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Specification

In video recorders, it is known to record the video signal by frequency modulation of a picture carrier, on so-called oblique tracks which extend obliquely to the longitudinal direction of the tape at an angle of about 6° . In the course of this, one field is preferably recorded along each such oblique track. Recording and scanning are effected with two heads which each scan the oblique tracks alternately.

In such equipment, the sound signal is recorded and scanned by a stationary head, on a longitudinal track extending parallel to the edge of the tape and having a width of about 1 mm. Thus for the recording and scanning of the sound signal, it is the translational speed of the tape and not the considerably higher relative speed between head and tape on the oblique tracks which is decisive. In practice, the translational speed of the tape has been reduced to values of the order of magnitude of 2 cm/s in order to increase the total playing time of a tape. This low relative speed between the tape and the sound head has a disadvantageous influence on the quality of the sound signal recorded. A hi-fi quality can practically no longer be achieved at this low relative speed. The recorded sound signal only has a bandwidth of about 70 Hz to 7-10 KHz. Because of the narrow width of the longitudinal track, there is also a relatively poor signal-to-noise ratio. This becomes even worse during the recording of

two sound signals for stereo reproduction, as a result of the halving of the width of the longitudinal track which then becomes necessary.

In itself, it is conceivable to record the sound signal together with the picture carrier on the oblique tracks, as on a video disc. Nevertheless, it has hitherto not been possible to realize such a solution successfully in practice. On the one hand, the available frequency range is already fully utilized. The range of about 1-1.3 MHz is taken up by the quadrature-modulated chrominance carrier reduced in frequency and the rest of the frequency range is taken up by the frequency spectrum of the modulated picture carrier. Recording of a sound carrier in the narrow gaps in frequency still present between the modulated chrominance carrier and the frequency spectrum of the picture carrier is practically impossible as a result of the necessary steep filter flanks for the chrominance carrier and the picture carrier because of the errors which occur in phase delay and envelope delay. On the other hand, when the sound signal is recorded on the oblique tracks, a considerable disturbance occurs as a result of the change of heads during the reproduction. The change of heads is not disturbing during the picture reproduction because it is effected during the field blanking intervals. During the reproduction of the sound signal, however, this change of heads is audible as a disturbing noise because the scanning of the sound signal, modulated on a carrier for example, from the tape is briefly interrupted each time with 50 Hz as a result of the change of heads. The resulting needle-shaped interference pulses with a fundamental frequency of 50 Hz and a high proportion of harmonics produce a continuous disturbing noise during the sound reproduction.

One possibility of reducing disturbances during the change of heads is described in US-A-3 346 702. A continuous signal, frequency-modulated on a carrier, is recorded

in the form of a transverse recording with overlapping recording tracks on a magnetic tape by means of a plurality of magnetic heads. During the reproduction, in order to reduce switching disturbances as a result of switching over from one magnetic head to the next, the frequency-modulated signals are conveyed through switches in such a manner that the frequency-modulated signals of the one track are switched over in relation to those of the other track with a delay in time which lies within the overlapping range of the recording tracks. After the demodulation of the individual track components with interference components staggered in time in relation to one another, the continuous signal is re-assembled in a further switch by selection of the undisturbed signal components of the two tracks.

This possibility of reducing disturbances by means of such a switching over is very expensive since, on the one hand, the frequency-modulated signal of the one track has to be switched over with a delay in time and on the other hand, the demodulated signal has to be re-assembled to form one signal from two signals suffering from interference components, at the correct moment.

Another possibility of reducing disturbances due to the change of heads is described by the inventor of this Application in the Application EP-A-61050 (published on the 29.9.82), in which, in a video recorder with helical recording of the video signals by a plurality of rotating magnetic heads, the sound signal is likewise recorded on the oblique tracks by means of the same magnetic heads. Disturbances in the sound signal through the change of heads are reduced in that the head output signals are brought to different amplitudes, for example by amplification of only one of the two head output signals, before the sound FM demodulators, and are then added.

It is the object of the invention to reduce the disturbances occurring in the sound during the reproduction, as a result of the change of heads, during the recording

of the sound signal on the track of the picture carrier, in a further simple circuit arrangement.

This problem is solved by the invention described in Claim 1. Advantageous further developments of the invention are described in the sub-claims.

The invention is based on the following considerations and knowledge. When the necessary switching over between the two video heads is effected in the path of the scanned FM sound carrier, there are inevitable shifts in phase in the signal at the inputs of the single FM demodulator. Such shifts in phase are recorded as signals in an FM demodulator and produce a disturbance in the a.f. signal at the output. Since this disturbance is repeated at a frequency of 50 Hz, an audible clicking results in the reproduced sound signal. This disturbance occurs even when the switching over is effected satisfactorily and in an extremely short time. A switching-over in the a.f. signal can be carried out, however, without a disturbance becoming audible during the reproduction as a result. Such a switching-over is possible with ordinary commercial switch components such as integrated switching circuits for example, and is used in studio technology, for example to mix in a replacement signal in the event of drop-out disturbances. The said disturbances as a result of a shift in phase no longer occur because no switching over is effected in the path of the sound carrier and the switching-over in the a.f. signal is effected at a moment when both video heads are delivering an uninterrupted sound carrier as a result of the overlapping in their scanning times and thus both FM demodulators are delivering an uninterrupted a.f. sound signal.

It is true that the expenditure on circuitry is increased as a result of the fact that altogether two FM demodulators are necessary for one sound signal. This additional expenditure can, however, be kept low by the

use of integrated switching circuits. The invention can be used independently of the recording system, that is to say with the VHS system, with the Betamax system, with the video 2000 system and also further systems with helical recording with a plurality of video heads. A signal-to-noise ratio of > 50 dB can be achieved by the invention. This means that the change of heads no longer produces any audible disturbance during the sound reproduction.

One example of embodiment of the invention is explained with reference to the drawing. In this:

Figure 1 shows a block circuit diagram for the recording;

Figure 2 shows a block circuit diagram for the reproduction;

Figure 3 shows curves to explain the mode of operation of the circuit shown in Figure 2 and

Figure 4 shows a circuit which has been tried out in practice for realizing the a.f. switching-over for two recorded sound signals.

In Figure 1, the colour video signal is supplied from the terminal 1 to the amplifier 2. The modulated PAL chrominance carrier F of 4.43 MHz is evaluated by the filter 3 and reduced to a frequency of 0.63 MHz in the frequency converter 4. This chrominance carrier F reaches the adding stage 5. The luminance signal Y is evaluated by the low-pass filter 6 and modulated on a carrier in the FM modulator 7. This signal likewise reaches the adding stage 5. The output signal of the adding stage 5 is supplied to the filter 8. This filter contains a band-pass 9 for the chrominance carrier F reduced in frequency and a band-pass 10 for the picture carrier modulated with the signal Y. The band-pass 10 includes a stop position 11 at 1.92 MHz and a further stop position 12 at 2.17 MHz. The output of the filter 10 is connected to an input of the adding stage 11, the output of which is connected to the series connection of the two video heads 12, 13. The video heads 12, 13 record the signal alternately from field to field on tracks which extend obliquely to the edge of the

tape at an angle of 6° .

A sound signal NF1 is supplied to the FM demodulator 16 via a preemphasis stage 15 serving to emphasize the high frequencies and having a time constant of $50 \mu s$. This FM modulator produces a sound carrier frequency-modulated with NF1 and having the frequency of 1.92 MHz and a deviation of ± 50 KHz. This second sound carrier likewise reaches the adding stage 11. Thus altogether, the chrominance carrier F reduced in frequency in the band-pass 9 of the filter 10, the picture carrier frequency-modulated with the signal Y in the band-pass 10, the sound carrier modulated with NF1 in the stop band 11 of the filter 8 and the sound carrier frequency-modulated with NF2 in the stop band 12 of the filter 8 are recorded on the tape. The stop positions 11, 12 serve to reserve the frequency ranges taken up by the sound carriers in the modulated picture carrier and to reduce a disturbance of the sound by the picture signal. The filter 8 is preferably realized by notch filters. Supplying the chrominance carrier F to the modulated picture carrier before the filter 8 has the following advantage. In itself, the chrominance carrier F only occupies the frequency range which is indicated by the pass band 9 of the filter 8, that is to say a frequency range of 0.63 MHz ± 500 KHz. In practice, however, this modulated chrominance carrier also has frequency components which are higher and come within the frequency range which is occupied by the two sound carriers. As a result, the chrominance carrier can cause disturbances in the sound. In the circuit illustrated, such frequency components of the chrominance carrier F are eliminated again in the region of the stop positions 11, 12. In principle, however, the chrominance carrier F may also be supplied directly to the adding stage 11 via the line 19. Then the filter 8 does not need to have the pass band 9.

Figure 2 shows a reproduction circuit for the signal recorded according to Figure 1. The signals from the

two video heads 12, 13 arrive via preamplifiers 15, 16 at the two inputs of the change-over switch 17. This is actuated from the head-switching control unit 18 by the head-change pulse 19 at the beginning of each field and delivers a continuous signal at its output. From this, the chrominance carrier F is evaluated by the low-pass filter 18, converted back to the original PAL chrominance-carrier frequency of 4.43 MHz in the frequency converter 19 and supplied to the adding stage 21 via the band-pass filter 20. The modulated picture carrier is evaluated by the filter 22 in the pass band 10 of Figure 1. The pass curve of the filter 22 again includes two stop positions at the frequencies 1.92 MHz and 2.17 MHz. The picture carrier reaches the FM demodulator 23 which delivers the luminance signal Y to the adding stage 21 via the low-pass filter 24. Thus the colour video signal for the picture reproduction appears at the output of the adding stage 21.

The outputs of the preamplifiers 15, 16 are also taken to two selective amplifiers 25, 26 which are tuned to the frequency of 1.92 MHz. The selectively evaluated sound carriers reach two FM demodulators 27, 28. Thus the demodulator 27 delivers the sound signal NF1a from the video head 12 and the demodulator 28 the sound signal NF1b from the video head 13. Lying in the path of these a.f. sound signals is the change-over switch 29 which is likewise actuated by the head-change pulse. The change-over switch 29 delivers the continuous sound signal NF1 which comes from the video head 12 and from the video head 13 alternately from field to field. This signal is conveyed via the de-emphasis stage 30 with a time constant of 50 μ s and appears at the terminal 31 as the corrected sound signal NF1 which no longer has any disturbances as a result of the change of heads.

In the same manner, the continuous sound signal NF2 is obtained at the terminal 38 by means of the amplifiers

32, 33 and the correspondingly tuned FM demodulators 34, 35 as well as the change-over switch 36 and the de-emphasis stage 37. The signals NF1, NF2 are a stereo sound signal. They may also represent a sound signal in different languages.

Figure 3a shows the modulated picture carrier at the output of the change-over switch 17 for successive fields which each have a duration of 20 ms. The areas illustrated, which are hatched alternately horizontally and vertically, therefore correspond to parcels of picture carriers which come alternately from the two video heads 12, 13. The signal according to Figure 3a results from a hard switching-over in the change-over switch 17. Such a hard switching-over in the path of the carrier-frequency signal is not disturbing for the picture reproduction because, during this time, namely the field blanking time, no picture reproduction takes place. A noise signal would result, however, for the sound reproduction. Figure 3b shows the modulated sound carrier at the output of the amplifier 25 and Figure 3c the modulated sound carrier at the output of the amplifier 26. The scanning by the video heads 12, 13 has an overlapping region so that for a period of about 1 ms there is a sound carrier present from the head 12 and also a sound carrier from the head 13. The a.f. signal according to Figure 3d results through demodulation of the sound carrier according to 3b and the a.f. signal according to Figure 3e results through demodulation of the sound carrier according to 3c. Thus the a.f. signals obtained likewise have an overlapping region. At each of the moments t_1 , t_2 , t_3 , t_4 ...the switching-over with the change-over switch 29 is effected. Here, therefore, a hard change-over, without inertia, between the a.f. signals according to Figure 3d and Figure 3e is effected. As a result, a continuous a.f. sound signal according to Figure 3f ensues, which is available at the terminal 31 and does not contain any noise signals which are audible during the sound reproduction. The same applies to the processing of the sound signal NF2.

Figure 4 shows a construction for the change-over switches 29 and 36 in Figure 2. The signals NF1a, NF1b, NF2a and NF2b are applied, in the manner illustrated, to an integrated circuit of the type MC 14066 acting as a switch. In addition, this is controlled by the two head-change pulses 19a and 19b in phase opposition. The pulses 19a cause the switching-over in the path of the signal NF1 corresponding to the switch 29 in Figure 2 and the pulses 19b cause the switching-over in the path of the signal NF2 corresponding to the switch 36 in Figure 2. An IC of the type MC 14066 B of Messrs. Motorola may be used, for example, as an integrated switching circuit.

Patent Claims

1. A video recorder with improved recording of the sound signal, wherein a picture carrier frequency-modulated with the video signal and a sound carrier frequency-modulated with the sound signal and lying within the frequency spectrum of the picture carrier are recorded on oblique tracks of the recording medium by two video heads (12, 13) alternating periodically, while both video heads (12, 13) are effective at the same time in overlapping zones and, during the reproduction, the output signals of the two video heads (12, 13) are applied on the one hand to the video signal path (17-24) and on the other hand to the sound signal path (25-31; 32-38) and a switching-over (17) is effected in the video signal path between the signals coming from the video heads (12, 13) at moments during the overlapping ranges, characterised in that, during the reproduction, in order to reduce disturbances in the sound as a result of the change of heads, the sound carriers (Figures 3b,c) delivered by the video heads (12, 13) are first applied continuously to two separate FM demodulators (27, 28; 34,35), then a switching-over (29; 36) is effected after the demodulators in the a.f. path and the switching-over is carried out by the same head-change pulse (19) which switches over the path of the modulated picture carrier between the video heads (12,13) in the overlapping range in the video signal path.



16

- 11 -

Figure 4 shows a construction for the change-over switches 29 and 36 in Figure 2. The signals NF1a, NF1b, NF2a and NF2b are applied, in the manner illustrated, to an integrated circuit of the type MC 14066 acting as a switch. In addition, this is controlled by the two head-change pulses 19a and 19b in phase opposition. The pulses 19a cause the switching-over in the path of the signal NF1 corresponding to the switch 29 in Figure 2 and the pulses 19b cause the switching-over in the path of the signal NF2 corresponding to the switch 36 in Figure 2. An IC of the type MC 14066 B of Messrs. Motorola may be used, for example, as an integrated switching circuit.

Patent Claims

1. A video recorder with improved recording of the sound signal, wherein a picture carrier frequency-modulated with the video signal and a sound carrier frequency-modulated with the sound signal and lying within the frequency spectrum of the picture carrier are recorded on oblique tracks of the recording medium by two video heads (12, 13) alternating periodically, while both video heads (12, 13) are effective at the same time in overlapping zones and, during the reproduction, the output signals of the two video heads (12, 13) are applied on the one hand to the video signal path (17-24) and on the other hand to the sound signal path (25-31; 32-38) and a switching-over (17) is effected in the video signal path between the signals coming from the video heads (12, 13) at moments during the overlapping ranges, characterised in that, during the reproduction, in order to reduce disturbances in the sound as a result of the change of heads, the sound carriers (Figures 3b,c) delivered by the video heads (12, 13) are first applied continuously to two separate FM demodulators (27, 28; 34,35), then a switching-over (29; 36) is effected after the demodulators in the a.f. path and the switching-over is carried out by the same head-change pulse (19) which switches over the path of the modulated picture carrier between the video heads (12,13) in the overlapping range in the video signal path.



(17)

- 12 -

2. A recorder according to Claim 1, characterised in that, during the recording, a filter (8) having a stop position (11, 12) at the frequency of the sound carrier or each of a plurality of sound carriers, lies in the path of the modulated picture carrier.

3. A recorder according to Claim 2, characterised in that a modulated chrominance carrier (F) is added to the modulated picture carrier before the filter (8) and the filter (8) has a passband (9) for the chrominance carrier (f) and its side bands.

4. A recorder according to Claim 1, characterised in that two sound carriers which are displaced in frequency in relation to one another are recorded for the recording of a stereo signal.

5. A recorder according to Claim 1, characterised in that the change-over switches (29, 36) are constructed in the form of integrated switching circuits. (Figure 4).

Figure 1

Colour video signal

Figure 2

Colour video signal
Switching-over of heads