

PATENT SPECIFICATION

(11)

1 520 004

9

1 520 004

- (21) Application No. 43217/75 (22) Filed 21 Oct. 1975
(31) Convention Application Nos. 522816 (32) Filed 12 Nov. 1974 in
522819
(33) United States of America (US)
(44) Complete Specification published 2 Aug. 1978
(51) INT. CL.² G05D 13/62
G11B 19/24
(52) Index at acceptance
G3R 110C; 33D3A; 4; 72N; 72Y; 9E
H3A C11D; C16; L3X; LX

(19)



(54) VELOCITY CORRECTION FOR VIDEO DISCS

(71) We, RCA CORPORATION, a corporation organized under the laws of the State of Delaware, United States of America, of 30 Rockefeller Plaza, City and State of New York, 10020, United States of America, do, hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This application is concerned with a video disc player apparatus and more particularly, to circuitry utilized to correct relative velocity errors in information retrieved from a rotating video disc.

In one type of video disc reproducing system, capacitance variations measured between a signal pickup stylus and video disc record is sensed to reconstruct the information embossed within a spiral groove on the record. In this type of video disc system, composite video signals including time varying image components and regularly recurring synchronization components are recorded in the form of geometric variations in the spiral groove on the surface of the record. The disc surface may include a conductive material covered with a thin coating of dielectric material. A metal electrode associated with the stylus playback device cooperates with the conductive material and dielectric coating to form a capacitor. Capacitance variations due to the signal representative geometrical variations in the spiral groove are sensed and decoded to provide a video representative output signal. A detailed description of a capacitive video disc system is described in U.S. Patent No. 3,842,194, Oct. 15, 1974, Jon K. Clemens and entitled, INFORMATION RECORDS

AND RECORDING PLAYBACK SYSTEMS THEREFOR.

In order to accurately reconstruct the signal information received from the video disc into a relatively jitter-free color image, it is desirable to compensate for all velocity and phase errors in the derived video information. Composite video signals that are derived from the rotating video disc may be subject to velocity errors that are due, for example, to disc warpage or eccentricity of the information storing spiral groove with respect to the center hole in the disc. As a result of eccentricity or disc warpage, a signal sensed by an associated signal pickup arm may be received at alternately faster and slower speeds than that at which it was recorded. One scheme that may be utilized to compensate for such alternating velocity errors incorporates an electromechanical device for repositioning the signal pickup stylus in response to velocity errors. An electromechanical device of this type, referred to in the description and claims as an "arm stretcher", may include a transducer that is mechanically coupled to the signal pickup stylus. Upon application of appropriate electrical signals to this transducer, the pickup stylus may be caused to traverse along the spiral groove in consonance with the velocity errors. A typical arm stretcher is described in U.S. Patent No. 3,711,641, in the name of Richard C. Palmer, issued January 16, 1973.

In previous video disc player systems, the "arm stretcher" apparatus was controlled by timing signals such as vertical or horizontal sync pulses. The use of sync pulse signals, however, requires separate and additional circuitry for providing such signals

10

with relatively stable leading edges. Further, in the use of such synchronizing signals, relatively elaborate circuitry is desirably utilized to minimize the probability of erroneous signals caused by noise impulses.

The presence of noise signals or unstable edges on the timing signals may undesirably produce erroneous control signals to the arm stretcher resulting in a severe degrading of the displayed image.

Further, the "arm stretcher" transducer is generally capacitively coupled to the driving circuitry in order to eliminate high transducer currents at extremely low frequencies. The use of capacitive coupling, however, undesirably contributes phase shift to the arm stretcher control circuitry limiting the resultant transducer frequency response.

In accordance with various aspects of the present invention, there are provided Claim 1 or Claim 7 or Claim 10 or Claim 13. Features of the invention may include circuitry for controlling an arm stretcher while concurrently correcting phase errors in the received chrominance subcarrier signal. This apparatus comprises means that are coupled to the signal pickup stylus for decoding composite video signals provided from a rotating video disc. A heterodyning means receptive to the decoded signals, heterodynes these signals with signals from a voltage controlled oscillator to produce frequency translated composite video signals. A reference oscillator provides signals at substantially the same frequency as a burst component in the translated signal. Means that are receptive to signals from the heterodyning means and from the reference oscillator provide signals that represent the phase difference between the two received signals. The difference signal produced by this latter means is coupled to the voltage controlled oscillator and used to control the heterodyning frequency of the heterodyning means to provide a relatively stable translated chroma subcarrier frequency signal. A transducer means is coupled to the pickup stylus for repositioning the stylus along the groove of the record in response to the difference signals.

An improved arm stretcher control circuit embodiment having direct current coupling and utilizing the color subcarrier burst signal recorded on the video disc for providing velocity reference signals may include a first filter means which also receives difference signals from the phase comparator and provides the low frequency portion of these signals at a relatively high gain to the electrical signal input of the arm stretcher transducer.

Signals provided at the output of the first filter means are further coupled to a second filter means. The second filter means is also coupled to the heterodyning means

and effects an increase in the amount of difference signal thereto at frequencies other than that of the rotational velocity of the video disc record.

Referring to the accompanying drawings of which:

Figure 1 is a block diagram of circuitry suitable for providing phase locking of the chrominance subcarrier signal and controlling an arm stretcher transducer.

Figure 2 is a block diagram of an "arm stretcher" transducer control circuit.

Figure 3 is a schematic diagram of control circuitry utilized to drive an arm stretcher transducer in accordance with the present invention;

Figures 4a-4d are frequency response curves of the apparatus shown in Figures 2 and 3.

Figure 5 is a schematic drawing of a voltage controlled oscillator suitable for use with the apparatus shown in Figures 1 and 2.

With reference to Figure 1, a video disc player 10 has a video disc 12 located thereon. A signal pickup arm 14, associated with the video disc player, has a signal pickup stylus located therein, not shown in the drawing. Signals derived from pickup arm 14 are coupled to an FM demodulator 16. Demodulator 16 provides signals to a balanced modulator 18. Modulator 18 has an output terminal coupled to a low-pass filter 20. Signals provided by filter 20 are coupled to a phase detector 22. Phase detector 22 receives signals from a reference oscillator 24 and from a burst key input line 26. Signals provided by detector 22 are coupled to a voltage controlled oscillator 40. Oscillator 40, which is preferably a voltage controlled crystal oscillator (VCXO), provides signals to modulator 18. Detector 22 further provides signals to an electromechanical "arm stretcher" transducer 34 through a frequency compensating network 17 and an amplifier 28. Transducer 34 is mechanically coupled to a signal pickup stylus located in pickup arm 14. Frequency translated signals at the output of filter 20 are coupled through a transcoder 44 to television receiver 46 where they may be displayed.

In the operation of the above-described circuitry, the video disc 12 is rotated on a turntable associated with player 10. For purposes of illustration, it may be assumed that the center hole of the disc is not centered with respect to the spiral groove information recorded thereon. Hence, signal information derived from the disc is subject to changes in velocity as the disc rotates. A signal pickup stylus located within signal pickup arm 14 detects the capacitance variations associated with the recorded topography in the spiral groove of the disc and couples this capacitive variation to circuitry not shown within arm 14. The circuitry within

arm 14 converts the capacitive variations into electrical signals which are then coupled to an FM demodulator 16. Demodulator 16 decodes the FM signals provided from arm 14 into the recorded composite video signals. Composite color video signals recorded on the video disc may be in a buried subcarrier format. A buried subcarrier signal illustratively includes a broad band luminance signal component of about 3 MHz bandwidth and an interleaved narrow band chrominance signal component. The chrominance signal component may be in the form of 1/2 MHz sidebands of a 1.53 MHz subcarrier substantially located in the midband of the broad band luminance component. A chrominance reference burst signal may further be incorporated during the back porch interval of the horizontal synchronization signals.

The signals provided from demodulator 16 are coupled to a balanced modulator 18. Modulator 18 may be of a singly balanced type for which the input portion is balanced. By utilizing a balanced type of modulator, the baseband video modulating component may be substantially eliminated from the modulator output signal. The elimination of the baseband signal is desirable for providing simplified filtering at the output of the modulator in order to recover substantially only the frequency translated video signal. Video signals applied to modulator 18 are translated in frequency by signals provided by voltage controlled crystal oscillator (VCXO) 40. Oscillator 40 provides signals that are substantially at 5.11 MHz. Upon heterodyning the signals from oscillator 40 with the video signal provided by demodulator 16, a frequency translated video signal is produced having upper and lower sideband components on each side of 5.11 MHz. The chrominance subcarrier signal, which was at 1.53 MHz in the signal provided from demodulator 16, is translated to 3.58 MHz in the lower sideband component of the frequency translated video signal. A low-pass filter 20, having a bandpass of about 8 MHz, passes substantially only the first modulation product of modulator 18, i.e., the sidebands on each side of a carrier at about 5.11 MHz.

Frequency translated signals provided at the output of filter 20 are coupled to a phase detector 22. Phase detector 22 gates the video signal received from low-pass filter 20 in response to burst key signals applied at terminal 26. Burst key signals follow the horizontal synchronization signals which have been decoded by circuitry not shown. The gated video signals within phase detector 22 are compared to signals from reference oscillator 24. Reference oscillator 24 is a relatively stable oscillator which provides signals at 3.58 MHz. This oscillator is preferably of the crystal controlled variety. A

resultant difference signal between the phase of the signals supplied by oscillator 24 and the chroma reference burst signal in the lower sideband of the frequency translated video signal is provided at the output of detector 22 and coupled to the frequency control input of VCXO 40. Oscillator 40 varies in frequency in accordance with the applied difference signal and operates to minimize this difference signal by varying the frequency about which the composite video signal is translated. A voltage controlled crystal oscillator suitable for use as oscillator 40 is illustrated in Figure 5. Hence, the frequency of VCXO 40 is caused to jitter by the applied difference signal in accordance with the jitter of the signal received from disc 12. The resulting frequency translated video signal at the output of modulator 18 therefore has a stabilized chrominance subcarrier component that is phase locked with reference oscillator 24.

Stabilization of the chrominance subcarrier signal is necessary for producing accurate color reproduction of image produced from the video disc information. However, stabilization of only the chrominance subcarrier signal is inadequate for minimizing the gross timing errors produced by video disc warpage or eccentricity. To minimize such timing errors, an arm stretcher transducer, capable of continuously repositioning the signal pick-up stylus along the groove of the video disc, may be utilized. Signals utilized to control the arm stretcher transducer are derived from the phase difference signals produced by detector 22. Phase difference signals are particularly well suited for controlling an arm stretcher transducer since these signals may be produced with a relatively high degree of noise immunity and accuracy. The presence of several cycles of color burst reference signal information recurring about 2000 times each disc revolution enable the formation of a phase difference signal capable of accurately following the timing errors of the rotating video disc.

With reference to the drawing, an arm stretcher transducer 34 is controlled by signals derived from phase detector 22. Transducer 34, as described in the aforementioned U.S. Patent 3,711,641, may be formed in a similar manner to a relatively small loudspeaker. For example, the cone of the loudspeaker may be mechanically coupled to the signal pickup stylus and the electro-magnetic field of the speaker coupled to the source of phase difference signals.

A frequency compensating network 17 receives signals from detector 22 and operates as a lead-lag network to minimize signal phase shift to transducer 34. Signals that have been phase compensated by network 17 are coupled to transducer 34 through an amplifier 28. Amplifier 28 pro-

vides signals at a relatively low impedance level for driving transducer 34. By applying appropriate signals to the coil of the transducer, the signal pickup stylus may be caused to traverse along the spiral groove in the video disc. Signal amplitudes applied to transducer 34 and VCXO 40 are desirably adjusted in the following manner. First, the signal gain of amplifier 28 is adjusted to provide a maximum amount of jitter correction in the displayed image. After the picture jitter has been reduced to a subjectively acceptable level, signal gain to VCXO 40 is adjusted. Gain control 54 is rotated to provide a maximum amount of signal gain to VCXO 40 without detrimentally affecting the jitter stabilization of the displayed image. Too much signal gain to VCXO 40 reduces the amount of correction signal to transducer 34. Too little signal gain to VCXO 40 may detrimentally affect the stability of the chrominance subcarrier signal and therefore affect the chrominance of the displayed image. By properly adjusting the signal gains to both transducer 34 and VCXO 40, a displayed image may be produced with subjectively acceptable color and minimum jitter.

Operation of the arm stretcher transducer from phase difference signals utilized by the phase-locked loop allows a reduction in otherwise duplicated circuitry and further provides transducer control signals which are relatively noise free and of a high degree of accuracy. Hence, an improved arm stretcher control signal is provided by utilizing the phase difference signal developed by circuitry for phase stabilizing the chrominance subcarrier burst component in the composite video signal extracted from the video disc.

With reference to Figure 2, an embodiment of the invention is shown in block form which includes circuitry suitable for coupling a desired amount of signal to transducer 34 and VCXO 40. Those portions of Figure 2 having the same function as the equivalent portions of Figure 1 have the same reference numbers.

Operation of the embodiment of Figure 2 is similar to that of Figure 1 to the point where the output of the phase detector 22 is coupled to the oscillator 40 and transducer 34. Bandpass filter 21 selects one sideband of the modulated chroma signal for application to the phase detector.

Signals provided by phase detector 22 are coupled through a buffer amplifier 28 to an active filter 30 and a summing network 32. Filter 30 modifies the applied signals and couples the modified signals to an arm stretcher transducer 34 through a variable resistor 36. Transducer 34 is mechanically coupled to the signal pickup stylus in signal pickup arm 14 and provides mechanical motion to this stylus. A low-pass filter 38

also receives signals from filter 30 and couples these signals to the aforementioned summing junction 32. Signals summed at junction 32 are coupled to a voltage controlled crystal oscillator 40 which in turn provides signals to the balanced modulator 18.

In the operation of the above-described circuitry, signals provided by filter 20 have chrominance reference burst components that have been translated from 1.53 MHz in the baseband signal to 3.58 MHz and 6.64 MHz in the frequency translated signals. A bandpass filter 21 receives signals from filter 20 and passes signals in the region of 3.58 MHz allowing the chrominance reference burst signals in the lower sideband of the translated video signal to pass there-through. Chrominance reference burst signals provided at the output of filter 21 are phase compared in detector 22 with a 3.58 MHz reference signal provided by a relatively stable frequency source 24.

A resultant difference signal provided at the output of the phase detector 22 is coupled through a terminal 27 to a buffer amplifier 28. Amplifier 28 receives the phase difference signals from detector 22 and couples these signals at a relatively low impedance to an active filter 30 and a summing circuit 32.

The resultant difference signals provided at the output of detector 22 may be utilized for stabilizing the entire video signal with the aforementioned arm stretcher and stabilizing the chrominance reference burst signal with an appropriate feedback loop. Stabilization of the chrominance reference burst signal is desirable for effecting color decoding by a television receiver. Stabilization of the entire video signal is desirable for minimizing undesired effects in the displayed image caused by the aforementioned disc warp and eccentricity. It is desirable to provide both types of stabilization. It will be appreciated that stabilization of either the chrominance reference burst signal or the entire video signal will, as correction occurs, operate to minimize the amplitude of the difference signals provided by detector 22. Therefore gain adjustment of the difference signals to each stabilizing circuit is of particular importance. The problem of providing a desired amount of signal gain to each of the stabilizing circuits is substantially eliminated by utilizing filters 30 and 38.

Stabilization of the chrominance subcarrier frequency is accomplished by shifting the frequency of VCXO 40 in consonance with the difference signal provided by detector 22, as before.

Stabilization of the entire video signal is accomplished by supplying phase difference signals to arm stretcher transducer 34.

If the playback speed of the turntable

70

75

80

85

90

95

100

105

110

115

120

125

130

on player 10 is operated at about 450 rpm, then the velocity change in received signal information recurs at about 7.5 times per second. Because of the information velocity change with each disc revolution, filters 30 and 38 are adjusted to provide a greater amount of difference signal passage to arm stretcher 34 at 7.5 Hz than to the VCXO 40. A detailed description of filters 30 and 38 is given with reference to Figure 3. By utilizing the arm stretcher to provide correction at relatively low frequencies, e.g., 7.5 Hz, gross velocity errors in the derived video information may be minimized.

Signals that have been stabilized by both arm stretcher 34 and VCXO 40 appear at the output of filter 20. A transcoding device described in detail in U.S. Patent 3938179 in the name of John Amery, entitled, "COMB FILTERING FOR VIDEO PROCESSING," receives stabilized signals from filter 20 and rearranges these signals into a format that is easily decoded by an unmodified television receiver such as receiver 46.

With reference to Figure 3, an input terminal of buffer amplifier 28 is coupled to terminal 27 for receiving signals provided by phase detector 22. Signals provided by amplifier 28 are coupled through a resistor 80 to a non-inverting input of amplifier 52. A series combination of resistor 82 and capacitor 84 is further coupled to the non-inverting input of amplifier 52. Signals provided at the output of amplifier 52 are coupled to an inverting input terminal through resistors 90 and 92, and to the base electrodes of a driver amplifier formed by transistors 58 and 60. Transistors 58 and 60 have commonly coupled emitter electrodes and provide signals therefrom to an inverting input terminal of amplifier 52 through the series combination of capacitor 62 and resistor 64. Signals provided at the emitters of transistors 58 and 60 are further coupled to a terminal 39 through a resistor 66 and to a summing terminal 33 through a low-pass filter formed by the series combination of resistors 68, 70 and 72 and shunt capacitor 74. Signal limiting diodes 86 and 88 are coupled across capacitor 74. Summing terminal 33 further receives signals from the output of amplifier 28 through series coupled resistors 54 and 56.

A squelch circuit, utilized when signal information is not being derived from video disc 12, comprises a transistor 76 having an emitter electrode coupled to the junction of resistors 90 and 92. Control signals to operate this squelch circuit are provided to the base electrode of transistor 76 through a resistor 78.

In the operation of the circuit described in Figure 3, phase difference signals (error signals) provided by the phase detector 22 (Figures 1 & 2) are coupled through

terminal 27 to amplifier 28. Amplifier 28 is arranged to provide unity gain by having an output terminal coupled to an inverting input terminal. The signals provided at the output of amplifier 28 are coupled to amplifier 52. Amplifier 52 is arranged as an active filter for providing appropriate signals to both the arm stretcher and voltage controlled oscillator. Signals provided by buffer amplifier 28 are coupled through summing resistors 54 and 56 to a terminal 33 and also to a non-inverting input terminal of amplifier 52. The signals provided to terminal 33 form one path of the phase difference signals utilized to control VCXO 40. Amplifier 52 incorporates RC time circuits for forming appropriate break points in its frequency response. The first RC time constants are formed by resistors 80, 82 and capacitor 84. This RC timing network forms break points in the amplifier response at about 7.5 Hz and 59 Hz. A second RC timing network is formed by resistor 64 and capacitor 62. This second timing network forms a break point at about 59 Hz. The two break points formed at 59 Hz are in consonance with a break point in the frequency response of transducer 34. A curve illustrating the frequency response from terminal 27 to the output of transducer 34 is shown in Figure 4a. The transducer output is in terms of velocity and the input in electrical amplitude, so the ordinate while calibrated in decibels is merely a relative plot.

Transistors 58 and 60 are arranged in emitter-follower configuration and utilized for providing current amplification to the signals provided by amplifier 52. Signals provided by transistors 58 and 60 are coupled through a resistor 66 and terminal 39 to the arm stretcher transducer. Since the electrical portion of the arm stretcher transducer is of a relatively low impedance, it is desirable to provide controlling circuitry which will supply a relatively low current to the arm stretcher transducer for frequencies near 0 Hz. To enable a low transducer current at near d.c. frequencies, VCXO 40 is arranged to receive a maximum amount of difference signals in the vicinity of 0 Hz. By providing the largest amount of signal gain to VCXO 40 at the extremely low frequencies, error signals provided by detector 22 are minimized, keeping the control signal current to arm stretcher 34 at a minimum at low frequencies.

The signals at the relatively low impedance emitters of transistors 58 and 60 are further coupled to a low-pass filter formed by resistors 68, 70 and 72 and capacitor 74. This latter low-pass filter has a 3 db point at about 27 Hz which provides, when taken with the frequency response of amplifier 52, a frequency response curve substantially as shown in Figure 4b. This plot is represen-

5 tative of the amplitude response from terminal 27 to terminal 33 with terminal 33 terminated in 180 ohms and with the junction of resistors 54 and 56 opened. The resistance value of 180 ohms represents the input impedance of VCXO 40. Opening the junction of resistors 54 and 56 prevents passage of signal from the output of amplifier 28 to summing junction 33 by way of 54,56 so the response of the path through filter 30 and low pass filter 38 may be observed. Signals provided from this latter low-pass filter are coupled to terminal 33 and add to those signals supplied to terminal 33 directly from amplifier 28. Combined signals formed at terminal 33 have a frequency response substantially as shown in Figure 4c. A pair of diodes 86 and 88 are incorporated in the low-pass filter for preventing inadvertent large signal excursions caused, for example, by noise impulses.

By comparing the relative response of the active filter and transducer 34, as shown in Figure 4a, with the frequency response provided to VCXO 40 (terminal 33), as shown in Figure 4c, a resultant curve, shown in Figure 4d, may be produced which illustrates the relative difference in gain between the arm stretcher response and the voltage controlled crystal oscillator response. With reference to Figure 4d, it can be seen that the amplitude response of arm stretcher transducer 34, as compared to the response associated with VCXO 40, is at a maximum at about 7.5 Hz. This gain maximum allows the arm stretcher to provide a desired amount of correction for velocity errors caused by eccentricity and warpage of the video disc. It will be appreciated that the frequency range over which the arm stretcher transducer has its greatest relative response to error signals is relatively narrow. By keeping this frequency range narrow, velocity error correction by arm stretcher 34 may be effectively accomplished without adversely affecting the phase error correction of the reference burst by VCXO 40.

A squelch transistor 76 is further incorporated with the amplifier 52. This transistor operates in the saturation mode during the period of time when signal information is extracted from the video disc. In the absence of signals from the video disc as, for example, when a video disc is not being played, a control signal is applied through resistor 78 to the base of transistor 76 causing this transistor to turn off. When transistor 76 is off, signals provided at the output of amplifier 52 are coupled through resistors 90 and 92 to the inverting input terminal of this amplifier causing the gain of amplifier 52 to change to substantially unity gain.

The above-described circuitry illustrates that a relatively low impedance arm stretcher

transducer may be direct current coupled to appropriate drive circuitry without being subject to high input currents at extremely low frequencies. Further, by adjusting the appropriate time constants associated with filter 38 and the active filter incorporating amplifier 52, the amount of transducer output may be increased at a frequency corresponding to the rotational velocity of the video disc allowing the arm stretcher to effectively minimize signal velocity errors due to disc eccentricity and warpage.

WHAT WE CLAIM IS:—

1. In a video disc player in which a signal pickup stylus cooperates with a signal information storing groove of a video disc, said information storing groove including recorded luminance, chrominance and color synchronization signal components, and said signal components as recovered by said pickup stylus being subject to recurring frequency and phase errors as a consequence of errors in velocity of relative motion between said disc groove and said pickup stylus, apparatus for providing correction of said signal component errors comprising: means coupled to said signal pickup stylus for decoding signals provided from said video disc;

a voltage controlled oscillator;

heterodyning means receptive to signals from said decoding means and said voltage controlled oscillator for frequency translating the constituent components of said decoded signal;

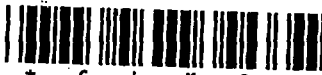
a reference oscillator for providing signals at a reference frequency;

means receptive to signals from said heterodyning means and said reference oscillator for providing an error signal indicative of departures, if any, of a color synchronization component in the frequency translated output of said heterodyning means from correspondence in frequency with said reference frequency;

means for rendering said voltage controlled oscillator responsive to said error signal to control the frequency thereof in a manner opposing said departures from said frequency correspondence; and

transducer means coupled to said pickup stylus for repositioning said stylus along the groove of said video disc records in response to said error signal in a manner opposing said errors in velocity of relative motion.

2. Apparatus according to Claim 1 wherein: said receptive means is a phase detector having input terminals for receiving signals from said reference oscillator and said heterodyning means, and an output terminal for providing signals proportional to the phase difference between said reference signals and a color synchronization component in the frequency translated signal provided by said heterodyning means.



14

6

1,520,004

6

tative of the amplitude response from terminal 27 to terminal 33 with terminal 33 terminated in 180 ohms and with the junction of resistors 54 and 56 opened. The resistance value of 180 ohms represents the input impedance of VCXO 40. Opening the junction of resistors 54 and 56 prevents passage of signal from the output of amplifier 28 to summing junction 33 by way of 54,56 so the response of the path through filter 30 and low pass filter 38 may be observed. Signals provided from this latter low-pass filter are coupled to terminal 33 and add to those signals supplied to terminal 33 directly from amplifier 28. Combined signals formed at terminal 33 have a frequency response substantially as shown in Figure 4c. A pair of diodes 86 and 88 are incorporated in the low-pass filter for preventing inadvertent large signal excursions caused, for example, by noise impulses.

By comparing the relative response of the active filter and transducer 34, as shown in Figure 4a, with the frequency response provided to VCXO 40 (terminal 33), as shown in Figure 4c, a resultant curve, shown in Figure 4d, may be produced which illustrates the relative difference in gain between the arm stretcher response and the voltage controlled crystal oscillator response. With reference to Figure 4d, it can be seen that the amplitude response of arm stretcher transducer 34, as compared to the response associated with VCXO 40, is at a maximum at about 7.5 Hz. This gain maximum allows the arm stretcher to provide a desired amount of correction for velocity errors caused by eccentricity and warpage of the video disc. It will be appreciated that the frequency range over which the arm stretcher transducer has its greatest relative response to error signals is relatively narrow. By keeping this frequency range narrow, velocity error correction by arm stretcher 34 may be effectively accomplished without adversely affecting the phase error correction of the reference burst by VCXO 40.

A squelch transistor 76 is further incorporated with the amplifier 52. This transistor operates in the saturation mode during the period of time when signal information is extracted from the video disc. In the absence of signals from the video disc as, for example, when a video disc is not being played, a control signal is applied through resistor 78 to the base of transistor 76 causing this transistor to turn off. When transistor 76 is off, signals provided at the output of amplifier 52 are coupled through resistors 90 and 92 to the inverting input terminal of this amplifier causing the gain of amplifier 52 to change to substantially unity gain.

The above-described circuitry illustrates that a relatively low impedance arm stretcher

transducer may be direct current coupled to appropriate drive circuitry without being subject to high input currents at extremely low frequencies. Further, by adjusting the appropriate time constants associated with filter 38 and the active filter incorporating amplifier 52, the amount of transducer output may be increased at a frequency corresponding to the rotational velocity of the video disc allowing the arm stretcher to effectively minimize signal velocity errors due to disc eccentricity and warpage.

WHAT WE CLAIM IS:—

1. In a video disc player in which a signal pickup stylus cooperates with a signal information storing groove of a video disc, said information storing groove including recorded luminance, chrominance and color synchronization signal components, and said signal components as recovered by said pickup stylus being subject to recurring frequency and phase errors as a consequence of errors in velocity of relative motion between said disc groove and said pickup stylus, apparatus for providing correction of said signal component errors comprising:

means coupled to said signal pickup stylus for decoding signals provided from said video disc;

a voltage controlled oscillator;

heterodyning means receptive to signals from said decoding means and said voltage controlled oscillator for frequency translating the constituent components of said decoded signal;

a reference oscillator for providing signals at a reference frequency;

means receptive to signals from said heterodyning means and said reference oscillator for providing an error signal indicative of departures, if any, of a color synchronization component in the frequency translated output of said heterodyning means from correspondence in frequency with said reference frequency;

means for rendering said voltage controlled oscillator responsive to said error signal to control the frequency thereof in a manner opposing said departures from said frequency correspondence; and

transducer means coupled to said pickup stylus for repositioning said stylus along the groove of said video disc records in response to said error signal in a manner opposing said errors in velocity of relative motion.

2. Apparatus according to Claim 1 wherein: said receptive means is a phase detector having input terminals for receiving signals from said reference oscillator and said heterodyning means, and an output terminal for providing signals proportional to the phase difference between said reference signals and a color synchronization component in the frequency translated signal provided by said heterodyning means.



* E L N S *

1,520,004

(15)

7

7

3. Apparatus according to Claim 2 wherein:

said reference oscillator provides output signals at substantially 3.58 MHz and said color synchronization component in said frequency translated signal is also at substantially 3.58 MHz.

4. Apparatus according to Claim 3 wherein:

said heterodyning means has a balanced input terminal for receiving video signals and an output terminal for providing frequency translated signals substantially free of baseband video signals.

5. Apparatus according to Claim 4 wherein:

said means coupled to said pickup stylus includes apparatus for decoding capacitive variations sensed by said pickup stylus into electrical signals representative of the information recorded on said video disc.

6. Apparatus according to Claim 5 wherein said voltage controlled oscillator is a voltage controlled crystal oscillator having an output frequency of about 5.11 MHz.

7. In a video disc player including a signal pickup stylus for recovering signals from a rotating video disc, said player being subject to recurring errors in the velocity of relative motion between said disc and said stylus; apparatus comprising:

a source of oscillations;

heterodyning means coupled to said stylus and responsive to oscillations from said source for frequency translating signals recovered by said stylus;

a source of reference signals;

a phase comparator receptive to said reference signals and frequency translated signals from said heterodyning means for developing an output indicative of departures, if any, from frequency correspondence between the frequency of said reference signals and the frequency of a periodically recurring component of said frequency translated signals;

an "arm stretcher" transducer coupled to said signal pickup stylus;

means coupling said phase comparator to said transducer for repositioning said stylus in response to said output of said phase comparator in a sense opposing said errors in said velocity of relative motion; and

further means coupling said phase comparator to said source of oscillations for controlling the frequency of said oscillations, in accordance with said output of said phase comparator, in a sense tending to maintain frequency and phase synchronism between said periodically recurring component of said frequency translated signals and said reference signals.

8. Apparatus according to Claim 7 wherein:

said signals recorded on the video disc

include varying video components and a regularly recurring color synchronization component; and

said periodically recurring component of said frequency translated signals corresponds to a product of the heterodyning of said regularly recurring color synchronization component with oscillations from said source by said heterodyning means.

9. Apparatus according to Claim 8 wherein:

said source of oscillations includes a voltage controlled oscillator receptive to said output of said phase comparator and having an output frequency of about 5.11 MHz.

10. In a video disc player in which a signal pickup stylus cooperates with a signal information storing groove of a disc subject to rotation at a given rotational frequency, said information storing groove including recorded luminance, chrominance, and color synchronization signal components, and said signal components as recovered by said pickup stylus being subject to frequency errors as a consequence of errors in the velocity of relative motion between said disc groove and said pickup stylus, apparatus for providing correction of said signal component errors comprising:

means coupled to said signal pickup stylus for providing video signals from information recorded on said video disc;

a voltage controlled oscillator providing oscillations of controlled frequency;

heterodyning means responsive to said video signals and said oscillations for frequency translating said video signals;

a reference oscillator;

phase detecting means responsive to a frequency translated color synchronization component derived from said heterodyning means and to an output of said reference oscillator for providing error signals;

means for supplying said error signals to said voltage controlled oscillator to provide, over a range of error signal frequencies, an adjustment of the frequency of said oscillations in a sense opposing departures from frequency correspondence between said reference oscillator output and said frequency translated color synchronization component;

a transducer coupled to said signal pickup stylus for repositioning said stylus along said video disc groove in response to electrical signals;

means for rendering said transducer responsive to error signals from said phase detecting means in a sense opposing said errors in velocity of relative motion;

said last-named means including an error signal amplifier having an input and an output, means providing a direct current coupling for error signal information between said phase detecting means and said error signal amplifier input, additional means pro-



- viding a direct current coupling for error signal information between said error signal amplifier output and said transducer, and frequency selective means coupled to said error signal amplifier for shaping the frequency response characteristic thereof in a manner effectively restricting the velocity error opposition provided by said transducer to a relatively narrow low frequency portion of said error signal frequency range, said portion encompassing error signal frequencies inclusive of said rotational frequency; and means coupled between the output of said error signal amplifier and said voltage controlled oscillator for augmenting the error signal applied thereto by said first-named error signal supplying means, said error signal augmenting means having a frequency response characteristic effectively confining said augmentation to a narrow segment of said low frequency range portion below said rotational frequency.
11. Apparatus according to Claim 10 wherein: said frequency response characteristic of said error signal amplifier has a break point at a frequency corresponding to said rotational frequency.
12. Apparatus according to Claim 11 wherein:
- 30 said frequency response characteristic of said error signal augmenting means has a break point at less than one hertz.
13. In a video disc player in which a signal pickup stylus cooperates with a signal information storing groove of a disc subject to rotation at a given rotational frequency to recover recorded composite video signals including luminance, chrominance and color synchronization signal components, and wherein said recovered signal components are undesirably subject to frequency errors as a consequence of deviations from a desired velocity of relative motion between said disc groove and said pickup stylus, correction apparatus comprising:
- 45 means coupled to said stylus for developing composite video signals representative of information stored in said video disc groove; a voltage controlled oscillator providing oscillations of a controllable frequency; heterodyning means responsive to said oscillations and said developed signals for frequency translating said developed signals; a reference oscillator; an "arm stretcher" transducer coupled to said stylus for imparting motion to said stylus along said groove in response to signals applied thereto; means for phase comparing signals from said reference oscillator with a color synchronization component of said frequency translated signals to develop error signals indicative of departures from frequency correspondence therebetween; means, having a first frequency response characteristic for supplying said error signals from said phase comparing means to said voltage controlled oscillator to establish a first component frequency error correction loop; and means, coupled to said phase comparing means and having a second frequency response characteristic, for supplying said error signals to said arm stretcher transducer to establish a second component frequency error correction loop; said first frequency response characteristic differing from said second frequency response characteristic in such manner that correction of frequency errors which recur at said rotational frequency is predominately effected by said second correction loop to the substantial exclusion of said first correction loop, whereas said first correction loop provides significant correction of errors which recur at frequencies in a narrow range below said rotational frequency.
14. Apparatus according to Claim 13 wherein: said narrow range lies below a frequency of one hertz.
15. A velocity error compensation method or apparatus substantially as hereinbefore described with reference to Figures 1 and 2 or to Figures 1-5 of the drawings.
- JOHN A. DOUGLAS,
Chartered Patent Agent,
50 Curzon Street,
London W1Y 8EU.
Agent for the Applicant