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### Specification

In videorecorders, it is known (DE-OS 31 10 968) to record one or more sound carriers frequency-modulated with sound signals together with the picture carrier on the oblique tracks of a magnetic tape by the video heads. By means of this type of sound recording, a higher quality of sound is achieved in comparison with a.f. sound recording on a longitudinal track of the tape. The sound carrier has a frequency of 2 MHz for example and lies in the lower frequency range of the picture carrier frequency-modulated with the video signal.

Since the recording is effected by two video heads alternately, with an overlap time, it is necessary, during the reproduction, to switch over the paths for the frequency-modulated picture carrier and the sound carrier between the two video heads from one field to the next. This switching over is not disturbing in the path of the picture carrier because in any case no image reproduction is effected during the vertical flyback period between two fields. In the path of the sound carrier, however, such a periodic switching over can lead to disturbances because the sound

signal is a continuous signal without interruptions.

It is known (DE-OS 31 10 968), during the reproduction, to add the sound carriers from the two video heads and supply them to an FM demodulator. During the said overlap time, the sound carriers of both video heads are then effective. As a result of the influence of tolerances in the video heads and as a result of resilient and non-resilient deformation of the tape, statistically fluctuating phase displacements occur, however, between the sound carriers of the two video heads. A cancellation of the two sound carriers may therefore occur during the overlap time and hence a break in the signal which causes disturbances after an FM demodulation. In order to avoid this break in the signal, the two sound carriers are added with different amplitude in this known circuit so that a compensation is no longer possible.

It is also known (DE-OS 31 16 130), to convey the combined sound carriers via a selective amplifier and to increase its amplification during the change of head so that the amplifier oscillates at its resonance frequency. As a result, assurance is provided that there is always one sound carrier present during the change of head even if it is not modulated for a short time.

It is further possible to switch over the sound channels like the picture channels, by carrier-frequency means, from one field to the next, in response to the output signals of the two video heads. In this case, however, a phase jump may occur in the path of the sound carrier during the

switching over, as a result of the said statistical phase displacements, which jump again produces a disturbance after the FM demodulation.

It is the object of the invention to provide a reproduction circuit for the sound carriers with switching over in the path of the frequency-modulated sound carrier, wherein no disturbances occur in the sound signal.

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

With the invention, therefore, a phase control of the sound carriers is initiated already before the moment of switching over the sound channel between the video heads, in such a manner that the sound carriers have the same phase at the moment of switching over. The sound carrier appearing at the output of the change-over switch then does not suffer any phase jump so that no disturbance occurs even after the FM demodulation of the sound carrier. Thus all phase deviations between the sound carriers fed to the change-over switch are controlled regardless of their particular magnitude and direction up to the moment of changeover.

Examples of embodiment of the invention are explained with reference to the drawing. In it,

Figure 1 shows a block circuit diagram of a solution according to the invention,

Figure 2 shows curves to explain the circuit of Figure 1,

Figure 3 shows a further example of embodiment of the

invention,

Figure 4 shows curves to explain the mode of operation of the circuit in Figure 3,

Figure 5 shows a detailed block circuit diagram with digital components for the circuit of Figure 3 and

Figure 6 shows curves to explain the mode of operation of the circuit of Figure 5.

In each case, the lower-case letters show at which points of the circuit diagrams the voltages according to the curve diagrams appear.

In Figure 1, the sound carriers T1, T2 are scanned from the magnetic tape 1 from one field to the next by the video heads 1, 2. The signal paths for the picture carriers, which are likewise scanned, the chrominance carrier and other signals are not illustrated. The sound carrier T1 passes via the selective amplifier 4 for the sound-carrier frequency and the controllable delay stage 5 to an input of the change-over switch 6. The sound carrier T2 likewise passes via the selective amplifier 7 and the controllable delay stage 8 to the other input of the change-over switch 6. At the output of the change-over switch 6, a continuous sound carrier T appears which delivers an a.f. sound signal to the terminal 10 via the FM demodulator 9. Further illustrated are a gate 11, a phase comparison stage 12, two switches 13, 14, two low-pass filters 15, 16 acting as integrating elements, a pulse generator 17 and a control unit 18.

The mode of operation is explained with reference to Figure 2. In the time before  $t_1$ , the sound carrier  $T_1$  is switched through with the switch 6 in the position illustrated. A fixed reference voltage  $U_n$  is applied to the control input of the delay stage 5 through the switch 13 and the low-pass filter 15. The delay time of the stage 5 is therefore constant and is about  $2 \mu s$ . This constant delay time causes only a slight delay of the sound carrier and is of no significance during this time. During this time, the sound carrier  $T_2$  is not used by the video head 2, with the switch 6. At the moment  $t_1$ , the scanning of the sound carrier  $T_2$  by the video head 2 begins. The gate 11 is rendered transmissive by the control voltage  $f$  so that the sound carriers  $T_1$  and  $T_2$ , which are now present simultaneously, reach the phase comparison stage 12. This produces a voltage  $g$  depending on the phase deviation. This voltage passes, as a correcting condition  $U_s$ , via the change-over switch 13 switched over into the position shown in broken lines by the control voltage  $g$  at the moment  $t_1$  and via the low-pass filter 15 to the stage 5. Depending on the phase deviation between the sound carriers  $T_1$  and  $T_2$  at the outputs of the stages 5, 8, the delay time of the stage 5 is altered by about  $\pm 0.5 \mu s$  according to the sign of the phase deviation, starting from its basic delay time of  $2 \mu s$ . As a result, the phase of the sound carrier  $T_1$  alters at the output of the stage 5 in the sense that the phases of the sound carriers  $T_1$ ,  $T_2$  at the outputs of the stages 5, 8 are brought into coincidence. During this time, the delay time of the stage 8 is kept constant by the

correcting condition  $U_s$  supplied via the change-over switch 14. The low-pass filter 15 ensures that the voltage  $g$ , which appears abruptly at the moment  $t_1$  depending on the phase deviation, is not effective abruptly as a correcting condition  $U_s$  at the input of the stage 5. As a result, a phase jump would actually occur in the sound carrier  $T_1$  and would again act as a disturbance. The limiting frequency of the low-pass filter 15 or the time constant of the integrating element formed thereby is calculated from the following points of view. The time constant is so small that the correcting condition  $U_s$  can completely control the phase deviation of the sound carriers within the time  $t_1-t_2$ .

On the other hand, the time constant is so great that the change in the phase of the sound carrier  $T_1$  is only effected so slowly that no disturbance occurs in the a.f. sound signal at the terminal 10 as a result. Actually, the phase of the sound carrier  $T_1$  is falsified by the correcting condition  $U_s$  through control of the delay time of the stage 5. This phase variation has such a low frequency, however, that no disturbance occurs in the a.f. sound signal at the terminal 10 as a result.

At the moment  $t_5$ , phase coincidence between the sound carriers  $T_1$ ,  $T_2$  at the inputs of the change-over switch 6 is ascertained in the phase comparison stage 12. The pulse  $c$  actually serves to switch over the change-over switch 6 and would cause this change-over at  $t_1$ . But the change-over pulse  $e$  is only produced in the pulse stage 17

when both pulses c and d appear. Thus the change-over pulse for the change-over switch 6 is produced at the moment  $t_5$  and changes over the change-over switch 6 into the position shown in broken lines. At this moment, the sound carriers T1, T2 at the inputs of the change-over switch 6 have the same phase so that no phase jump and so no disturbance in the a.f. signal at the terminal 10 occurs

in the sound carrier T at the output of the change-over switch 6. Thus, beginning from the moment  $t_5$ , the sound carrier T2 is now switched through by the change-over switch

6. The correcting condition  $U_s$  for the stage 8 is determined by the constant reference voltage  $U_r$ , through the position of the change-over switch 14 as illustrated, so that now the delay time of the stage 8 is constant. The stage 5 now has no effect because the sound carrier T1 is not being used. During the time  $t_2$ - $t_3$ , the correcting condition  $U_s$  can now adjust itself to the value of  $U_r$  again because the change-over switch 13 has been changed back into the position illustrated, at the moment  $t_2$ .

At the moment  $t_3$ , this procedure is effected in the reverse direction. The pulse b now switches the input of the integrating element 16 to the output of the phase comparison stage 12 so that now the delay time of the stage 8 is regulated to the same phase of T1 and T2, while the delay time of stage 5 remains constant. At the moment  $t_6$ , phase coincidence is again reached. The pulses d and c then together produce the edge of the pulse e as a result

of which the change-over switch 6 is changed back into the upper position.

The control unit 18 produces the pulses f and c which indicate the overlap periods in time,  $t_1-t_2$  and  $t_3-t_4$ , during the scanning of the sound carriers. These pulses are derived from a head wheel carrying the video heads 1, 2. This head wheel contains a pulse generator which delivers actuating pulses to the control unit 18.

In the case of a sound carrier with a frequency of 2 MHz, the phase deviation between  $T_1$  and  $T_2$  may be greater than  $90^\circ$  as a result of tolerances and tape deformation. Accordingly, it may be advisable to use not the sound carrier itself for the phase measurement in the phase comparison stage 12 but an additionally recorded pilot carrier, for example with a frequency of 50 kHz. A frequency which is lower than the frequency of the sound carrier is preferably selected for the pilot carrier because otherwise ambiguity may occur with regard to the control of the phase of the sound carrier. If two pilot carriers scanned with a lower frequency coincide in phase, the sound carriers with a higher frequency recorded at the same time must necessarily also coincide in phase. An additionally recorded chrominance carrier of 625 kHz for example may also be used as a pilot carrier. The phase comparison of  $t_1-t_5$  and  $t_3-t_6$  during the overlap range of the two sound carriers  $T_1$ ,  $T_2$  is effected during a time when no image reproduction is taking place. Therefore a pilot carrier or a chrominance carrier can be

recorded with an increased amplitude during this time because it cannot cause a disturbance in the reproduced picture.

In a further development of the invention according to Figures 3-6, the sound carrier of the starting track to which switching over is to be effected during the overlap time, becomes available, regardless of its particular phase, cyclically in succession, during the overlap time, with various phase rotations. The phase relationship between the particular sound carrier being used on the track coming to an end and the sound carrier to which switching over is to be effected is constantly checked by a monitoring circuit. If the phase shifter makes the sound carriers available with different phase positions which are a sufficiently small distance apart and in a sufficiently large number, at some time a sufficient phase coincidence will occur between the two sound carriers. As soon as this is detected, the switching over of the sound channel between the two video heads is initiated.

As a result of this circuit, a phase adaptation range of  $360^\circ$  is provided. In an advantageous manner, no frequency variation of the output signal occurs so that the sound signal is not falsified. Nor is it necessary to produce an analogue control voltage for the production of the phase coincidence so that low-pass filters necessary for such a control voltage are also avoided. The phase shifters do not have to be reset into a defined starting position between the changes of head. In particular, the

circuit can be constructed in the form of a digital circuit and can therefore be easily integrated.

This solution is described with reference to Figures 3-6.

Figure 3 shows a video tape 3, from the oblique tracks of which the signals are scanned alternately by two video heads 1 and 2. Recorded on the magnetic tape 3, inter alia, is a frequency-modulated sound carrier which is to be used by the circuit. The use of other recorded signals such as frequency-modulated picture carrier and the like is not dealt with in detail for the sake of simplification. The sound carrier T1 passes from the first video head 1 via the selective, limiting amplifier 5 and the phase shifter 20a, which can be switched over to eight different values  $\varphi 1 - \varphi 8$ , to the change-over switch 6. The sound carrier T2 from the video head 2 passes correspondingly via the selective, limiting amplifier 7 and the phase shifter 20b to the other input of the change-over switch 6. The stages 4 and 7 as well as 20a and 20b are identical.

The mode of operation of this circuit is explained in connection with Figure 4. The logic 21 is controlled by the 25 Hz pulse 24 which comes from the servo circuit of the recorder. The logic 21 delivers to the phase shifter a constant correcting condition  $U_s$  which keeps the phase rotation of the phase shifter 20a at its value. The sound carrier T1' therefore differs from the sound carrier T1 only by a constant phase rotation which is not important for the further consideration. The sound carrier T1' reaches the phase comparison stage Ph. At the moment t1

(Figure 4), the change-over switch 6 is still in the position illustrated so that the sound carrier T1' still appears at the terminal 22. During the overlap period t1-t4, the pulse 24 appears with its negative edge and prepares the switching over of the change-over switch 6 but without causing this. The pulse 24 essentially determines the direction in which the impending change-over is to be effected. Beginning from the moment t2, the change-over voltage 30 passes from the logic 21 to the control input of the phase shifter 20b and cyclically causes a variation in the phase rotation in steps of 45°, altogether over 360°, the period of the sound carrier T. The sound carrier T2', thus changed over in phase, likewise reaches the phase comparison stage Ph. As a result of the constant phase of the sound carrier T1' and the phase of the sound carrier T2' changing in stages, an adequate phase coincidence of T1' and T2' is found during the overlap period t1-t4 in the phase comparison stage Ph. At this moment t3, the logic 21 is activated by the phase comparison stage Ph. This logic then produces the change-over pulse 23 according to Figure 4d which causes the switching over of the change-over switch 6 into the position shown in broken lines so that now the sound carrier T2' reaches the terminal 22. Since, at this moment, there is largely phase coincidence between T1' and T2', no disturbing phase jump occurs in the sound carrier T' at the terminal 22 during the switching over at the moment t3.

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During the next change-over from T2' to T1' during the following overlap period t5-t6, the phase shifters 20a and 20b are exchanged in their operation. Then the phase shifter 20b is controlled by the constant correcting condition U<sub>s</sub> and the phase shifter 20a by the change-over voltage 30.

In Figure 5, the reference numerals from Figure 3 indicate which parts correspond to one another in the Figures 3 and 5. The mode of operation is explained in connection with Figure 6, likewise for the change-over from the video head 1 to the video head 2. The letters a-f show at which points in Figure 5, the voltages according to Figure 6 appear.

In the circuit shown in Figure 5, the phase shifters 20a and 20b each contain a delay network with four taps. The phase displacement between successive taps is about 45°. The signal from one of the taps is fed via a selection circuit to an exclusive OR-gate 25a or 25b which acts as an inverter which can be switched on and off. By means of the three output signals of a 3-bit counter Z1 or Z2, the selection circuits and the gates 25a and 25b are controlled so that with one counting cycle of the counter, eight different phase rotations are produced, each differing by about 45°. Depending on the connection of the counter, the phase adjustments can take place in rising, falling or non-monotonous sequence. The number of taps of the delay line may also be increased and the counting cycle enlarged accordingly. The delays between the taps are selected so

that the adjustable phase rotations are distributed substantially uniformly over the range of  $360^\circ$ .

At the beginning of the overlap time  $t_1$ - $t_4$ , the phase shifter 20a is still in the position which was set for the previous signal change-over. The phase shifter also remains in this position at least up to the next change-over. The phase shifter 20b may be in any position. The phase between the signals  $T_1'$  and  $T_2'$  is dependent on mechanical deviations in the track length and the head wheel diameter in relation to the recording and on the adjustments of the two phase shifters. The phase comparison stage Ph consists of the exclusive OR-gate 27. In so far as the phases of the two signals  $T_1'$  and  $T_2'$  almost coincide, the gate 27 delivers no pulses or only very narrow positive pulses (Ph in Figure 6) via the RC network 28 to the input of the monostable multivibrator 29. The RC network 28 has the effect that this input of the monostable multivibrator 29 then remains at "0" so that the monostable multivibrator 29 cannot be triggered.

So long as the positive pulses Ph exceed a certain width, the monostable multivibrator 29 is in any case triggered at an interval of about one period of the signal T. The circuit must be constructed so that this is ensured. The monostable multivibrator 29 delivers a pulse  $b$  (Figure 6) of about 75% of the period each time. This pulse steps on the phase adjustment counter Z1 or Z2 for the signal of the new track by one step. At the same time, a further counter Z3 is set to "0".

If there is sufficient phase coincidence between  $T1'$  and  $T2'$ , the pulses  $b$  at the output of the monostable multivibrator 29 do not appear. The phase rotation then remains unaltered. The counter Z3 counts the periods of the T signal. At a preset value of periods, for example 4 or 8, the output of the counter Z3 goes to "1". As a result of this, the actual signal switching-over by the switch 6 is initiated and care is taken to ensure that all adjustments remain unaltered until the next change of head. The counter Z3 prevents a signal change-over being initiated by the switch 6 as a result of a signal disturbance. There is actually the possibility that, as a result of the disturbance, a brief phase coincidence may be simulated at the inputs of the phase comparison stage Ph, thus causing the switching over of the change-over switch 6.

The time constant of the RC network 28 and the final value of the counter Z3 are adapted to one another so that the actuation of the change-over switch 6 after phase adaptation of  $T1'$  and  $T2'$  is effected with sufficient certainty within the overlap time  $t1-t4$  or  $t5-t6$ . In addition, means may be provided which cause a compulsory switching over of the change-over switch 6 shortly before the end of the overlap time if the switching over has not been initiated by the phase comparison stage Ph. The switching over must be effected then in any case because, without switching over, the signal would drop out at the end of the overlap time  $t1-t4$ .

Some further details of the circuit in Figure 5 will be discussed with reference to Figure 6.

The level transitions of the pulses 24 in synchronism with the rotation of the head wheel should lie in the first half of the overlap time  $t_1$ - $t_4$ . Each level transition of this pulse train produces a starting pulse as shown in Figure 6 which sets the counter Z3 to "0" (voltage a in Figure 6). In addition care is taken, by the pulses 24, to ensure that the flip-flop FF2 changes over with the correct phase (voltage f) and that only the phase adjustment counter Z1 or Z2 can ever be stepped on which has to adapt the signal of the new track to the signal of the previous track (voltage c1 or c2). So long as the voltage a in Figure 6 is at "0", the phase adaptation circuit is active. In this time, the monostable multivibrator 29 can be triggered, the counter Z3 receives counting pulses d and the flip-flop FF1 is reset so that the voltage e is "1". The starting position for the phase adaptation counter Z2 is "4" in the example of Figure 5. In this position, only an inversion of the signal T2 is effected through the exclusive OR-gate 25. During the further counting, the phase of T2' is then turned on through 45° per stage. Finally,, with the counter position "1", the most favourable phase adjustment is reached. As a result of fluctuations in phase, a pulse may appear at the output of the monostable multivibrator 29 in this position before the counter Z3 has reached its final

state. In this case, a renewed phase adaptation cycle must be run through.

After the voltage a has gone to "1", the monostable multivibrator 29 can no longer be triggered and the counter Z3 has to retain its position until the next starting pulse. The flip-flop FF1 is changed over with the next pulse d. The resulting falling edge of the voltage e causes, through the flip-flop FF2, the actual switching over of the signal by the change-over switch 6. Without this delay in switching over, a pulse might still be released at the output of the monostable multivibrator 29 more or less simultaneously with the switching over of the flip-flop FF2 and would then again activate the phase adaptation circuit. This could cause considerable disturbances. The OR-gate 26 has the effect that the switching over by the switch 6 only takes place when T1' and T2' are at "0". With the change-over switch used here, the changing over cannot cause any disturbing switching pulse at this moment. During the next change of head, that is to say with the rising edge of the pulse 24, the phase adaptation and change-over operation takes place in a corresponding manner.

The frequency of the change-over pulses 30 (voltage c2 in Figure 6) is substantially equal to the FM carrier frequency. Thus with a frequency of the sound carrier of 2 MHz, nearly 2000 phase adjustments can be checked or an adjustment cycle of 8 or 16 different phase rotations can be run through about 100 or 50 times during an overlap

time of 1 ms. Delays in the change-over pulses 30 occur, however, if the phase coincidence is already satisfactory and monostable multivibrator 29 is not triggered immediately at the beginning of the counting time of the counter.

The comparatively long overlap time is in any case sufficient to find a favourable moment for the switching over, with great certainty - even in the event of disturbances.

### Patent Claims

1. A video recorder with recording of a sound carrier (T) which is scanned alternately by two video heads (1, 2) from a magnetic tape (3), with an overlap time, having a change-over switch (6) which switches over the sound channel carrying the sound carrier (T) between the two video heads (1, 2) during the overlap time ( $t_1-t_2$ ,  $t_3-t_4$ ), characterised in that the phase relationship between the sound carriers (T1, T2) fed to the inputs of the change-over switch (6) during the overlap time ( $t_1-t_2$ ,  $t_3-t_4$ ) is controlled by a correcting condition (Us) so that both sound carriers (T1, T2) have substantially the same phase at the moment of switching over ( $t_5$ ,  $t_6$ ).

2. A recorder as claimed in Claim 1, characterised in that a controllable delay stage (5, 8) is connected into the path of each of the two sound carriers (T1, T2).

3. A recorder as claimed in Claim 2, characterised in that the correcting condition (Us) is obtained in a phase



time of 1 ms. Delays in the change-over pulses 30 occur, however, if the phase coincidence is already satisfactory and monostable multivibrator 29 is not triggered immediately at the beginning of the counting time of the counter.

The comparatively long overlap time is in any case sufficient to find a favourable moment for the switching over, with great certainty - even in the event of disturbances.

### Patent Claims

1. A video recorder with recording of a sound carrier (T) which is scanned alternately by two video heads (1, 2) from a magnetic tape (3), with an overlap time, having a change-over switch (6) which switches over the sound channel carrying the sound carrier (T) between the two video heads (1, 2) during the overlap time ( $t_1-t_2$ ,  $t_3-t_4$ ), characterised in that the phase relationship between the sound carriers (T1, T2) fed to the inputs of the change-over switch (6) during the overlap time ( $t_1-t_2$ ,  $t_3-t_4$ ) is controlled by a correcting condition (Us) so that both sound carriers (T1, T2) have substantially the same phase at the moment of switching over ( $t_5$ ,  $t_6$ ).

2. A recorder as claimed in Claim 1, characterised in that a controllable delay stage (5, 8) is connected into the path of each of the two sound carriers (T1, T2).

3. A recorder as claimed in Claim 2, characterised in that the correcting condition (Us) is obtained in a phase



comparison stage (12) connected to the outputs of the delay stage (5, 8).

4. A recorder as claimed in Claim 2, characterised in that the delay times of the delay stages (5, 8) are controlled at fixed values outside the overlap times ( $t_1-t_2$ ,  $t_3-t_4$ ).

5. A recorder as claimed in Claim 1, characterised in that the phase is controlled of that sound carrier ( $T_1$ ,  $T_2$ ), the scanning of which ends at the end of the overlap time ( $t_1-t_2$ ,  $t_3-t_4$ ).

6. A recorder as claimed in Claim 1, characterised in that the change-over switch (6) is actuated each time when phase coincidence is reached between the two sound carriers ( $T_1$ ,  $T_2$ ).

7. A recorder as claimed in Claim 1, characterised in that the correcting condition ( $U_s$ ) is conveyed through an integrating element (15, 16).

8. A recorder as claimed in Claim 1, characterised in that the correcting condition ( $U_s$ ) is obtained from an additionally recorded pilot carrier, by phase comparison.

9. A recorder as claimed in Claim 8, characterised in that the frequency of the pilot carrier is lower than the frequency of the sound carrier ( $T$ ).



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10. A recorder as claimed in Claim 8 or 9, characterised in that a recorded chrominance carrier is used as pilot carrier.

11. A recorder as claimed in Claim 8, characterised in that the pilot carrier is recorded each time with increased amplitude during the overlap time ( $t_1-t_2$ ,  $t_3-t_4$ ).

12. A recorder as claimed in Claim 1, characterised in that during the overlap time ( $t_1-t_4$ ), the sound carrier (T2) from the second head (2) is conveyed through a phase shifter (20b) which is switched over cyclically to different discrete values ( $\varphi_1-\varphi_8$ ) and is fed, together with the sound carrier (T1) from the first head (1) to a phase comparison stage (ph), the output voltage of which, when there is sufficient phase coincidence between the sound carriers supplied, stops the step-by-step action of the phase shifter (20b) and initiates the actuation of the change-over switch (6) (Figure 3).

13. A recorder as claimed in Claim 12, characterised in that the values of the phase shifter (20) extend over a range of about  $360^\circ$  of the sound-carrier period (T), (Figure 3).

14. A recorder as claimed in Claim 22, characterised in that the various values ( $\varphi_2-\varphi_8$ ) of the phase shifter (20) have a spacing of about  $45^\circ$  for the period of the sound carrier (T) Figure 3).



15. A recorder as claimed in Claim 12 or 13, characterised in that the phase shifter (20) contains a delay network with n taps which are connected cyclically in succession to the input of an inverter (25) which is switched on and off cyclically so that this delivers, at the output, the sound carriers (T) in succession with 2n different phase positions (Figure 5).

16. A recorder as claimed in Claim 12, characterised in that the phase comparison stage (Ph) is formed by an exclusive OR-gate (27) (Figure 5).

17. A recorder as claimed in Claim 22, characterised in that delay means (Z3, FF1) are provided which have the effect that the actuation of the change-over switch (6) is only effected when it is guaranteed that the phase coincidence has not been simulated by a brief disturbance.

18. A recorder as claimed in Claim 27, characterised in that the phase adjustment cycle can be run through repeatedly before actuation of the change-over switch (6).

19. A recorder as claimed in Claim 12, characterised in that a forced actuation of the change-over switch (6) is effected shortly before the end of the overlap time ( $t_1$ - $t_4$ ) if the phase comparison stage (Ph) has not initiated any switching over.



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Claims

1. A video recorder with recording of a sound carrier (T) which is reproduced on a magnetic tape (3) with an overlap time, alternately by two video heads (1, 2), comprising a change-over switch (6) which switches over the sound channel transmitting the sound carrier (T) between the two video heads (1, 2) during the overlap time ( $t_1-t_2$ ,  $t_3-t_4$ ), characterised in that the phase relationship between the sound carriers (T1, T2) applied to the inputs of the change-over switch (6) is controlled during the overlap time ( $t_1-t_2$ ,  $t_3-t_4$ ) by an actuating variable ( $U_s$ ) in such a manner that the two sound carriers (T1, T2) have substantially the same phase at the moment of switching over ( $t_5$ ,  $t_6$ ).

2. A video recorder as claimed in Claim 1, characterised in that a delay stage (5, 7) which can be controlled is provided in the paths of the two sound carriers (T1, T2).

3. A video recorder as claimed in Claim 2, characterised in that the actuating variable ( $U_s$ ) is obtained in a comparison stage for phases (12) connected to the outputs of the delay stage (5, 8).

4. A video recorder as claimed in Claim 2, characterised in that the delay times of the delay stages (5, 8) are forced to fixed values outside the overlap time ( $t_1-t_2$ ,  $t_3-t_4$ ).

5. A video recorder as claimed in Claim 1, characterised in that the phase is controlled of the sound carrier (T1, T2)



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the reproduction of which ends at the end of the overlap time ( $t_1-t_2$ ,  $t_3-t_4$ ).

6. A video recorder as claimed in Claim 1, characterised in that the change-over switch (6) is actuated each time when phase equality is reached between the two sound carriers ( $T_1$ ,  $T_2$ ).

7. A video recorder as claimed in Claim 1, characterised in that the actuating variable ( $U_s$ ) passes through an integrating element (15, 16).

8. A video recorder as claimed in Claim 1, characterised in that the actuating variable ( $U_s$ ) is obtained by a phase comparison with a pilot carrier recorded additionally.

9. A video recorder as claimed in Claim 8, characterised in that the frequency of the pilot carrier is lower than the frequency of the sound carrier ( $T$ ).

10. A video recorder as claimed in Claim 8 or 9, characterised in that a recorded chrominance carrier is used as pilot carrier.

11. A video recorder as claimed in Claim 8, characterised in that the pilot carrier is recorded each time during the overlap time ( $t_1-t_2$ ,  $t_3-t_4$ ) with an increased amplitude.

12. A video recorder as claimed in Claim 1, characterised in that, during the overlap time ( $t_1-t_4$ ), the sound carrier



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originating from the second head (2) enters a phase-rotation element (20b) switched cyclically to different discrete values ( $\varphi 1 - \varphi 8$ ) and is transmitted, at the same time as the sound carrier (T1) from the first head (1), to a phase comparison stage (Ph), the output voltage of which, in the event of a sufficient identity of phase of the sound carrier introduced, ensures the stopping of the operation of the phase rotation element (20b) and initiates the actuation of the change-over switch (6) (Figure 3).

13. A video recorder as claimed in Claim 12, characterised in that the values of the phase rotation element (20) cover a zone of about  $360^\circ$  of the sound-carrier period (T) (Figure 3)

14. A video recorder as claimed in Claim 12, characterised in that the different values ( $\varphi 1 - \varphi 8$ ) of the phase rotation element (20) have a spacing of about  $45^\circ$  for the sound-carrier period (T) (Figure 3).

15. A video recorder as claimed in Claim 12 or 13, characterised in that the phase rotation element (20) comprises a delay element having  $n$  taps which are connected cyclically, one after the other, to the input of an inverter (25) started and stopped cyclically in such a manner that it delivers successively, at its output, the sound carriers (T) with  $2n$  different phase positions (Figure 5).



3A

16. A video recorder as claimed in Claim 12, characterised in that the phase comparison stage (Ph) consists of an exclusive OR gate (27).

17. A video recorder as claimed in Claim 12, characterised in that delay means (Z3, FF1) are provided which cause the actuation of the change-over switch (6) to be effected only when it has been ascertained that the coincidence of phase has not been impaired by a disturbance of short duration.

18. A video recorder as claimed in Claim 17 characterised in that the phase adjustment cycle can be effected several times before the actuation of the change-over switch (6).

19. A video recorder as claimed in Claim 12, characterised in that, shortly before the end of the overlap time ( $t_1-t_4$ ), an automatic actuation of the change-over switch (6) occurs when the phase comparison stage (Ph) has not initiated any switching over.

Figure 3

Logic

from Servo

Figure 5

from 1

1 out of 4

1 out of 4

from 2

from servo

Start



35

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Figure 6

Start

old track

new track

(T1')

(T2')

Figure 6 shows the old track  
and the new track. The old track  
is shown in the left column  
and the new track is shown  
in the right column.