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(54) COLOR VIDEO SIGNAL RECORDING AND/OR REPRODUCING SYSTEM

(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:—

10 This invention relates generally to color video signal recording and/or reproducing systems, and more particularly to a system for recording and reproducing with large signal to noise (S/N) ratio color burst signals of color video signals.

15 In general, it is necessary to carry out phase correction of a carrier chrominance signal in the reproduction system of a color video signal recording and reproducing system. In this case, the phase of the color burst signal within the reproduced signal is detected, and, with the use of the resulting detection output, the above mentioned phase correction is carried out.

25 Accordingly, in order to accomplish accurately and positively the above stated phase correction, it is necessary that the color burst signal be recorded and reproduced with a large S/N ratio and, moreover, in a stable manner.

30 Therefore, we have previously proposed a system in which an automatic gain control circuit is operated only in the periods where a color burst signal is present, and the color burst signal is recorded always at a constant level which is optimum for recording. However, in the case where the video signal introduced into this system is a black-and-white (monochrome) video signal, since a color burst signal does not exist, the high-frequency component of the monochrome video signal is amplified to an abnormally high level by an automatic gain control circuit, and a deleterious effect is produced in the luminance signal.

45 For this reason, it is necessary, in this system, to provide a so-called color-killer circuit for detecting the presence or absence of a color burst signal and cutting off the carrier chrominance signal transmission system at the time when there is no

color burst signal. However, the organization of this color-killer circuit is complicated, whereby the recording system cannot be produced at low cost. Furthermore, in the case where a monochrome video signal of small S/N ratio enters as input, a noise component is erroneously detected as a color burst signal, and the above mentioned color-killer circuit does not operate normally in spite of the introduction of a monochrome video signal.

65 Accordingly, as a system in which a color-killer circuit is not used, a system in which the peak value (maximum level value) of the entire chrominance signal at the time of recording is detected, and automatic chroma control (hereinafter referred to as ACC) is carried out, has been proposed. The ACC circuit in this system detects the peak value of the color burst signal thereby to carry out ACC operation in the case where the amplitude of the carrier chrominance signal is less than the amplitude of the color burst signal. Conversely, in the case where the amplitude of the carrier chrominance signal is greater than the amplitude of the color burst signal, the ACC circuit detects the peak value of the carrier chrominance signal thereby to carry out ACC operation. For this reason, the amplitude of the color burst signal is disadvantageously varied by the magnitude (saturation) of the amplitude of the carrier chrominance signal, and the amplitude of the color burst signal cannot be controlled continually at a constant amplitude, whereby color shading is produced.

85 Accordingly, we have solved the problems accompanying the previously conceived systems as described above and have devised the improved system of the present invention.

90 The present invention provides a color video signal recording system comprising: first separation means for separating a luminance signal from an input color video signal; means for frequency modulating said luminance signal thus separated; second separation means for separating a color burst signal and a carrier chrominance signal from said input color video signal; means for intensifying the amplitude of said color burst signal of said separated color burst signal

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and carrier chrominance signal relatively with respect to the amplitude of said carrier chrominance signal; automatic gain control means supplied with the color burst signal thus intensified in amplitude by said intensifying means and with the carrier chrominance signal not relatively intensified and operating to effect level control so that, as a whole, a specific level is not exceeded; first frequency conversion means for frequency converting the output signal of said automatic gain control means into a band which is lower than the band of said frequency-modulated luminance signal; and means for mixing and multiplexing said frequency-modulated luminance signal and the resulting output signal of said first frequency conversion means and recording the resulting mixed and multiplexed signal on a recording medium. The present invention further provides a color video signal reproducing system for reproducing a signal recorded by the above described recording system said reproducing system comprising: means for reproducing said mixed and multiplexed signal recorded on said recording medium; third separation means for separating the frequency-modulated luminance signal from the reproduced signal; means for demodulating the frequency-modulated luminance signal thus separated; fourth separation means for separating the frequency converted color burst signal and carrier chrominance signal from the reproduced signal; second frequency conversion means for frequency converting the signal thus separated by said fourth separation means into the original frequency band thereby to produce as output a color burst signal and a carrier chrominance signal; means for suppressing the amplitude of said color burst signal of the output color burst and carrier chrominance signals of said second frequency conversion means relatively with respect to the amplitude of said carrier chrominance signal; and means for mixing said luminance signal thus demodulated, said color burst signal of suppressed amplitude, and the carrier chrominance signal not relatively suppressed and deriving the resulting signal thus mixed as a reproduced color video signal.

It is a general object of the present invention to provide a novel and useful color video signal recording and/or reproducing system in which the above described difficulties have been overcome.

Another and more specific object of the invention is to provide a color video signal recording and reproducing system capable of recording and reproducing with high S/N ratio the color burst signal of a color video signal. In accordance with the invention, it has become possible to record and reproduce a color burst signal continually at a constant level and, moreover, with a large S/N ratio.

Furthermore, a color-killer circuit is not necessary.

Still another object of the invention is to provide a color video signal recording and reproducing system adapted to carry out an operation which comprises relatively intensifying the color burst signal of a color video signal, recording the color video signal after passing the entire chrominance signal through an ACC circuit, and, after reproducing the signal thus recorded, suppressing the color burst signal.

Other objects and further features of the invention will be apparent from the following detailed description when read in conjunction with the accompanying drawings, in which:—

Fig. 1 is a block diagram showing the general organization of one embodiment of the recording system of a color video signal recording and reproducing system according to the present invention;

Fig. 2(A) is a waveform chart of a luminance signal, and Figs. 2(B) and 2(C) are waveform charts respectively of a color burst signal and a carrier chrominance signal;

Fig. 3 is a block diagram showing the general organization of one embodiment of the reproducing system of the system according to the invention;

Fig. 4 is a circuit diagram showing one embodiment of a specific circuit organization in concrete form of a burst intensification circuit in the system shown in Fig. 1 and a burst suppression circuit in the system shown in Fig. 3; and

Figs. 5(A) and 5(B) are waveform charts respectively of signals applied to the circuits shown in Fig. 4.

In the recording system illustrated in Fig. 1, an input recording color video signal applied to an input terminal 10 is supplied to a low-pass filter 11 and a band-pass filter 15. The low-pass filter 11 thereby passes a luminance signal of a waveform as indicated in Fig. 2(A) which is frequency modulated by a frequency modulator 12. The resulting output frequency-modulated luminance signal is fed to a high-pass filter 13, where its unwanted components are removed, and is then supplied to a mixer 14.

On the other hand, a carrier chrominance signal and a color burst signal which have passed through the band-pass filter 15 are supplied to a burst intensification circuit 16. This burst intensification circuit 16 operates in response to a signal applied to a terminal 17 and described hereinafter to intensify the amplitude of only the color burst signal relatively with respect to the carrier chrominance signal. In the instant embodiment of the invention, this burst intensification circuit 16 increases the amplitude of only the color burst signal by two times, that is by 6dB. Accordingly, when a signal comprising a

color burst signal a and a carrier chrominance signal b of amplitudes as indicated in Fig. 2(B) is supplied to the burst intensification circuit 16, this circuit 16 produces as

output a signal comprising a color burst signal a^1 of an amplitude which is double that of the input signal and a carrier chrominance signal b of the same amplitude as the input signal as indicated in Fig. 2(C). The same video signal as that supplied through the input terminal is supplied through the input terminal 38 of the reproducing system shown in Fig. 3 and, passing through a video output circuit 36, is led out through an output terminal 37. This output signal is fed to a monitor receiver and reproduced on a monitor picture screen. Simultaneously, the output signal of the video output circuit 36 is supplied to a synchronizing signal separation circuit 39, and a synchronizing signal thus separated is supplied to a burst flag pulse generating circuit 40. Signals of mutually inverted phases are led out respectively from the output terminals 41a and 41b of the generating circuit 40. The signal led out of the output terminal 41a is supplied through the above mentioned terminal 17 to the burst intensification circuit 16.

The signal resulting from the intensification of the burst signal as indicated in Fig. 2(C) is supplied to a gain control circuit 18. The gain control circuit 18 operates automatically in response to the output signal of a level detector 19 for detecting the level of the output signal of the gain control circuit 18 to carry out gain control. The gain control circuit 18 and the level detector 19 constitute an ordinary ACC circuit 20. Here, the ACC circuit 20 carries out an ACC operation so that the color burst signal a^1 and the carrier chrominance signal b , in entirety, will be accommodated within a specific amplitude value.

In actual practice, even in the case where the carrier chrominance signal b is a color bar signal of the greatest amplitude in the signal indicated in Fig. 2(B), the amplitude of the color bar signal is of the order of twice the amplitude of the color burst signal a . For this reason, in the signal indicated in Fig. 2(C), the amplitude of the color burst signal a^1 intensified two times in amplitude is always of the same order as or greater than the amplitude of the carrier chrominance signal b . As a result, even after passing through the ACC circuit 20, the color burst signal a^1 is always recorded at the maximum level as described hereinafter.

Therefore, the color burst signal can be recorded and reproduced with double S/N ratio, that is, with a S/N ratio improved by 6 dB. Furthermore, even after passing through the ACC circuit 20, the amplitude of the color burst signal a^1 is always con-

stant, not being influenced by the amplitude of the carrier chrominance signal b , and for this reason, color shading does not occur in the reproduced signal.

The output signal of the gain control circuit 18 is supplied to a frequency converter 21, where it is frequency converted by an oscillation output from a local oscillator 22 to a frequency band which is lower than the band of the aforementioned frequency-modulated luminance signal. The resulting frequency converted output signal is then passed through a low-pass filter 23, where its unwanted component is removed, and is then supplied to the aforementioned mixer 14 thereby to be mixed and multiplexed with the above mentioned frequency-modulated luminance signal. The resulting output signal of the mixer 14 is amplified by a recording amplifier 24 is thereafter recorded by a recording head 25 on a recording medium 26.

Even in the case where a monochrome video signal is applied to the input terminal 10 instead of a color video signal, and, moreover, a high-frequency component such as noise of this monochrome video signal has passed through the band-pass filter 15, the ACC circuit 20 operates to detect the maximum level of this noise component and to carry out ACC operation thereby to prevent this maximum level from exceeding a specific level. Therefore, even if a color burst signal does not exist, an undesirable amplification of the noise component to an abnormally high level does not occur. Accordingly, there is no necessity of providing a color-killer circuit in the carrier chrominance signal transmission system.

Next, a reproducing system for reproducing a signal recorded in the above described manner will be described with reference to Fig. 3.

A signal recorded by the above described recording system on the recording medium 26 is reproduced by a reproducing head 30. The reproducing head 30 may be the same as the recording head 25. The reproduced signal is passed through a pre-amplifier 31 and then supplied to a high-pass filter 32 and a low-pass filter 42. The frequency-modulated luminance signal which has passed through the high-pass filter 32 is demodulated by a demodulator 33. The luminance signal thus demodulated is fed to a low-pass filter 34, where its unwanted component is removed, and is then supplied to a mixer 35.

On the other hand, the color burst signal and the carrier chrominance signal which have passed through the low-pass filter 42 are supplied to a gain control circuit 43 which is gain controlled in conformance with the detection output of a level detector 46. The gain control circuit 43 and the

level detector 46 constitute an ACC circuit 53. The output signal of the gain control circuit 43 is supplied to a frequency conversion circuit 44, where it is restored by frequency conversion to the original frequency band by the oscillation output of a voltage controlled oscillator (VCO) 48. The resulting output signal of the frequency converter 44 is fed to a band-pass filter 45, where its unwanted component is removed, and is then supplied to a burst suppression circuit 49 and, at the same time, to the level detector 46 and a phase detector 47. The resulting output of the phase detector 47 is fed to the VCO 48 to control the oscillation frequency thereof.

Thus, the frequency converter 44 carries out frequency conversion in conformance with the oscillation output of the VCO 48 the oscillation frequency of which is controlled by the output of the phase detector 47. For this reason, the color burst signal and the carrier chrominance signal are frequency converted by the frequency converter 44 and, at the same time, are phase corrected, the time base fluctuation component being removed.

The burst suppression circuit 49 operates in response to a signal applied through a terminal 50 to suppress the amplitude of only the color burst signal to a quantity ($\frac{1}{2}$ in the instant embodiment of the invention) corresponding to the intensification quantity in the aforescribed recording system thereby to restore this amplitude to the original amplitude. The carrier chrominance signal which has passed through the burst suppression circuit 49 and the color burst signal which has been suppressed in this circuit are passed through a color-killer circuit 51 and supplied to the aforementioned mixer 35, where they are mixed with the aforementioned demodulated luminance signal thereby to form a color video signal.

The output signal of the phase detector 47 is also supplied to a color-killer control voltage detector 52. This detector 52 operates when the reproduced signal is a monochrome signal, and a color burst signal is not supplied to the phase detector 47 to apply a killer voltage to the color-killer circuit 51 thereby to open this circuit.

The reproduced color video signal from the mixer 35 passes through the aforementioned video output circuit 36 and is supplied through the output terminal 37 to a television receiver to be reproduced as a picture. On the other hand, the output signal of the video output circuit 36 is supplied also to the synchronizing signal separation circuit 39, and the signal from the output terminal 41b of the burst flag pulse generating circuit 40 is applied to the aforementioned terminal 50.

While, in the above described embodiment of the invention, the recording system shown in Fig. 1 is so adapted that, in the intensifying of the burst signal in the burst intensification circuit 16, the amplitude of the color burst signal itself is increased, the recording system may be so adapted that the color burst signal is maintained as it is, and the amplitude of the carrier chrominance signal is suppressed. The essential requirement is that the amplitude of the color burst signal be increased relative to the amplitude of the carrier chrominance signal. Accordingly, while the reproducing system shown in Fig. 3, also, is adapted to suppress only the color burst signal, it may be so adapted that the color burst signal is maintained as it is, while the carrier chrominance signal is increased thereby to cause the color burst signal to be suppressed relative to the carrier chrominance signal.

One embodiment of a specific circuit in concrete form of a burst intensification circuit 16 and the burst suppression circuit 49 operating in this manner is illustrated in Fig. 4. The circuit organizations of the burst intensification circuit 16 and the burst suppression circuit 49 are exactly the same, and the signal applied to the terminal 17 (or 50) differs. In the case of the burst intensification circuit 16 in the recording system, a color burst signal and a carrier chrominance signal from the band-pass filter 15 are supplied to an input terminal 60. These signals pass through transistors 61 and 62 and are led to an output terminal 64, then being supplied to the ACC circuit 20. Between the emitter of the transistor 61 and the base of the transistor 62, there is connected a resistor 65. Between a junction between this resistor 65 and the base of the transistor 62 and ground (earth), a resistor 66 and a field-effect transistor (FET) 63 are connected in series. The aforementioned terminal 17 is connected to the gate of the FET 63.

A signal of low level L in a color burst signal period B.S and of high level H in other periods as indicated in Fig. 5(A), which signal has been led out of the aforementioned terminal 41a, is applied to the terminal 17. As a consequence, during the color burst signal period B.S, the FET 63 becomes "OFF", and the carrier chrominance signal is led out with its amplitude unchanged through the output terminal 64.

Then, in periods other than the color burst signal period, the FET 63 becomes "ON". Here, the internal resistance of the FET 63 in its conductive state is approximately $180\ \Omega$, and the resistance values of the resistors 65 and 66 are selected at $1\ \text{K}\Omega$ and $820\ \Omega$, respectively. Consequently, when the FET 63 is "ON", the carrier chrominance signal is voltage divided by the

resistance value (1 K Ω) of the resistor 65 and the sum (1 K Ω) of the resistance value of the resistor 66 and the internal resistance value of the FET 63, and its amplitude is halved and led out through the output terminal 64. Therefore, since the amplitude of the carrier chrominance signal is suppressed to $\frac{1}{2}$, while, in contrast, the amplitude of the color burst signal is maintained as it is, the resultant effect is that the amplitude of the color burst signal has been intensified by two times relative to the amplitude of the carrier chrominance signal.

In the case where the circuit shown in Fig. 4 is used as the burst suppression circuit 49 in the reproducing system, a signal from the band-pass filter 45 is applied to the terminal 60, and a signal as indicated in Fig. 5(B) which has been led out of the aforementioned terminal 41b is applied to the terminal 50 of the same position as the terminal 17. A signal applied to the terminal 50 has a relationship of inverted phase relative to a signal applied to the terminal 17, and the color burst signal period B.S. is at a high level H, while the other periods are at a low level L. Consequently, during the color burst signal period B.S., the FET 63 is in its conductive state, and the amplitude of the color burst signal is suppressed to $\frac{1}{2}$. During other periods, the FET 63 is in its nonconductive state, and the carrier chrominance signal is led out with its amplitude as it is. Therefore, the color burst signal is suppressed in amplitude to $\frac{1}{2}$ relatively with respect to the carrier chrominance signal.

Since a color burst signal recorded and reproduced by the system of the present invention as described above is improved in S/N ratio by 6 dB, for example, jitter corrected through the use of this color burst signal is also improved by 6 dB.

Further, this invention is not limited to these embodiments but various variations and modifications may be made without departing from the scope and spirit of the invention.

50 WHAT WE CLAIM IS:—

1. A color video signal recording system comprising:

55 first separation means for separating a luminance signal from an input color video signal;

means for frequency modulating said luminance signal thus separated;

60 second separation means for separating a color burst signal and a carrier chrominance signal from said input color video signal;

65 means for intensifying the amplitude of said color burst signal of said separated color burst signal and carrier chrominance

signal relatively with respect to the amplitude of said carrier chrominance signal;

automatic gain control means supplied with the color burst signal thus intensified in amplitude by said intensifying means and with the carrier chrominance signal not relatively intensified and operating to effect level control so that, as a whole, a specific level is not exceeded;

75 first frequency conversion means for frequency converting the output signal of said automatic gain control means into a band which is lower than the band of said frequency-modulated luminance signal; and

80 means for mixing and multiplexing said frequency-modulated luminance signal and the resulting output signal of said first frequency conversion means and recording the resulting mixed and multiplexed signal on a recording medium.

2. A color video signal recording system as claimed in claim 1 in which said intensifying means intensifies the amplitude of said color burst signal to a value which is two times relative to the amplitude of said carrier chrominance signal.

3. A color video signal recording system as claimed in claim 1 in which said intensifying means operates to intensify the amplitude of said color burst signal and to pass said carrier chrominance signal with the amplitude thereof maintained unchanged as it is.

4. A color video signal recording system as claimed in claim 1 in which said intensifying means operates to pass said color burst signal with the amplitude thereof maintained unchanged as it is and to suppress the amplitude of said carrier chrominance signal.

5. A color video signal reproducing system for reproducing a signal recorded by the recording system as claimed in claim 1, said reproducing system comprising:

means for reproducing said mixed and multiplexed signal recorded on said recording medium;

115 third separation means for separating the frequency-modulated luminance signal from the reproduced signal;

means for demodulating the frequency-modulated luminance signal thus separated;

120 fourth separation means for separating the frequency converted color burst signal and carrier chrominance signal from the reproduced signal;

125 second frequency conversion means for frequency converting the signal thus separated by said fourth separation means into the original frequency band thereby to produce as output a color burst signal



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resistance value (1 K Ω) of the resistor 65 and the sum (1 K Ω) of the resistance value of the resistor 66 and the internal resistance value of the FET 63, and its amplitude is halved and led out through the output terminal 64. Therefore, since the amplitude of the carrier chrominance signal is suppressed to $\frac{1}{2}$, while, in contrast, the amplitude of the color burst signal is maintained as it is, the resultant effect is that the amplitude of the color burst signal has been intensified by two times relative to the amplitude of the carrier chrominance signal.

In the case where the circuit shown in Fig. 4 is used as the burst suppression circuit 49 in the reproducing system, a signal from the band-pass filter 45 is applied to the terminal 60, and a signal as indicated in Fig. 5(B) which has been led out of the aforementioned terminal 41b is applied to the terminal 50 of the same position as the terminal 17. A signal applied to the terminal 50 has a relationship of inverted phase relative to a signal applied to the terminal 17, and the color burst signal period B.S. is at a high level H , while the other periods are at a low level L . Consequently, during the color burst signal period B.S., the FET 63 is in its conductive state, and the amplitude of the color burst signal is suppressed to $\frac{1}{2}$. During other periods, the FET 63 is in its nonconductive state, and the carrier chrominance signal is led out with its amplitude as it is. Therefore, the color burst signal is suppressed in amplitude to $\frac{1}{2}$ relatively with respect to the carrier chrominance signal.

Since a color burst signal recorded and reproduced by the system of the present invention as described above is improved in S/N ratio by 6 dB, for example, jitter corrected through the use of this color burst signal is also improved by 6 dB.

Further, this invention is not limited to these embodiments but various variations and modifications may be made without departing from the scope and spirit of the invention.

WHAT WE CLAIM IS:—

1. A color video signal recording system comprising:

first separation means for separating a luminance signal from an input color video signal;

means for frequency modulating said luminance signal thus separated;

second separation means for separating a color burst signal and a carrier chrominance signal from said input color video signal;

means for intensifying the amplitude of said color burst signal of said separated color burst signal and carrier chrominance

signal relatively with respect to the amplitude of said carrier chrominance signal;

automatic gain control means supplied with the color burst signal thus intensified in amplitude by said intensifying means and with the carrier chrominance signal not relatively intensified and operating to effect level control so that, as a whole, a specific level is not exceeded;

first frequency conversion means for frequency converting the output signal of said automatic gain control means into a band which is lower than the band of said frequency-modulated luminance signal; and

means for mixing and multiplexing said frequency-modulated luminance signal and the resulting output signal of said first frequency conversion means and recording the resulting mixed and multiplexed signal on a recording medium.

2. A color video signal recording system as claimed in claim 1 in which said intensifying means intensifies the amplitude of said color burst signal to a value which is two times relative to the amplitude of said carrier chrominance signal.

3. A color video signal recording system as claimed in claim 1 in which said intensifying means operates to intensify the amplitude of said color burst signal and to pass said carrier chrominance signal with the amplitude thereof maintained unchanged as it is.

4. A color video signal recording system as claimed in claim 1 in which said intensifying means operates to pass said color burst signal with the amplitude thereof maintained unchanged as it is and to suppress the amplitude of said carrier chrominance signal.

5. A color video signal reproducing system for reproducing a signal recorded by the recording system as claimed in claim 1, said reproducing system comprising:

means for reproducing said mixed and multiplexed signal recorded on said recording medium;

third separation means for separating the frequency-modulated luminance signal from the reproduced signal;

means for demodulating the frequency-modulated luminance signal thus separated;

fourth separation means for separating the frequency converted color burst signal and carrier chrominance signal from the reproduced signal;

second frequency conversion means for frequency converting the signal thus separated by said fourth separation means into the original frequency band thereby to produce as output a color burst signal

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and a carrier chrominance signal;
means for suppressing the amplitude
of said color burst signal of the output
color burst and carrier chrominance signals
of said second frequency conversion
means relatively with respect to the amplitude
of said carrier chrominance signal;
and
means for mixing said luminance signal
thus demodulated, said color burst signal
of suppressed amplitude, and the carrier
chrominance signal not relatively suppressed
and deriving the resulting signal
thus mixed as a reproduced color video
signal.

6. A color video signal reproducing system
as claimed in claim 5, said reproducing
system reproducing a signal recorded by the
recording system claimed in claim 2, in
which said suppression means suppresses the
amplitude of said color burst signal to $\frac{1}{2}$
relatively with respect to the amplitude of
said carrier chrominance signal.

7. A color video signal reproducing system
as claimed in claim 5 in which said suppression
means has the same circuit organ-

ization as said intensifying means and, moreover,
is supplied with an operation control
signal of a phase opposite to that of an
operation control signal supplied to said intensifying
means.

8. A color video signal reproducing system
as claimed in claim 5 in which said second
frequency conversion means comprises a frequency
converter supplied with the output of said
fourth separation means, means for phase
detecting the output signal of said frequency
converter, and variable frequency oscillation
means operating at an oscillation frequency
controlled by the output of said phase
detecting means and supplying the resulting
oscillation output thereof to said frequency
converter.

9. A color video signal recording and/or
reproducing system substantially as described
with reference to the accompanying
drawings.

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