modulated onto a lowpower intermediate-frequency sound carrier in the frequency modulator 113. A circuit 114 additively combines the output signals from the modulators 112 and 113 to generate a low-level television signal, which signal the selector switch 111 selects as input signal to the intermediate-frequency amplifier 107 during playback from a recorded video tape to the television monitor 100. An up converter 115 can be used to generate a low-level television signal for application to another television receiver. This up converter 115 is shown being located directly after the additive combining circuit 114, but may alternatively be located after the intermediate-frequency amplifier 107, so it acts as a vestigial sideband filter.

In the FIGURE 7 combo the television receiver front end 93 is modified so that a selector switch 116 selects the input signal applied to the sync separation circuitry 110. The composite video signal from the video tape machine 10 is selected to the sync separation circuitry 110 during playback of a recorded video tape; otherwise, the composite video signal from the video detector 109 is selected as the input signal for the sync separation circuitry 110. During the playback of a recorded video tape, a further selector switch 117 selects the chrominance signal from the video tape machine 10 to the chroma demodulator circuitry 98 as its input signal; otherwise, the selector switch 117 selects the chrominance signal from the luma/chroma separator 97 as the circuitry 98 input signal. During the playback of a recorded video tape, a still further selector switch 118 selects the luminance signal from the video tape machine 10 to be applied to the color matrix circuitry 99 as its luminance signal input; otherwise, the selector switch 118 selects the luminance signal from the luma/chroma separator 97 as the circuitry 99 luminance signal input. During the playback of a recorded video tape, yet another selector switch 119 selects the sound signal from the video tape machine 10 to be applied to the TV monitor 100; otherwise, the selector switch 119 selects the sound signal from the TV receiver front end 93 to be applied to the TV monitor 100.

Video tapes recorded responsive to ghosted radio-frequency television signals using any of the combinations shown in FIGURES 11 5, 6 and 7 of the drawing can be played back on a conventional video tape player to supply deghosted radio-frequency television signals to a conventional television receiver having no ghost-suppression circuitry; and the television images so recovered will be free of ghosts. This makes the combinations shown in FIGURE 1, 5, 6 and 7 of the drawing still more attractive commercially.

WHAT IS CLAIMED IS:

1. A combination comprising:

a television receiver front-end, including elements up to and including a sound detector for supplying a sound signal and a video detector for supplying a first composite video signal which is subject to having attendant ghosts;

ghost-suppression circuitry connected for receiving said first composite video output signal, said ghost-suppression circuitry generating a second composite video signal as a its deghosted response to said first composite video signal; and

a video tape machine with recording capability including recording electronics, to which the sound signal from said sound detector and said second composite video input signal are supplied for recording.

2. A combination of:

a television receiver front-end, including elements up to and including a sound detector for supplying a sound signal, a video detector for supplying in continuous analog signal form a first composite video signal which is subject to having attendant ghosts, a horizontal sync separator for supplying horizontal synchronizing pulses separated from said first composite video signal, and a vertical sync separator for supplying vertical synchronizing pulses separated from said first composite video signal;

a video tape machine with recording capability including recording electronics, to which the sound signal from said sound detector and a second composite video input signal in continuous analog signal form are supplied for recording; and

ghost-suppression circuitry for generating said second composite video signal in continuous analog signal form as a deghosted response to said first composite video signal in continuous analog signal form, said ghost-suppression circuitry comprising:

a converter for generating a first composite video signal in sampled-data form as a response to said first composite video signal in continuous analog signal form;

a filter for generating said second composite video signal in sampled-data form as a response to said first composite video signal in sampled-data form, the filtering parameters of said fitter being adjustable in accordance with weighting coefficients temporarily stored in registers included in said filter;

a converter for generating said second composite video signal in continuous analog signal form in response to said second composite video signal in sampled-data form;

a filter-coefficient computer for generating weighting coefficients for temporary storage in said registers included in said filter, said filter-coefficient computer including means for storing a ghost-free ghost cancelation reference signal, said filter-coefficient computer arranged for generating said weighting coefficients responsive to ghosted ghost cancelation reference signal supplied thereto and correlated with said ghost-free ghost cancelation reference signal;

a scan line counter for counting horizontal synchronizing pulses supplied from said horizontal sync separator to generate a scan line count, said scan line counter periodically reset to an initial value of scan line count responsive to vertical synchronizing pulses supplied from said vertical sync separator; and

means responding to said scan line count reaching a prescribed value for grabbing the current scan line of said first composite video signal as a component of said ghosted ghost cancelation reference signal.

3. A combination as set forth in Claim 2, further comprising:

a field counter for modularly counting vertical synchronizing pulses supplied from said vertical sync separator to generate a field count;

means for accumulating on an individual pixel-by-pixel basis the scan lines of said first composite video signal grabbed as components of said ghosted ghost cancelation reference signal until such time as a reset-to-zero signal is received thereat;

means responding to the scan line count and the field count reaching a first prescribed value and a second prescribed value, respectively, for generating said reset-to-zero signal; and

means for transfering said ghosted ghost cancelation reference signal into said filter-coefficient computer after its having been accumulated within said means for accumulating.

4. A combination as set forth in Claim 3, further comprising:

a controlled oscillator for generating sinusoidal oscillations, the frequency of which is controlled by an oscillator control signal;

a burst gate generator responding to horizontal synchronizing pulses supplied from said horizontal sync separator to generate burst gate pulses each delayed by a prescribed time period from a corresponding one of said horizontal synchronizing pulses;

means for separating color burst portions of said first composite video signal responsive to said burst gate pulses; and

means for generating said oscillator control signal responsive to said separated color burst portions of said first composite video signal.

5. A combination as set forth in Claim 3, further comprising:

a controlled oscillator for generating sinusoidal oscillations, the frequency of which is controlled by an oscillator control signal;

means for generating said oscillator control signal responsive to horizontal synchronizing pulses supplied from said horizontal sync separator; and

means responsive to said sinusoidal oscillations for determining the timing of sampled-data generated by said converter for generating a first composite video signal in sampled-data form.

6. A combination as set forth in Claim 2, further comprising:

a controlled oscillator for generating sinusoidal oscillations, the frequency of which is controlled by an oscillator control signal;

a burst gate generator responding to horizontal synchronizing pulses supplied from said horizontal sync separator to generate burst gate pulses each delayed by a prescribed time period from a corresponding one of said horizontal synchronizing pulses;

means for separating color burst portions of said first composite video signal responsive to said burst gate pulses;

means for generating said oscillator control signal responsive to said separated color burst portions of said first composite video signal; and

means responsive to said sinusoidal oscillations for determining the timing of sampled-data generated by said converter for generating a first composite video signal in sampled-data form.

7. A combination as set forth in Claim 2, further comprising:

a controlled oscillator for generating sinusoidal oscillations, the frequency of which is controlled by an oscillator control signal;

means for generating said oscillator control signal responsive to horizontal synchronizing pulses supplied form said horizontal sync separator; and means responsive to said sinusoidal oscillations for determining the timing of sampled-data generated by said converter for generating a first composite video signal in sampled-data form.

8. A combination as set forth in Claim 2, wherein said filter for generating said second composite video signal in sampled-data form as a response to said first composite video signal in sampled-data form is a digital filter; wherein said converter for generating a first composite video signal in sampled-data form is an analog-to-digital converter; and wherein said converter for generating said second composite video signal in continuous analog signal form in response to said second composite video signal in sampled-data form is a digital-to-analog converter.

9. A combination of:

a first television receiver front-end for receiving first radio-frequency television signal, said first television receiver front-end including elements up to and including a respective sound detector for supplying a first sound signal, a respective video detector for supplying a first composite video signal, a respective vertical sync separator for separating a first set of vertical synchronizing pulses from the first composite video signal, and a respective horizontal sync separator for separating a first set of horizontal synchronizing pulses from the first composite video signal;

a second television receiver front-end for receiving a second radio-frequency television signal, said second television receiver front-end including elements up to and including a respective sound detector for supplying a second sound signal, a respective video detector for supplying a second composite video signal, a respective vertical sync separator for separating a second set of vertical synchronizing pulses from the second composite video signal, and a respective horizontal sync separator for separating a second set of horizontal synchronizing pulses from the second composite video signal;

a first filter for generating a third composite video signal in response to said first composite video signal, the filtering parameters of said first filter being adjustable in accordance with weighting coefficients temporarily stored in registers included in said first filter;

a second filter for generating a fourth composite video signal in response to said second composite video signal, the filtering parameters of said second filter being adjustable in accordance with weighting coefficients temporarily stored in registers included in said second filter;

a filter-coefficient computer for generating weighting coefficients for temporary storage in said registers included in said first and second filters, said filter-coefficient computer including means for storing a ghost-free ghost cancelation reference signal, said filter-coefficient computer arranged for generating said the weighting coefficients of said first filter responsive to first ghosted ghost cancelation reference signals supplied thereto and correlated with said ghost-free ghost cancelation reference signal, said filter-coefficient computer arranged for generating said the weighting coefficients of said second filter responsive to second ghosted ghost cancelation reference signals supplied thereto and correlated with said ghost-free ghost cancelation reference signal;

a video tape machine with recording and playback capability including recording electronics, to which said first sound signal and said third composite video signal in sampled-data form are supplied for recording on video tape, and including playback electronics for reproducing from recorded video tape a playback sound signal and a playback composite video signal and modulating said playback sound signal and said playback composite video signal onto respective carrier waves to generate a third radio-frequency television signal;

means for selecting as said first radio-frequency television signal one accompanying said second radio-frequency television signal, said second radio-frequency television signal, or said third radio-frequency television signal;

a luma/chroma separator responding to said fourth composite video signal for generating a separated luminance signal and a separated chrominance signal;

chroma demodulation circuitry responding to said separated chrominance signal to generate first and second color-difference video signals;

color matrix circuitry responding to said first and second color-difference video signals and said separated luminance signal for generating red, green and blue color video signals;

a television monitor including a display device receptive of said second set of vertical synchronizing pulses and of said second set of horizontal synchronizing pulses, an audio portion receptive of a third sound signal, and a video portion for receiving said red and green and blue color video signals for application to said display device;

a first scan line counter for counting pulses in said first set of horizontal synchronizing pulses to generate a first scan-line count, said first scan line counter periodically reset to an initial value of first scan-line count responsive to vertical synchronizing pulses iii said first set;

means responding to said first scan line count reaching a prescribed value for grabbing the current scan line of said first composite video signal as a component of said first ghosted ghost cancelation reference signal;

a second scan line counter for counting pulses in said second set of horizontal synchronizing pulses to generate a second scan-line count, said second scan line counter periodically reset to an initial value of second scan-line count responsive to vertical synchronizing pulses in said second set; and

means responding to said second scan line count reaching a prescribed value for grabbing the current scan line of said second composite video signal as a component of said second ghosted ghost cancelation reference signal.

10. A combination of:

a first television receiver front-end for receiving a first radio-frequency television signal, said first television receiver front-end including a radio-frequency amplifier and converter responding to said first radio-frequency television signal for generating a first intermediate-frequency signal, said first television receiver front-end including an intermediate-frequency amplifier and means for selecting as an input signal for said intermediate-frequency amplifier either said first intermediate-frequency signal or a second intermediate-frequency signal, said first television receiver front-end including further elements up to and including a respective sound detector for supplying a first sound signal, a respective video detector for supplying a first composite video signal, a respective vertical sync separator for separating a first set of vertical synchronizing pulses from the first composite video signal, and a respective horizontal sync separator for separating a first set of horizontal synchronizing pulses from the first composite video signal;

a second television receiver front-end for receiving said first television radio-frequency signal or a second television radio-frequency signal accompanying said first television radio-frequency signal, said second television receiver front-end including elements up to and including a respective sound detector for supplying a second sound signal, a respective video detector for supplying a second composite video signal, a respective vertical sync separator for separating a second set of vertical synchronizing pulses from the second composite video signal, and a respective horizontal sync separator for separating a second set of horizontal synchronizing pulses from the second composite video signal;

a first fitter for generating a third composite video signal in response to said first composite video signal, the filtering parameters of said first filter being adjustable in accordance with weighting coefficients temporarily stored in registers included in said first filter;

a second filter for generating a fourth composite video signal in response to said second composite video signal, the filtering parameters of said second filter being adjustable in accordance with weighting coefficients temporarily stored in registers included in said second filter;

a filter-coefficient computer for generating weighting coefficients for temporary storage in said registers included in said first and second filters, said filter-coefficient computer including means for storing a ghost-free ghost cancelation reference signal, said filter-coefficient computer arranged for generating said the weighting coefficients of said first filter responsive to first ghosted ghost cancelation reference signals supplied thereto and correlated with said ghost-free ghost cancelation reference signal, said filter-coefficient computer arranged for generating said the weighting coefficients of said second filter responsive to second ghosted ghost cancelation reference signals supplied thereto and correlated with said ghost-free ghost cancelation reference signal;

a video tape machine with recording and playback capability including recording electronics, to which said first sound signal and said third composite video signal in sampled-data form are supplied for recording on video tape, and including playback electronics for reproducing from recorded video tape a playback sound signal and a playback composite video signal and modulating said playback sound signal and said playback composite video signal onto respective carrier waves to generate said second intermediate-frequency signal;

a luma/chroma separator responding to said fourth composite video signal for generating a separated luminance signal and a separated chrominance signal;

chroma demodulation circuitry responding to said separated chrominance signal to generate first and second color-difference video signals;

color matrix circuitry responding to said first and second color difference video signals and said separated luminance signal for generating red, green and blue color video signals;

a television monitor including a display device receptive of said second set of vertical synchronizing pulses and of said second set of horizontal synchronizing pulses, an audio portion receptive of a third sound signal, and a video portion for receiving said red and green and blue color video signals for application to said display device;

a first scan line counter for counting pulses in said first set of horizontal synchronizing pulses to generate a first scan-line count, said first scan line counter,periodically reset to an initial value of first scan-line count responsive to vertical synchronizing pulses in said first set;

means responding to said first scan line count reaching a prescribed value for grabbing the current scan line of said first composite video signal as a component of said first ghosted ghost cancelation reference signal;

a second scan line counter for counting pulses in said second set of horizontal synchronizing pulses to generate a second scan-line count, said second scan line counter periodically reset to an initial value of second scan-line count responsive to vertical synchronizing pulses in said second set; and

means responding to said second scan line count reaching a prescribed value for grabbing the current scan line of said second composite video signal as a component of said second ghosted ghost cancelation reference signal.

11. A combination of:

a first television receiver front-end for receiving a first radio-frequency television signal, said first television receiver front-end including elements up to and including a respective sound detector for supplying a first sound signal, a respective video detector for supplying a first composite video signal, means for selecting a second composite video signal corresponding either to said first composite video signal or to a third composite video signal, a second a respective vertical sync separator for separating a first set of vertical synchronizing pulses from said second composite video signal, and a respective horizontal sync separator for separating a first set of horizontal synchronizing pulses from said second composite video signal;

a second television receiver front-end for receiving said first television radio-frequency signal or a sec(ind television radio-frequency signal accompanying said first television radio-frequency signal, said second television receiver front-end including elements up to and including a respective sound detector for supplying a second sound signal, a respective video detector for supplying a fourth composite video signal, a respective vertical sync separator for separating a second set of vertical synchronizing pulses from the fourth composite video signal, and a respective horizontal sync separator for separating a second set of horizontal synchronizing pulses from the fourth composite video signal;

a first filter for generating a fifth composite video signal in response to said first composite video signal, the filtering parameters of said first filter being adjustable in accordance with weighting coefficients temporarily stored in registers included in said first filter;

a second filter for generating a sixth composite video signal in response to said fourth composite video signal, the filtering parameters of said second filter being adjustable in accordance with weighting coefficients temporarily stored in registers included in said second filter;

a filter-coefficient computer for generating weighting coefficients for temporary storage in said registers included in said first and second filters, said filter-coefficient computer including means for storing a ghost-free ghost cancelation reference signal, aid filter-coefficient computer arranged for generating said the weighting coefficients of said first filter responsive to first ghosted host cancelation reference signals supplied thereto and correlated with said ghost-free ghost cancelation reference signal, said filter-coefficient computer arranged for generating said the weighting coefficients of said second filter responsive to second ghosted ghost cancelation reference signals supplied thereto and correlated with aid ghost-free ghost cancelation reference signal;

a video tape machine with recording and playback capability including recording electronics, to which said first sound signal and said fifth composite video signal in sampled-data form are supplied for recording on video tape, and including playback electronics for reproducing from recorded video tape a playback sound signal and a playback composite video signal, which playback sound signal is a third sound signal and which playback composite video signal is said third composite video signal;

means for selecting either said second or said third sound signal as a fourth sound signal;

a luma/chroma separator responding to said sixth composite video signal for generating a separated luminance signal and a separated chrominance signal;

chroma demodulation circuitry responding to said separated chrominance signal to generate first and second color-difference video signals;

color matrix circuitry responding to said first and second color-difference video signals and said separated luminance signal for generating red, green and blue color video signals;

a television monitor including a display device receptive of said second set of vertical synchronizing pulses and of said second set of horizontal synchronizing pulses, an audio portion receptive of said fourth sound signal, and a video portion for receiving said red and green and blue color video signals for application to said display device;

a first scan line counter for counting pulses in said first set of horizontal synchronizing pulses to generate a first scan-line count, said first scan line counter periodically reset to an initial value of first scan-line count responsive to vertical synchronizing pulses in said first set;

means responding to said first scan line count reaching a prescribed value for grabbing the current stan line of said first composite video signal as a component of said first ghosted ghost cancelation reference signal;

a second scan line counter for counting pulses in said second et of horizontal synchronizing pulses to generate a second scan-line count, said second scan line counter periodically reset to an initial value of second scan-line count responsive to vertical synchronizing pulses in said second set; and

means responding to said second scan line count reaching a prescribed value for grabbing the current scan line of said second composite video signal as a component of said second ghosted ghost cancelation reference signal.

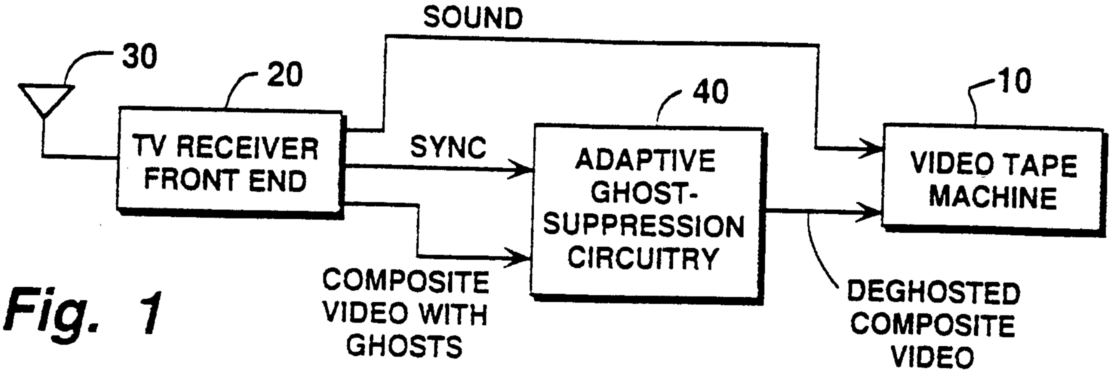
SOUND
30
20
TV RECEIVER FRONT END
SYNC
40
ADAPTIVE GHOST-SUPPRESSION CIRCUITRY
10
VIDEO TAPE MACHINE
COMPOSITE VIDEO WITH GHOSTS
DEGHOSTED COMPOSITE VIDEO

Fig. 1

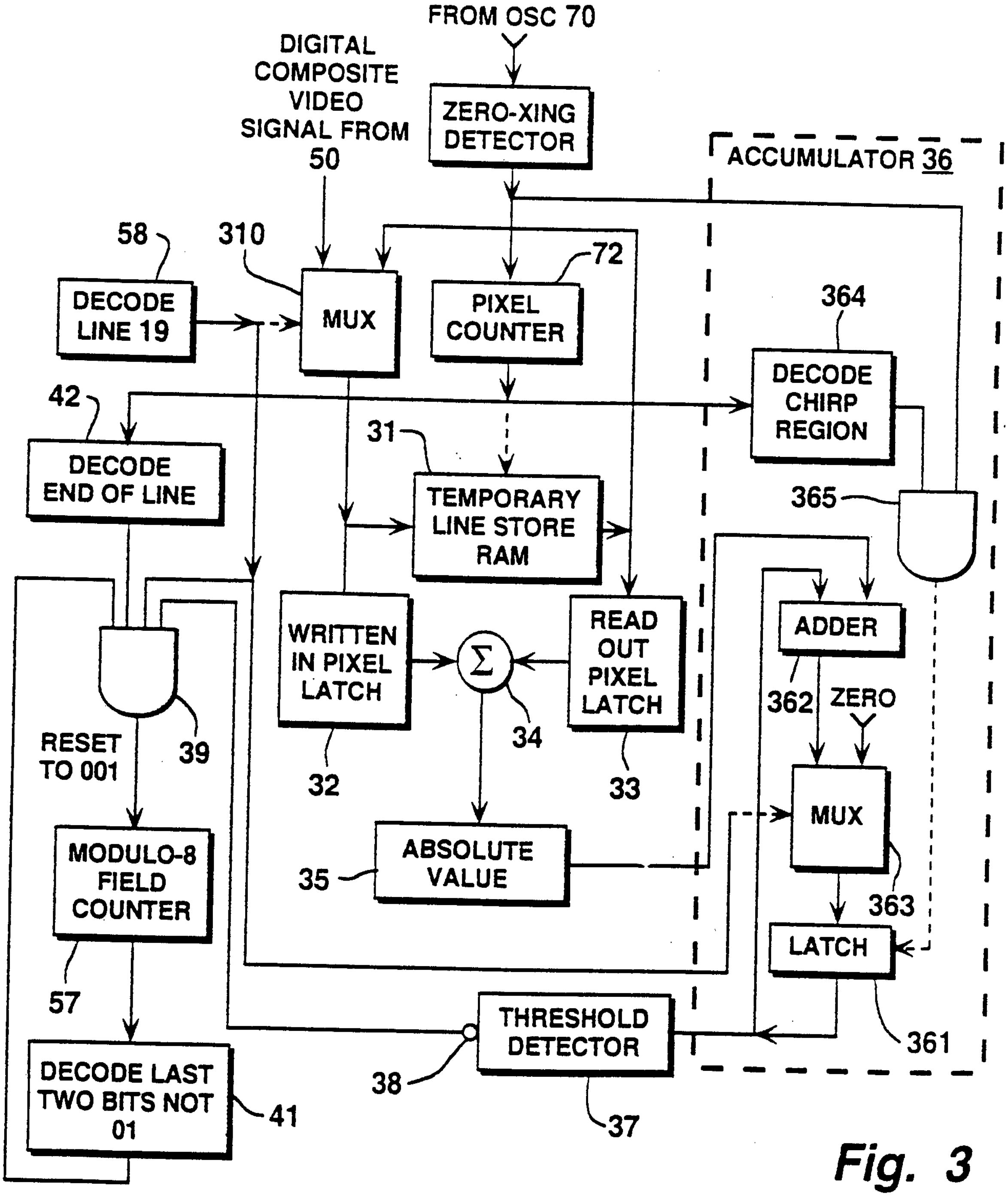
FROM OSC 70
DIGITAL COMPOSITE VIDEO SIGNAL FROM 50
ZERO-XING DETECTOR
ACCUMULATOR 36
58
310
72
DECODE LINE 19
MUX
PIXEL COUNTER
364
DECODE CHIRP REGION
42
31
DECODE END OF LINE
TEMPORARY LINE STORE RAM
365
WRITTEN IN PIXEL LATCH
READ OUT PIXEL LATCH
ADDER
Σ
362
ZERO
RESET TO 001
39
34
32
33
MUX
MODULO-8 FIELD COUNTER
35
ABSOLUTE VALUE
363
LATCH
57
THRESHOLD DETECTOR
361
38
DECODE LAST TWO BITS NOT 01
41
37

Fig. 3

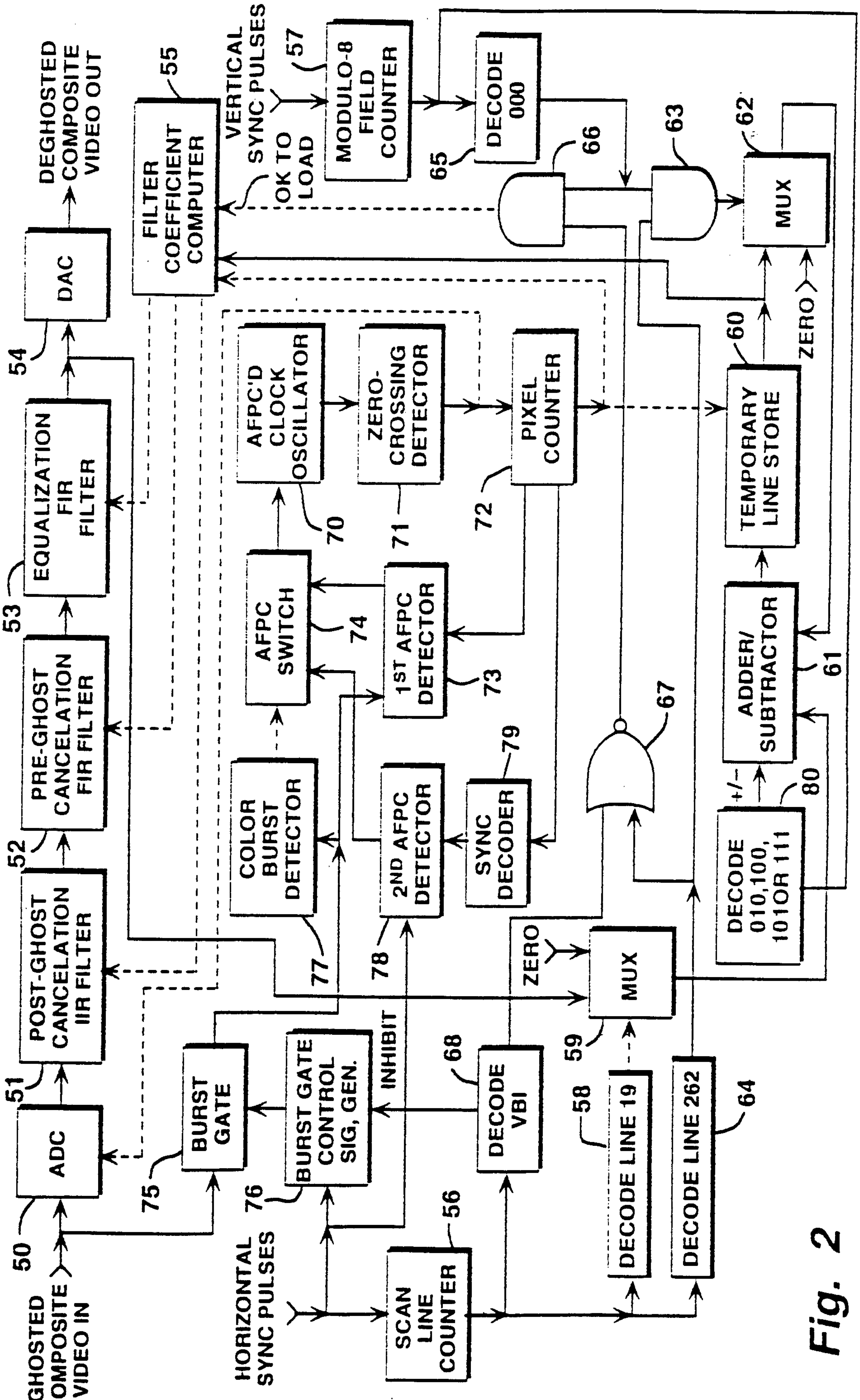
GHOSTED COMPOSITE VIDEO IN
50
ADC
51
POST-GHOST CANCELATION IIR FILTER
52
PRE-GHOST CANCELATION FIR FILTER
53
EQUALIZATION FIR FILTER
54
DAC
DEGHOSTED COMPOSITE VIDEO OUT
55
FILTER COEFFICIENT COMPUTER
OK TO LOAD
VERTICAL SYNC PULSES
57
MODULO-8 FIELD COUNTER
65
DECODE 000
66
63
62
MUX
ZERO
60
TEMPORARY LINE STORE
61
ADDER/ SUBTRACTOR
80
+/-
DECODE 010,100, 101OR 111
AFPC'D CLOCK OSCILLATOR
70
ZERO-CROSSING DETECTOR
71
PIXEL COUNTER
72
AFPC SWITCH
74
1ST AFPC DETECTOR
73
67
COLOR BURST DETECTOR
77
2ND AFPC DETECTOR
78
SYNC DECODER
79
ZERO
MUX
59
75
BURST GATE
76
BURST GATE CONTROL SIG, GEN.
INHIBIT
68
DECODE VBI
58
DECODE LINE 19
64
DECODE LINE 262
HORIZONTAL SYNC PULSES
SCAN LINE COUNTER
56

Fig. 2

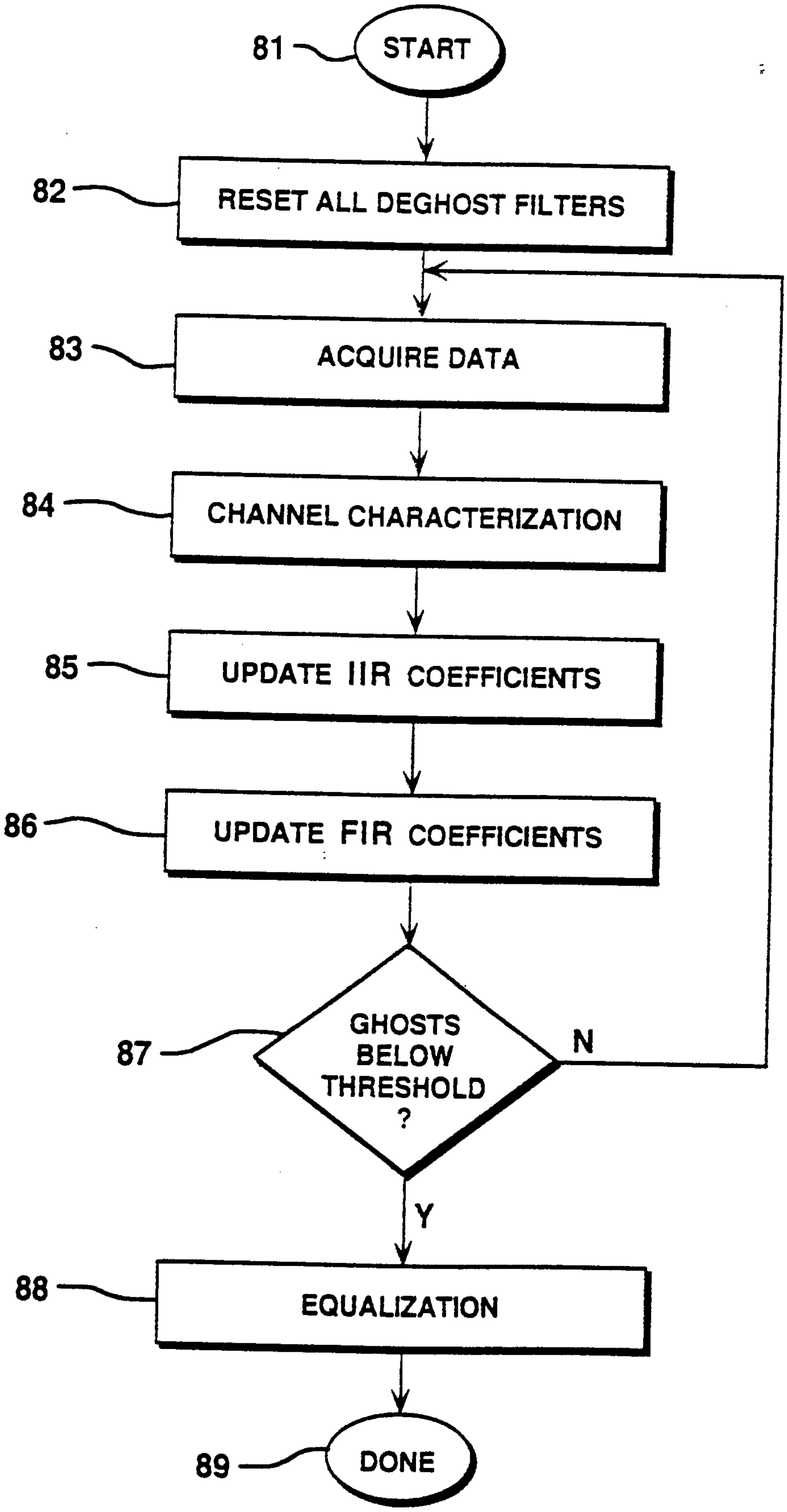
81
START
82
RESET ALL DEGHOST FILTERS
83
ACQUIRE DATA
84
CHANNEL CHARACTERIZATION
85
UPDATE IIR COEFFICIENTS
86
UPDATE FIR COEFFICIENTS
87
GHOSTS BELOW THRESHOLD ?
N
Y
88
EQUALIZATION
89
DONE

Fig. 4

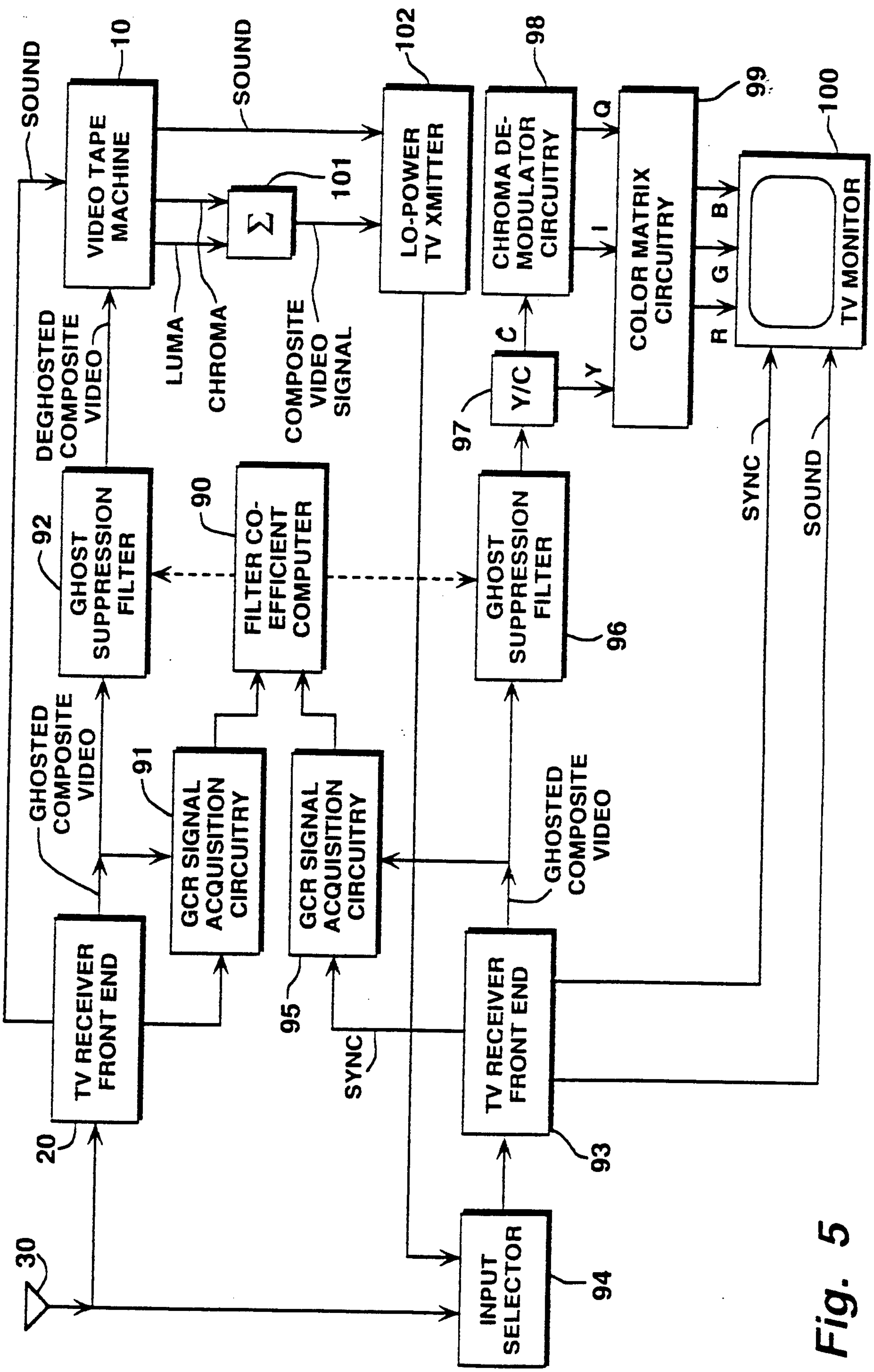
SOUND
VIDEO TAPE MACHINE
10
SOUND
102
LO-POWER TV XMITTER
98
CHROMA DE-MODULATOR CIRCUITRY
Q
I
99
COLOR MATRIX CIRCUITRY
100
TV MONITOR
R
G
B
101
Σ
LUMA
CHROMA
COMPOSITE VIDEO SIGNAL
DEGHOSTED COMPOSITE VIDEO
Y/C
97
Y
C
92
GHOST SUPPRESSION FILTER
90
FILTER CO-EFFICIENT COMPUTER
GHOST SUPPRESSION FILTER
96
SYNC
SOUND
GHOSTED COMPOSITE VIDEO
91
GCR SIGNAL ACQUISITION CIRCUITRY
GCR SIGNAL ACQUISITION CIRCUITRY
95
GHOSTED COMPOSITE VIDEO
TV RECEIVER FRONT END
20
SYNC
TV RECEIVER FRONT END
93
30
INPUT SELECTOR
94

Fig. 5

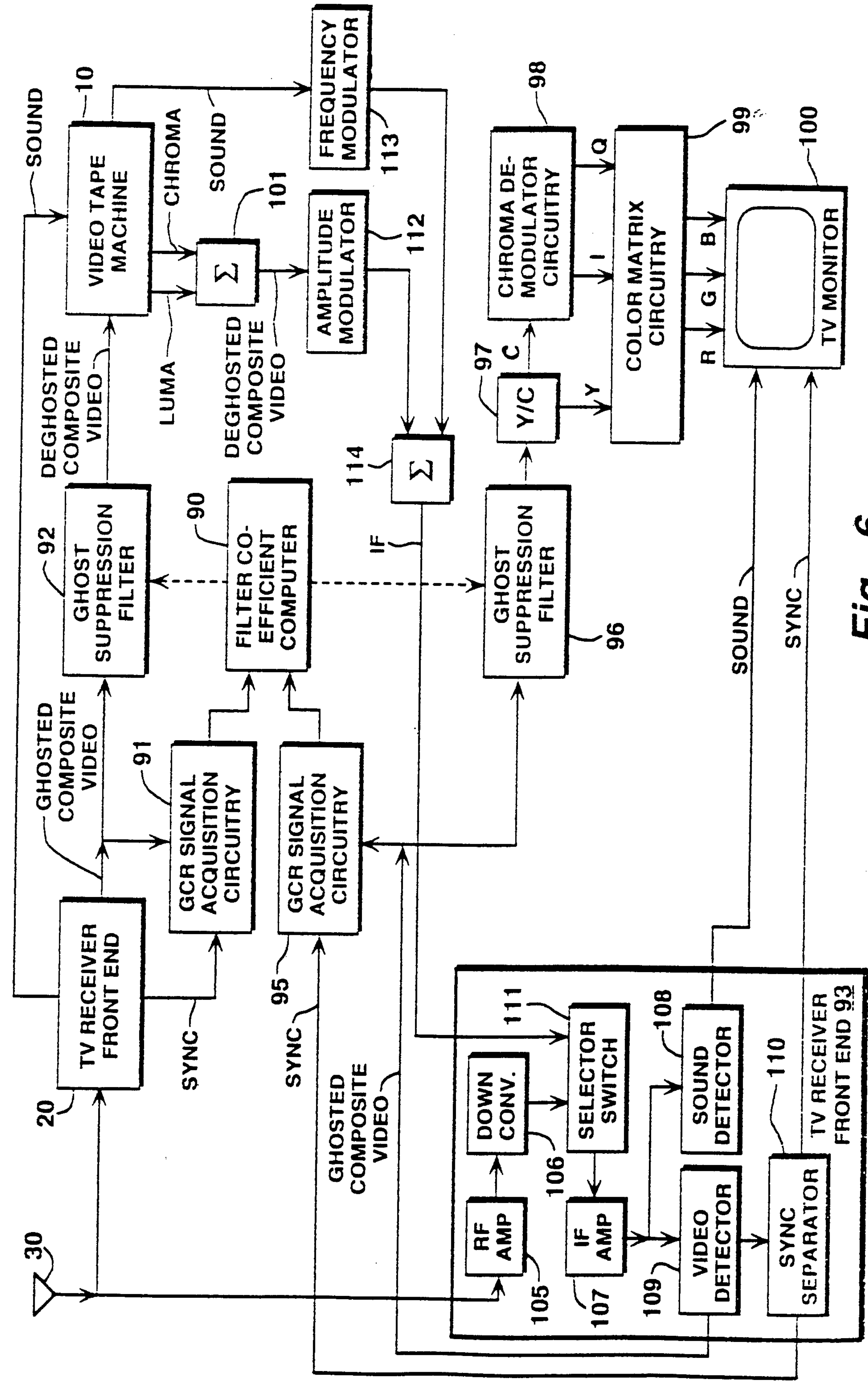
30
TV RECEIVER FRONT END
20
SOUND
SYNC
GHOSTED COMPOSITE VIDEO
GCR SIGNAL ACQUISITION CIRCUITRY
91
GHOST SUPPRESSION FILTER
92
DEGHOSTED COMPOSITE VIDEO
VIDEO TAPE MACHINE
10
CHROMA
LUMA
SOUND
Σ
101
DEGHOSTED COMPOSITE VIDEO
AMPLITUDE MODULATOR
112
FREQUENCY MODULATOR
113
FILTER CO-EFFICIENT COMPUTER
90
GCR SIGNAL ACQUISITION CIRCUITRY
95
SYNC
GHOSTED COMPOSITE VIDEO
Σ
114
IF
GHOST SUPPRESSION FILTER
96
Y/C
97
C
Y
CHROMA DE-MODULATOR CIRCUITRY
98
Q
I
COLOR MATRIX CIRCUITRY
99
R
G
B
TV MONITOR
100
SOUND
SYNC
RF AMP
105
DOWN CONV.
106
IF AMP
107
SELECTOR SWITCH
111
VIDEO DETECTOR
109
SOUND DETECTOR
108
SYNC SEPARATOR
110
TV RECEIVER FRONT END 93

Fig. 6

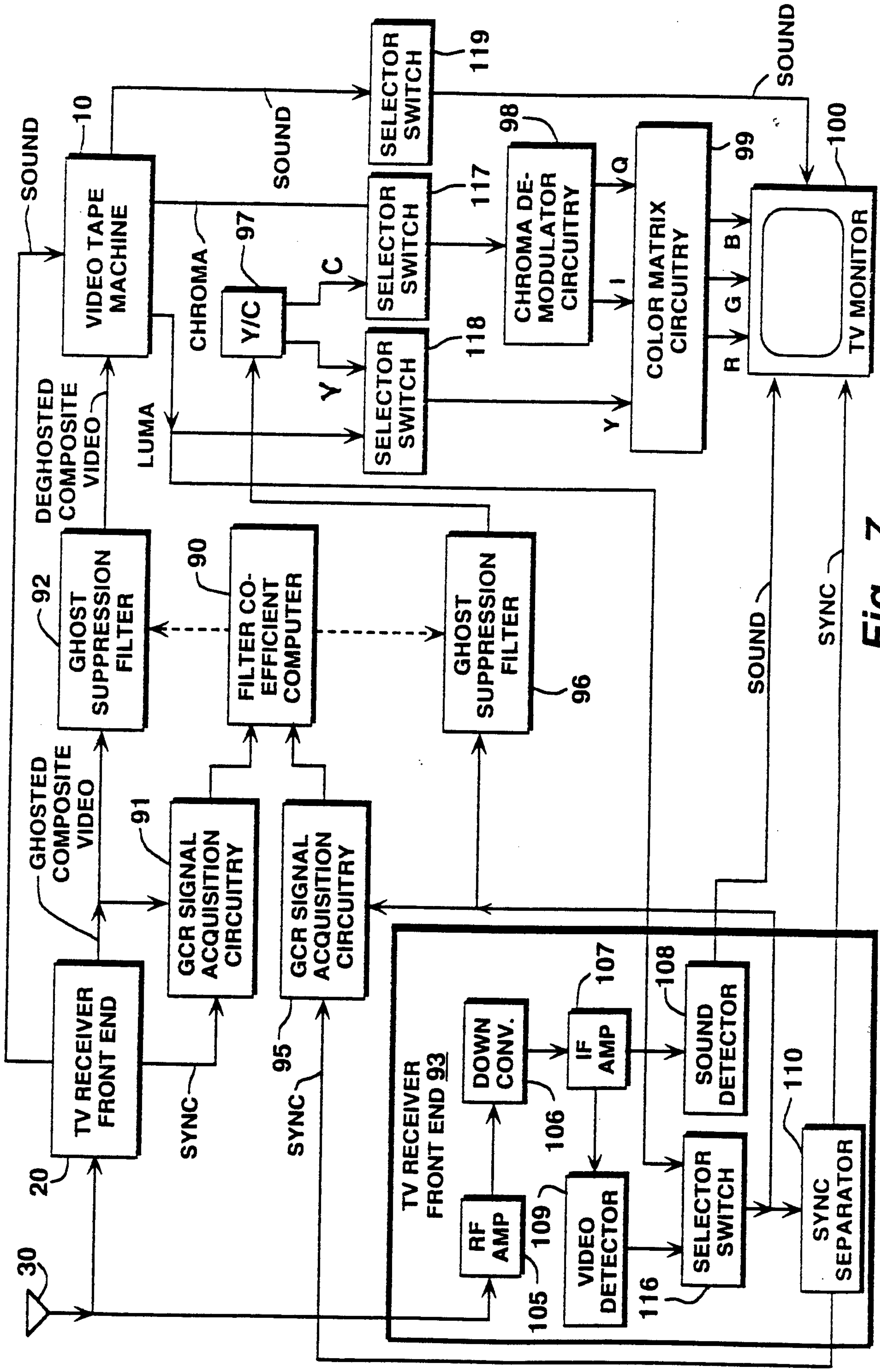
30
TV RECEIVER FRONT END
20
SYNC
SOUND
GHOSTED COMPOSITE VIDEO
GCR SIGNAL ACQUISITION CIRCUITRY
91
GHOST SUPPRESSION FILTER
92
DEGHOSTED COMPOSITE VIDEO
VIDEO TAPE MACHINE
10
SOUND
SELECTOR SWITCH
119
CHROMA
LUMA
Y/C
97
C
Y
SELECTOR SWITCH
117
SELECTOR SWITCH
118
FILTER CO-EFFICIENT COMPUTER
90
GCR SIGNAL ACQUISITION CIRCUITRY
95
SYNC
GHOST SUPPRESSION FILTER
96
CHROMA DE-MODULATOR CIRCUITRY
98
Q
I
Y
COLOR MATRIX CIRCUITRY
99
R
G
B
TV MONITOR
100
SOUND
SYNC
TV RECEIVER FRONT END 93
RF AMP
105
DOWN CONV.
106
IF AMP
107
SOUND DETECTOR
108
VIDEO DETECTOR
109
SELECTOR SWITCH
116
SYNC SEPARATOR
110

Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR 93/00014

A. CLASSIFICATION OF SUBJECT MATTER

IPC[5]: H 04 N 5/78, 5/21
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC[5]: H 04 N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP, A1, 0 400 745 (N.V.PHILIPS) 05 December 1990 (05.12.90), abstract; fig. 2; claim 1.	1,2
A	US, A, 4 564 862 (COHEN) 14 January 1986 (14.01.86), fig. 6; column 6, line 61 to column 7, line 10.	1,2
A	US, A, 5 025 317 (KOGUCHI et al.) 18 June 1991 (18.06.91), fig. 5; claim.	1,2
A	EP, A2, 0 467 338 (NEC CORPORATION) 22 January 1992 (22.01.92), fig. 3; column 4, line 48 to column 6, line 52.	1,2,3
A	IEEE, Transactions on consumer Electronics, Volume 36, no. 4, November 1990, Hiroyuki Iga et al., "Ghost clean system", pages 819 to 823; fig. 2,6; chapters 2.2, 2.3, 2.6. -----	1,2

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 May 1993 (18.05.93)	15 June 1993 (15.06.93)

Name and mailing address of the ISA/ AT	Authorized officer
AUSTRIAN PATENT OFFICE Kohlmarkt 8-10 A-1014 Vienna Facsimile No. 0222/53424/535	Dimitrow e.h. Telephone No. 0222/53424/340

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR 93/00014

Im Recherchenbericht angeführtes Patentdokument / Patent document cited in search report / Document de brevet cité dans le rapport de recherche	Datum der Veröffentlichung / Publication date / Date de publication	Mitglied(er) der Patentfamilie / Patent family member(s) / Membre(s) de la famille de brevets	Datum der Veröffentlichung / Publication date / Date de publication
EP A1 400745	05-12-90	BR A 9002590 JP A2 3022769 NL A 8901374 US A 5029007	20-08-91 31-01-91 17-12-90 02-07-91
US A 4564862	14-01-86	keine - none - rien	
US A 5025317		keine - none - rien	
EP A2 467338	22-01-92	EP A3 467338 JP A2 4077180	27-05-92 11-03-92

Form PCT/ISA/210 (patent family annex) (July 1992)