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Specification

In a video recorder, for example on the VHS recording system, the signals of the fields succeeding one another in time are recorded by two rotating video heads on so-called oblique tracks which extend obliquely to the edge of the magnetic tape at an angle of about 6° . During this, one field is recorded on an oblique track from one edge of the tape to the opposite edge of the tape each time. The adjacent tracks are recorded without any spacing apart, that is to say without any so-called lands.

In order to reduce the crosstalk between adjacent tracks in this case, it is known (DE-OS 3 011 635) to provide the two video heads, which each record a field alternately in time and are then inoperative for the next field, with different azimuth angles. This means that the gap of the magnetic heads relative to the transverse direction of the tracks is offset by $+6^\circ$ in one head and by -6° in the other head. Because of the so-called azimuth losses on deviation between the direction of the head gap and the direction of magnetization, a high crosstalk attenuation is achieved between neighbouring tracks. When the first video head is running on the track associated with it, at the correct azimuth angle, it picks up practically no signal from the adjoining track with the other azimuth angle.

In order that the video heads may always follow the oblique track precisely and also run on the track with the correct azimuth angle during the scanning, the tracks are marked by a 25 Hz pulse train which is recorded on a longitudinal track extending along one edge of the tape. By comparison of this pulse train scanned by a stationary head with a pulse train derived from the head wheel, the phase position of the head wheel carrying the video heads is controlled so that one head at a time runs on the track associated with it.

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It is also known (DE-AS 1 277 900) to record a carrier frequency-modulated with a sound signal on the said oblique tracks in addition to the picture carrier. This solution has the advantages that no separate longitudinal track is necessary at the edge of the tape for the recording of the a.f. sound signal, a larger bandwidth is available for the sound recording and so a higher sound quality and a greater crosstalk attenuation between a plurality of recorded sound signals are achieved.

With the oblique-track recording described, it is also known to carry out a reproduction at a speed differing from the normal speed by altering the forward speed of the magnetic tape and so to reproduce the picture in quick-motion or slow-motion operation. This is possible because the signals of the successive fields lie immediately beside one another on the said oblique tracks and so the video head encounters practically the same picture element of the following or preceding field on changing over from one track to the other.

Nevertheless, a disadvantage arises during the described scanning with altered forward speed of the magnetic tape. The video head only follows the recording track associated with it precisely if the magnetic tape is moved in the longitudinal direction at its normal speed. If this speed differs from its normal value, the video head must necessarily slide from one track to adjacent tracks. This means that, in contrast to the normal scanning, the video head also scans tracks with the wrong azimuth angle. Then the amplitude of the scanned signal becomes practically equal to zero. Thus the amplitude of the scanned signal fluctuates depending on the extent to which the video head is on the track with the correct azimuth angle and on the track with the wrong azimuth angle. This fluctuation in amplitude can lead to disturbances in the picture reproduction. In particular, the signal-to-noise ratio is reduced during the

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picture reproduction by the fluctuations in amplitude and the drops in amplitude in the scanned carrier.

It is known (IEEE Transaction on Consumer Electronics Vol. CE-26, February 1980, pages 121-128), during a reproduction wherein the magnetic tape is transported in its longitudinal direction at a speed differing from the normal speed, to offset the track covered by the video head in relation to the recorded track by such a geometrical amount in the longitudinal direction of the tape that the video head scans as large an area as possible of the recorded track at the azimuth angle associated with the video head. As a result of the displacement, the maximum of the amplitude of the scanned signal is substantially situated in the middle of an oblique track each time and hence in the middle of the picture where disturbances would be most noticeable.

It is the object of the invention to provide a recording of the sound signal in addition, in a video recorder of the kind last described, wherein an almost undistorted quick-motion and/or slow-motion reproduction is possible also for the sound without the frequencies of the sound signal being falsified.

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

In the earlier European Patent Applications 63 737, 61 050, 66 067 and 68 188, video recorders are described wherein one or more sound carriers are recorded together with a picture carrier frequency-modulated with the video signal along the whole length of the oblique tracks in each case and the frequencies of the sound carriers lie in a range from 1.7 - 1.9 MHz. The problem of rendering possible an undistorted sound reproduction with quick-motion or slow-motion reproduction is not dealt with there, however.

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In addition, no suggestion is made there that, in the selection of the frequencies of the sound carriers, the azimuth losses dependent on frequency should be taken into consideration in the sense that during the reproduction, a crosstalk attenuation causing the undistorted sound reproduction occurs between adjacent tracks for the sound carriers.

The quick-motion and/or slow-motion reproduction achieved for the sound without alteration of the frequency position of the sound signal can be explained as follows. Since the scanning of an oblique track only lasts 20 ms, in practice a whole syllable such as "nach" for example, of the sound signal is not recorded on one oblique track but only a vowel such as "a" for example or only a fraction of a vowel. Thus if such an oblique track is scanned several times, the result during the sound reproduction is not a meaningless or disturbing repetition of a whole syllable but merely a repetition of a vowel or of a consonant. This means that, for example the vowel "a" in the syllable "nach" is scanned several times and so the whole sound reproduction is extended. A slowed-down, understandable reproduction of speech then results during the reproduction. Since the relative speed between the video head and the oblique track remains practically unaltered despite the change in the speed of the magnetic tape in its longitudinal direction, the frequency of the scanned carrier is practically unaltered so that the frequency demodulation of the recorded carrier functions without alteration. Therefore, the vocal pitch of the sound is also retained and is not distorted as in a tape recorder with faster or slower scanning. Such a reproduction of the sound at increased or reduced speed with a correct vocal pitch otherwise requires great expenditure on circuitry in the form of bucket brigade devices and the like. This slowed-down or accelerated sound reproduction is

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advantageous in practice, for example in the event of too rapid a method of speaking when the sound signal is being recorded, for speech analysis or for teaching purposes. This principle is described in more detail in DE-PS 721 198.

In addition, the frequency position of the sound carriers according to the invention has the advantage that the sound carrier or carriers lie within a range in which the frequency response of the video head has a maximum, whereas the frequency response has already dropped greatly in the range of about 0.5-1.0 MHz. This is an advantage because the sound carrier is generally only recorded with an amplitude of 10% of the amplitude of the picture carrier. Thus an adequate signal-to-noise ratio for the sound carrier or carriers is additionally achieved by the frequency position of the sound carriers.

For the sound reproduction, there is also the following advantage. The scanning of the oblique track is effected alternately by the two video heads. During the change of heads, a disturbance occurs in the sound reproduction because the signal scanning is taken over by another head and during the scanning of an FM carrier, shifts in phase inevitably occur. The scanning forming the starting point of the invention is effected so that the minima in the amplitude of the scanned sound carrier lie at the transition from one field to another field, that is to say at the change of head. At the critical moment during the change of head, the scanned FM sound carrier then has its minimum amplitude so that shifts in phase in this carrier also have less effect on the demodulated sound signal. The translational speed of the magnetic tape may be varied for example from a minimum value of 5 mm/s through the normal value of 23.39 mm/s up to a maximum value of 46.8 mm/s. The relative speed of the video heads to the tape remains constant at about 4.8 m/s in an advantageous manner so that the frequency demodulation for the picture carrier

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and the sound carrier also remains practically uninfluenced.

The recording and the scanning of the oblique tracks is preferably effected with two video heads as in present-day ordinary commercial video recorders. Fundamentally, scanning with more than two video heads is also possible.

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

Figure 1 shows the arrangement of the oblique tracks during recording, reproduction and reproduction with increased translational speed,

Figure 2 shows diagrams to explain the scanning of the oblique tracks in Figure 1,

Figure 3 shows an example of the displacement of the scanning track,

Figure 4 shows a circuit for the amplitude control during the reproduction,

Figure 5 shows a diagram to explain the mode of operation of Figure 4 and

Figure 6 shows a block circuit diagram for the reproduction circuit for carrying out the invention.

In Figure 1, oblique tracks 2, which each extend from one edge of the tape to the other edge of the tape, are recorded on the magnetic tape 1. Further longitudinal tracks, which are present in practice for the additional recording of a sound signal or of a synchronizing signal, are not illustrated. In practice, the oblique tracks extend at a small angle of about 6° obliquely to the edge of the tape. The beginning and end of the oblique tracks shown are provided with the numerals 0-20. The oblique tracks are recorded alternately by two video heads 3a and 3b. Position and place of scanning the oblique tracks 2 is explained in connection with Figure 2. In the first instance, it is assumed that the translational speed V of the magnetic tape 1 in the direction 4 is equal to zero. During its rotation inside a head drum, the video head 3

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records the track 1-0. The position of this track results from the geometrical relationships during the wrapping of the magnetic tape 1 round the head drum. With the tape at a standstill, that is to say $V = 0$, the video head 3 would scan this track 1-0 again and again. The scanning of a track lasts 20 ms, namely the duration of a field of the television signal. Now let it be assumed that the magnetic tape 1 is moving in the direction 4 at the normal speed V_0 . During the scanning of the track beginning at 1, the tape 1 has then covered a distance a in the direction 4, which distance results from the time of 20 ms and $V_0 = 23.39$ mm/s. Thus at the normal speed V_0 , the video head no longer sweeps over the track 1-0 but the track 1-2. This scanning is represented in Figures 1 and 2 by hatching between the points 1 and 2. During the next 20 ms, the video head 3a no longer participates in any scanning but travels idly back to the lower edge of the tape. This return likewise lasts 20 ms so that after 40 ms, the video head 3a has arrived back at the lower edge of the tape, that is to say at the point 5. The magnetic tape 1 has then covered the distance $2a$ corresponding to the time of 40 ms. Then the scanning of the track 5-6 begins again in a time of 20 ms. In the same manner, the video head 3b scans the intervening tracks 3-4, 7-8, 11-12 etc which are not hatched. On a longitudinal track of the magnetic tape 1, the pulse train 5 of 25 Hz is also recorded which marks each of the tracks 1-2, 7-8, 11-12 etc. This pulse train ensures that the head 3a always finds these tracks and the video head 3b always finds the intervening video tracks.

Now let it be assumed that the speed V is increased to double the value $2V_0$. At the speed V_0 , the video head 3a has covered the distance 1-9 on the oblique tracks in the time of 80 ms. Since the speed V now = V_0 , the video head 3a must cover this distance 1-9 in half the time, that is to say in 40 ms. This means that in comparison

with V_0 , the displacement of the track from one edge of the tape to the other is now no longer $= a \approx 20$ ms, but $= Za \approx 40$ ms. The video head 3a therefore records the track 1-4 shown in chain line in Figure 1 and after the idle run has been effected, the track 9-12. Thus the video head 3a begins the scanning on the track 1-2 with the correct azimuth angle and hence full amplitude of the scanned signal, controlled by the pulse train 5. As illustrated by the track 1-4 in chain line, however, in the course of the track 1-4, the video head continuously leaves the correct track 1-2 and then runs onto the track 3-4 with the wrong azimuth angle at which the amplitude of the scanned signal is practically equal to zero. This results in an amplitude curve as shown in Figure 2b for the scanned carrier.

Now in Figure 3, the position of the scanning track in chain line is displaced towards the left by the amount $a/2 \approx 10$ ms. It can be seen that the scanning track in chain line of the track 1-2 is better coordinated with the correct azimuth angle. On the one hand, the optimum position in relation to the correct track 1-2 and hence the maximum amplitude of the scanned signal is transferred into the middle of the oblique track. On the other hand, the signal amplitude both at the beginning and at the end of the track is no longer zero but still has half the value because even at these points, the correct track 1-2 is still included. This now improved scanning results in the amplitude curve as shown in Figure 2c. The shifting of the maximum into the middle of a field has the advantage, during the picture reproduction, that the optimum position with the greatest signal-to-noise ratio now lies in the middle of the picture and not at the upper edge of the picture. Since experience has shown that the main events and the centre of observation of the picture lie in the middle of the picture and less at the edge of the picture,

this is an advantage for the picture reproduction. For the sound reproduction there is the advantage that the amplitude has a lower value at the ends of the oblique tracks, that is to say at the change of heads, where phase shifts in the scanned sound carrier can lead to disturbances.

The displacement of the scanning track in chain line, illustrated in Figure 3, can be achieved in a simple manner during the reproduction. It is known that the rotation of the head wheel is controlled by comparison of the pulse train 5 from the longitudinal track of the magnetic tape 1 with a pulse train derived from the head wheel so that the magnetic head follows the recording tracks precisely. Thus by intervention in this control loop, any desired displacement of the scanning tracks can be achieved, for example by the value $a/2$ in Figure 3. For this purpose, only one of the pulse trains supplied to the phase comparison needs to be displaced by the desired amount. Then another position of the pulse train 5 recorded on the tape 1 is simulated for the head-wheel control and so the position of the scanning tracks is displaced geometrically in the longitudinal direction of the tape.

Figure 4 shows a circuit whereby the variation in amplitude according to Figure 2c can be controlled in a picture carrier or sound carrier. The carrier is conveyed through the amplifier 6. The output signal of the amplifier 6 is rectified in the rectifier 7. At the output of the filter 8, a control voltage U_R is obtained which is dependent on the amplitude of the carrier and controls the gain of the amplifier 6 so that a carrier with constant amplitude appears at the output terminal 9. This amplitude stabilization can also be achieved by other regulating circuits, control circuits or limiters.

In Figure 5, the amplitude curve 10 as shown in Figure 2c is converted into the amplitude curve 11 by the circuit shown

in Figure 4. It can be seen that the carrier now has a largely constant amplitude over the whole field duration of 20 ms.

The amount of the displacement of the scanning track $a/2$ in Figure 3 may be dependent on the extent of the time extension or time compression. At double the translational speed $2V_0$, this amount is preferably equal to 10 ms. At a speed V reduced in comparison with V_0 , it is advisable to vary the speed in the following stages:

- 0.2 * V_0 = 4.678 mm/s
- 0.4 * V_0 = 9.356 mm/s
- 0.6 * V_0 = 14.034 mm/s
- 0.8 * V_0 = 18.712 mm/s.

For these values of the translational speed V , a displacement of the scanning track is advisable by an amount which corresponds to a time of 5 ms at the normal speed V_0 . It can be shown that then an optimum correlation of the scanning tracks with the tracks with the correct azimuth angle as shown in Figure 3 is achieved. In addition, the effect is achieved that this optimum correlation is continuously the same, that is to say from field to field, and no fluctuations occur over a relatively long period of time. The variation in the translational speed V between the said values can be achieved in that the pulse train derived from the tacho-generator for the translational drive V is doubled from 225 Hz to 450 Hz and then divided. Then the reference pulses necessary at the desired differing speeds are obtained for the control of the translational speed V . When the speed V is altered, the pulse trains 5 likewise come from the longitudinal track of the magnetic tape 1 at different frequencies which then serve in known manner for the correction of the scanning phase, that is to say the correlation of the head path with the tracks.

Thus the following table results for the various speeds V described altogether:

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Value of V	Frequency of the tacho-generator	Dividing factor for this frequency	Frequency delivered by the tacho-generator
$2 \cdot V_0$	450 Hz	9	50 Hz
$0.2 \cdot V_0$	450 Hz	90	5 Hz
$0.4 \cdot V_0$	450 Hz	45	10 Hz
$0.6 \cdot V_0$	450 Hz	30	15 Hz
$0.8 \cdot V_0$	450 Hz	22	20 Hz
$1.0 \cdot V_0$	450 Hz	18	25 Hz

The pulse train 5 scanned from the longitudinal track of the magnetic tape 1 at the individual speeds V then likewise has the frequencies given in the right-hand column. These pulse trains can then be compared in phase in known manner and be used to control the rotation phase of the head wheel carrying the video heads in the sense that the heads follow the desired tracks according to Figure 1 or Figure 3 each time.

Figure 6 shows a circuit whereby the displacement of the tracks during the reproduction can be achieved as described. What are illustrated are the magnetic tape 1, the oblique tracks 2, the direction 4 of the translational speed V, the track 12 for the pulse train 5 scanned by the synchronizing head 13, a pulse shaper 13' for the pulse train 5, the phase comparison stage 14 for the head-wheel control, the head drum 15 with the video heads 3a and 3b as well as two permanent magnets 16, 17, the scanning head 18 for scanning the head-wheel pulse train 19 produced by the magnets 16, 17 with a frequency of 25 Hz, an amplifier 20 for the control voltage U_R produced in the phase comparison stage 14 and a motor 21 for the drive of the head wheel 15. The pulse train 5 with 25 Hz, scanned from the synchronizing track 12 by the head 13 and the pulse train 19 with 25 Hz produced by the head 18 by means of the magnets 16, 17

are compared with one another in the phase comparison stage 14. The control voltage U_R obtained as a result controls, through the amplifier 20, the phase of the rotation of the motor 21 and hence of the head wheel 15 so that, during the reproduction, the video heads 3a and 3b follow the tracks 2 precisely and do so in such a manner that they scan the track with the correct azimuth angle each time. The delay stage 22 is provided in the path of the pulse train 5. This stage produces a pulse wherein the position in time of the trailing edge is adjustable. The trailing edge of the output pulse of the stage 22 produces the pulses at the output of the pulse shaper 13'. By these means, therefore, another position of the magnetic tape 1 in the direction 4 is simulated for the phase comparison stage 14 so that the head wheel 15 is correspondingly displaced in the direction 4 during the scanning. In this manner, therefore, the displacement according to Figure 3 can be adjusted to any value. It is true that the stage 22 cannot advance a pulse of the pulse train 5 in time, for example by the said 5 or 10 ms. Since the pulse train 5 is a continuous pulse train, however, a desired advance in time of a pulse can be replaced by a corresponding delay of the preceding pulse. With a period of 40 ms in the pulse train 5, a delay by 35 ms is equivalent to an advance in time by 5 ms. Thus by adjusting the delay in the stage 22, the optimum conditions according to Figures 1 and 3 can be adjusted. This pulse delaying may likewise be effected in the path of the pulse train 19.

The signals of the two video heads 3a and 3b are utilized alternately from field to field by the change-over switch 23. The recorded sound carrier is evaluated by the band-pass filter 24, amplified in the limiter 25 and demodulated in the FM demodulator 26. The output voltage of this is supplied to the loudspeaker 27 via a further amplifier. The recorded picture carrier with its sidebands

is evaluated by the filter 28 and supplied to the FM demodulator 30 via the limiter 29. This demodulator delivers the video signal for the picture reproduction to the terminal 31.

Claims

1. A video recorder with quick-motion and/or slow-motion reproduction, wherein two or more rotating video heads (16, 17) with different azimuth angles alternately record one field at a time along an oblique track (2) of a magnetic tape (1) transported at normal speed in its longitudinal direction (4) and during a reproduction during which the magnetic tape (1) is transported in its longitudinal direction (4) at a speed (V) differing from the normal speed (V_0), the track (2) covered by each video head (16, 17) is offset in relation to the recorded track (2) by such a geometrical amount ($a/2$) in the longitudinal direction (4) of the tape (1) that the video head (16, 17) scans as large a proportion as possible of the area of the recorded track (2) with the azimuth angle associated with the video head (16, 17), characterised in that a picture carrier frequency-modulated with the video signal and one or more sound carriers frequency-modulated with an audio-frequency sound signal are recorded jointly by the video heads (16, 17) each substantially along the whole length of the oblique tracks (2), in these, and that in order to achieve a substantially undistorted sound reproduction during quick-motion or slow-motion reproduction, the frequencies of the sound carriers lie within a range from 1.9 to 2.5 MHz at which the azimuth losses caused by the azimuth angle during the reproduction lead to a crosstalk attenuation between adjacent tracks (2) of from 40 to 60 dB.

2. A recorder according to Claim 1, characterised in that a circuit (Figure 4) is provided to keep the

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2. A recorder according to Claim 1, characterised in that a circuit (Figure 4) is provided to keep the



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amplitude of a scanned frequency-modulated carrier constant.

3. A recorder according to Claim 1, characterised in that the frequency of the sound carrier lies in the region of the maximum of the frequency response of the video head (3).

4. A recorder according to Claim 1, characterised in that the amplitude of the sound carrier is about 10% of the amplitude of the picture carrier.

Figure 2

Scan

idle

Scan

idle

Figure 6

Head-wheel control

Video



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