PATENT SPECIFICATION

(11) 1 526 517

1 526 517

(21) Application No. 29047/76 (22) Filed 13 July 1976

(31) Convention Application No. 50/096679U

(32) Filed 14 July 1975 in

(33) Japan (JP)

(44) Complete Specification published 27 Sept. 1978

(51) INT CL² H04N 5/78

(52) Index at acceptance

H4F D12M D30B D30H D30Q

(19)



(54) AMPLITUDE LIMITING CIRCUIT FOR FREQUENCY MODULATED VIDEO SIGNALS

(71) We, NIPPON VICTOR KABUSHIKI KAISHA, of No. 12, 3-Chome, Moriya-Cho, Kanagawa-Ku, Yokohama-City, Kanagawa-Ken, Japan, a Japanese Corporation, 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:—

The present invention relates generally to amplitude limiting circuits for frequency-modulated video signals, and more particularly to a circuit for amplitude limiting a frequency-modulated video signal reproduced from a magnetic tape by a magnetic recording and reproducing apparatus so that the inversion phenomenon, in which "black" and "white" are inverted, is not produced in a reproduced picture of a television receiver set.

In a recording system for recording a frequency-modulated video signal on a magnetic tape, the high frequency component of a video signal is increased by a pre-emphasis circuit, before frequency modulation, in order to decrease relatively the noise components. For frequency modulation of the video signal, in general, use is made of a so-called positive modulation in which a white peak of the video signal corresponds to the upper limit of a deviation of a carrier frequency modulated by the video signal, while a tip of a synchronizing signal of the video signal corresponds to the lower limit of the deviation. Accordingly, in a case where the quantity of pre-emphasis in the pre-emphasis circuit is large, when the content of the video signal abruptly changes from black to white, for example, overshoots are apt to be generated in the video signal at a portion wherein a picture changes from black to white.

When the overshoots are generated, as described above, a portion of the frequency-modulated carrier corresponding to the overshoots protrudes beyond the upper limit of the predetermined deviation. High frequency signal components including such a portion protruding beyond the upper limit of the deviation are not readily recorded and reproduced, whereby the level of the reproduced signal becomes small. Accordingly, information signal components are lost when the reproduced signal passes through an amplitude limiter, whereby the signal frequency of the signal portion corresponding to the overshoots is extremely lowered, as described hereinafter. At that time, a portion of the signal for representing "white" of which the frequency is high becomes a signal for representing "black" of which the frequency is low. As a result, there is produced the so-called inversion phenomenon in the reproduced picture wherein a portion of the picture originally to be "white" is inverted into "black".

In order to prevent such an inversion phenomenon, a white clipping circuit for removing the overshoots has been provided heretofore in the recording system. However, in the case where the clipping quantity at the white clipping circuit is large, a portion of the information signal component is removed as a result whereby a good reproducing picture characteristic cannot be obtained.

It is conceivable to increase the level of the reproduced signal with respect to the high frequency band higher than the upper limit of the deviation in order to prevent the occurrence of the inversion phenomenon. However, this approach is accompanied by an increasing of the level of the noise components and accordingly a lowering of signal to noise ratio. Therefore, this conceivable approach is undesirable for actual practice.

According to the invention, there is provided an amplitude limiting circuit for a frequency modulated video signal which is liable from time-to-time to a transient of

7 JAN 1981

relatively low frequency or large time constant and substantial amplitude, additional to the normal band of relatively high frequencies, comprising:

high-pass filtering means for passing the normal band of relatively high frequencies but not the transient;

first amplitude limiting means for limiting the amplitude of the band of relatively high frequencies passed by the high-pass filtering means;

low-pass filtering means for passing the transient of relatively low frequency or large time constant but not the band of relatively high frequencies;

adding means for adding the filtered transient (from the low-pass filtering means) to the filtered and amplitude-limited band of relatively high frequencies (from the first amplitude limiting means);

and second amplitude limiting means for limiting the amplitude of the resulting output of the adding means.

The invention will be further described, by way of example, with reference to the accompanying drawings, in which:—

Fig. 1 is a block diagram of a video signal reproducing system to which one embodiment of an amplitude limiting circuit according to the present invention is applied;

Fig. 2(A) through Fig. 2(F) are waveform time charts respectively showing waveforms of signals at different points in the block diagram illustrated in Fig. 1; and

Fig. 3 is a circuit diagram of one embodiment of an actual circuit of an essential part of the block diagram illustrated in Fig. 1.

In the system illustrated in Fig. 1, a frequency modulated video signal recorded on a magnetic tape 11 is reproduced therefrom by a reproducing magnetic head 12. The reproduced signal is amplified in a pre-amplifier 13, and is thereafter supplied to an automatic amplitude adjuster 14, which suppresses the gentle fluctuation of the amplitude of the signal due to causes such as difference of sensitivity of the magnetic tape and magnetic head and tracking error of the magnetic head. The output signal of the adjuster 14 is compensated for its dropout in a dropout compensator 15, and is thereafter supplied to a high-pass filter 16 and a low-pass filter 17. The dropout compensator 15 has a well-known organization which detects lack of signal or dropout in the reproduced signal and replaces the signal having dropout by a signal obtained by delaying the signal one horizontal scanning period before, whereby the dropout is compensated for.

It will be assumed that a modulating video signal in a recording system changes its level instantaneously from a "black" level *B* to a "white" level *W*, as shown in Fig. 2(A). The frequency modulated video signal which has been recorded and reproduced has a waveform as shown in Fig. 2(B). The frequency modulation in the recording system is carried out by frequency modulating a carrier with a modulating video signal. At this time, positive frequency modulation wherein the white peak of the video signal corresponds to the upper limit of the deviation and the tip of the synchronizing signal of the video signal corresponds to the lower limit of the deviation is employed. Accordingly, when the video signal changes instantaneously its level from the black level to the white level, the frequency of the frequency modulated signal changes abruptly from low frequency to high frequency.

The high frequency component is not readily recorded and reproduced responsive to the recording and reproducing capability of the magnetic recording and reproducing apparatus. This capability is determined by the characteristics of the magnetic tape and magnetic head, the relative speed of the magnetic tape and magnetic tape, and other like factors. Upon abrupt changing of the frequency to high frequency, the level of the reproduced signal is abruptly lowered. As a result, a waveform of the reproduced frequency modulated signal becomes an abnormal waveform, as shown in Fig. 2(B), during a small time interval T. The interval T starts from a time instant at which the modulating video signal changes from black to white.

If the signal having the waveform shown in Fig. 2(B) is amplitude limited at levels shown by dotted lines in the same figure, the frequency of the amplitude limited signal will become very low in a time interval (T1+T2≒T), because the waveform does not cross over a straight centerline *L* within respective intervals T1 and T2. As a result of the lowering of the frequency of the frequency modulated video signal, in a demodulated video signal, a level of a portion which should be inherently of white level drops to a black level, as shown by dotted lin in Fig. 2(A). In a reproduced picture of a television receiver set for reproducing the demodulated video signal, a portion showing inherently "white" will show "black", whereby the inversion phenomenon will occur.

Referring back to Fig. 1, at the high-pass filter 16, the low frequency component of the frequency modulated video signal having the waveform shown in Fig. 2(B) is removed. Only the frequency modulated carrier component is passed through the high-pass filter 16. The thus passed frequency modulated carrier component is

corrected in phase in a phase corrector 18 and is thereafter supplied to a limiting amplifier 19. The phase corrector 18 operates to cause the phase of the signal passed through the high-pass filter 16 to coincide with the phase of the signal passed through the low-pass filter 17. The phase corrector may alternatively be provided at an input stage of the high-pass filter 16 or at an output stage of the limiting amplifier 19.

The modulated carrier component is amplitude limited and amplified in the limiting amplifier 19 and becomes a signal having a waveform as shown in Fig. 2(C). This signal component has been passed through the high-pass filter 16, and therefore its low frequency fluctuation component has been removed during the interval T. Accordingly, the signal waveform of Fig. 2(C) crosses over the centerline *L* even during the interval *T* and has sufficiently large amplitude. The output signal of the limiting amplifier 19 is supplied to an adder 20.

On the other hand, the signal shown in Fig. 2(B), which has been supplied to the low-pass filter 17, has its frequency modulated carrier component removed therein. The low frequency component including lower side bands of the frequency modulated video signal is passed through the low-pass filter 17. The thus passed signal has a waveform as shown in Fig. 2(D). Side bands are actually generated as a result of variations of the level of the video signal between black and white levels. However, for the sake of simplifying the description, Fig. 2(D) exemplifies a waveform accompanied by no sideband in the case where the video signal maintains its white level after it is instantaneously changed from black level to white level.

The waveform of Fig. 2(D) is in the form of a non-linear or curved line indicating a fluctuation of low frequency within the signal waveform of Fig. 2(B) during the time interval T, that is, a fluctuation of a centerline connecting intermediate points of amplitude width of respective waves. The output signal of the low-pass filter 17 is supplied to the adder 20.

The signal having the waveform shown in Fig. 2(C) and supplied from the limiting amplifier 19 and the signal having the waveform shown in Fig. 2(D) and supplied from the low-pass filter 17 are added or mixed in the adder 20. A signal having a waveform as shown in Fig. 2(E) is thereby derived from the adder 20. The output signal of the adder 20 is a signal wherein the side band component is added to the modulated carrier component. Therefore, the output signal has no lack or loss in quantity of the signal to be transmitted. As clearly shown in Fig. 2(E), the waveform of this output signal crosses over the straight centerline *L* even during the time interval T.

This output signal of Fig. 2(E) from the adder 20 is supplied to a limiter 21 and is amplitude limited therein at levels shown by dotted lines in the same figure. As a result, an output signal having a waveform as shown in Fig. 2(F) is derived from the limiter 21. This signal does not have any signal waveform portion which does not cross over the centerline *L* as in the signal indicated in Fig. 2(B).

The frequency modulated video signal which has been amplitude limited in the limiter 21 is demodulated in a demodulator 22. The thus demodulated video signal is derived from an output terminal 23 and is supplied to a television receiver set (not shown). Since the undesired low frequency fluctuation component has already been removed from the output signal of the limiter 21, the picture portion which should be "white" is reproduced exactly as "white" on the reproduced picture of the television receiver set. Accordingly, the inversion phenomenon does not occur.

In the above described embodiment of the invention, the high-pass filter 16 and the low-pass filter 17 have respectively relatively gentle decreasing or attenuating characteristics such as those of a general differential circuit or integration circuit. The cross-over frequency of the decreasing characteristics of both filters 16 and 17 is selected at a frequency corresponding to the lower limit frequency of the frequency modulated carrier, for example.

One embodiment of an actual circuit organization of the essential part of the block diagram illustrated in Fig. 1 is described below with reference to Fig. 3.

An input terminal 31 is supplied with the reproduced frequency modulated video signal from the dropout compensator 15. This applied input signal is supplied to the high-pass filter 16 which comprises resistors R1 though R3 and capacitors C1 and C2 and to the low-pass filter 17 which comprises resistors R17 and R18, capacitors C10 and C11, and a coil L1. The frequency modulated carrier component, which has been passed through the high-pass filter 16, is corrected in phase at the phase corrector 18 which comprises resistors R4 through R11, capacitors C3 and C4, and transistors Q1 and Q2, and is thereafter supplied to the limiting amplifier 19 which comprises resistors R12 through R16, capacitors C5 through C9, a transistor Q3, and an integrated circuit IC1. The modulated carrier component is amplitude limited and amplified in the limiting amplifier 19, as described hereinbefore. The output signal derived from sixth pin of

the integrated circuit IC1 is applied to the base of a transistor Q6 of the adder 20 through a resistor R30 and a capacitor C14. The adder 20 comprises resistors R19 through R30, capacitors C12 through C14, and transistors Q4 through Q6.

The signal component including the lower side bands which has passed through the low-pass filter 17 is applied to the base of the transistor Q5 through the transistor Q4 of the adder 20. Both signals thus supplied to the adder 20 are added at a point connecting the collectors of the transistors Q5 and Q6. The thus added output signal is supplied to an integration circuit IC2 of a circuit 32.

The circuit 32 operates both as the limiter 21 and as the demodulator 22. The circuit 32 comprises resistors R31 through R43 capacitors C15 through C24, a coil L2, the integrated circuit IC2, a transistor Q7, a delay line 33, and a low-pass filter 34. The signal supplied to the integrated circuit IC2 is there amplitude limited and thereafter demodulated. The output demodulated signal derived from eighth pin of the integrated circuit IC2 is supplied to a de-emphasis circuit which comprises resistors R36, R40, and R41, capacitors C21, C23, and C24, and the transistor Q7. The output signal from the de-emphasis circuit is rid of its unnecessary component in the low-pass filter 34 having the upper limit frequency of 3 MHz and is thereafter derived from an output terminal 35 as a demodulated reproduced signal.

In the case where the modulating video signal is a color video signal, the luminance signal component of the color video signal is passed through the amplitude limiting circuit according to the present invention.

WHAT WE CLAIM IS:—

1. An amplitude limiting circuit for a frequency modulated video signal which is liable from time-to-time to a transient of relatively low frequency or large time constant and substantial amplitude, additional to the normal band of relatively high frequencies, comprising:—

high-pass filtering means for passing the normal band of relatively high frequencies but not the transient;

first amplitude limiting means for limiting the amplitude of the band of relatively high frequencies passed by the high-pass filtering means;

low-pass filtering means for passing the transient of relatively low frequency or large time constant but not the band of relatively high frequencies;

adding means for adding the filtered transient (from the low-pass filtering means) to the filtered and amplitude-limited band of relatively high frequencies (from the first amplitude limiting means);

and second amplitude limiting means for limiting the amplitude of the resulting output of the adding means.

2. An amplitude limiting circuit as claimed in claim 1 and including means for supplying the frequency modulated signal which is liable to said transient additional to the normal band.

3. An amplitude limiting circuit as claimed in claim 1, wherein said high-pass filtering means has a filtering characteristic for passing substantially a carrier component of the frequency modulated video signal, and said low-pass filtering means has a filtering characteristic for passing substantially lower side band components of the frequency modulated video signal.

4. An amplitude limiting circuit as claimed in claim 1, wherein said high-pass filtering means and said low-pass filtering means have respectively decreasing characteristics having relatively gentle slopes which cross over each other, the crossing over frequency of both decreasing characteristics being selected at a frequency equal to a lower limit frequency of the frequency modulated video signal.

5. An amplitude limiting circuit as claimed in claim 1 which further comprises means for correcting a phase of a signal which has passed or will be passed through the high-pass filtering means thereby to cause the phase of the signal passed through the high-pass filtering means to coincide with the phase of the signal passed through the low-pass filtering means.

6. An amplitude limiting circuit substantially as described with reference to the accompanying drawings.

MARKS & CLERK,
Chartered Patent Agents,
57—60 Lincolns Inn Fields,
London WC2A 3LS,
Agents for the Applicant(s).

Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1978
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

the integrated circuit IC1 is applied to the base of a transistor Q6 of the adder 20 through a resistor R30 and a capacitor C14. The adder 20 comprises resistors R19 through R30, capacitors C12 through C14, and transistors Q4 through Q6.

The signal component including the lower side bands which has passed through the low-pass filter 17 is applied to the base of the transistor Q5 through the transistor Q4 of the adder 20. Both signals thus supplied to the adder 20 are added at a point connecting the collectors of the transistors Q5 and Q6. The thus added output signal is supplied to an integration circuit IC2 of a circuit 32.

The circuit 32 operates both as the limiter 21 and as the demodulator 22. The circuit 32 comprises resistors R31 through R43 capacitors C15 through C24, a coil L2, the integrated circuit IC2, a transistor Q7, a delay line 33, and a low-pass filter 34. The signal supplied to the integrated circuit IC2 is there amplitude limited and thereafter demodulated. The output demodulated signal derived from eighth pin of the integrated circuit IC2 is supplied to a de-emphasis circuit which comprises resistors R36, R40, and R41, capacitors C21, C23, and C24, and the transistor Q7. The output signal from the de-emphasis circuit is rid of its unnecessary component in the low-pass filter 34 having the upper limit frequency of 3 MHz and is thereafter derived from an output terminal 35 as a demodulated reproduced signal.

In the case where the modulating video signal is a color video signal, the luminance signal component of the color video signal is passed through the amplitude limiting circuit according to the present invention.

WHAT WE CLAIM IS:—

1. An amplitude limiting circuit for a frequency modulated video signal which is liable from time-to-time to a transient of relatively low frequency or large time constant and substantial amplitude, additional to the normal band of relatively high frequencies, comprising:—

high-pass filtering means for passing the normal band of relatively high frequencies but not the transient;

first amplitude limiting means for limiting the amplitude of the band of relatively high frequencies passed by the high-pass filtering means;

low-pass filtering means for passing the transient of relatively low frequency or large time constant but not the band of relatively high frequencies;

adding means for adding the filtered transient (from the low-pass filtering means) to the filtered and amplitude-limited band of relatively high frequencies (from the first amplitude limiting means);

and second amplitude limiting means for limiting the amplitude of the resulting output of the adding means.

2. An amplitude limiting circuit as claimed in claim 1 and including means for supplying the frequency modulated signal which is liable to said transient additional to the normal band.

3. An amplitude limiting circuit as claimed in claim 1, wherein said high-pass filtering means has a filtering characteristic for passing substantially a carrier component of the frequency modulated video signal, and said low-pass filtering means has a filtering characteristic for passing substantially lower side band components of the frequency modulated video signal.

4. An amplitude limiting circuit as claimed in claim 1, wherein said high-pass filtering means and said low-pass filtering means have respectively decreasing characteristics having relatively gentle slopes which cross over each other, the crossing over frequency of both decreasing characteristics being selected at a frequency equal to a lower limit frequency of the frequency modulated video signal.

5. An amplitude limiting circuit as claimed in claim 1 which further comprises means for correcting a phase of a signal which has passed or will be passed through the high-pass filtering means thereby to cause the phase of the signal passed through the high-pass filtering means to coincide with the phase of the signal passed through the low-pass filtering means.

6. An amplitude limiting circuit substantially as described with reference to the accompanying drawings.

MARKS & CLERK,
Chartered Patent Agents,
57—60 Lincolns Inn Fields,
London WC2A 3LS,
Agents for the Applicant(s).

Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1978
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.