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INTERMITTENT MAGNETIC RECORDING METHOD AND APPARATUS THEREOF

BACKGROUND OF THE INVENTION

Field of the Invention:

The present invention relates to a method and an apparatus for an intermittent magnetic recording by which a video signal is intermittently recorded on a magnetic tape.

Description of the Related Arts:

As one method for recording a video signal on a magnetic tape, an intermittent magnetic recording method is widely known. This intermittent magnetic recording method is to effect a long-hour recording on the magnetic tape employing a picture (frame) skip recording technique.

In the intermittent magnetic recording method, a drive instruction signal is issued at every given period T. This signal is to supply the magnetic tape forwardly for a predetermined length. The periodical issue of this drive instruction signal at every given period T causes the tape supply to recur.

In practice, the video signal of one field is only recorded on the magnetic tape during the period T (hereinafter referred to "recording interval T") for generating the driving instruction signal. Assuming that a duration necessary for this recording, that is, the recording time of one field is

"t", a recording multiplying factor can be defined as T/t . A correlation between the recording interval T and the one-field recording time of one field "t", i.e., a record timing, is expressed as shown in Fig. 4.

The multiplying factor T/t is an index representing a ratio of field to be skipped. Provided that the multiplying factor T/t is 8, for example, recording can be made for 24 hours on a magnetic tape for three-hour recording use.

The recording multiplying factor T/t is usually determined to a multiple number of 8 such as 8, 16, 24, and the like. This is because a time available for recording can be defined like 24, 48, 72, etc. when recording is made on the magnetic tape for three-hour recording use. In other words, if the multiplying factor is set to a multiple number of 8, the time available for recording will become a value in accordance with the unit of one day (equivalent to 24 hours).

For instance, in the case of 50 Hz field frequency, a recording time of one field "t" is given by

$$t = 1/50 \text{ (Hz)}$$

$$= 20 \text{ (msec)}$$

If the recording interval T is set to 160 msec, the recording multiplying factor T/t will be 8, and a 24-hour recording will be realized by the use of the magnetic tape for 3-hour recording.

In principle, a video signal is generated in accordance with one of the three primary standards such as NTSC, PAL, and SECAM. The NTSC standard employs a field frequency of 60 Hz, a frame frequency of 30 Hz, and 525 horizontal scanning lines (line number). On the contrary, the PAL and SECAM standards employ a field frequency of 50 Hz, a frame frequency of 25 Hz, and 625 line numbers. Shortly, both the PAL and the SECAM systems are identical with respect to the frame, field and line number. Further, these two standards have a common in that a phase and/or a frequency of a burst signal is periodically switched between two predetermined values every one line at a two-line period. However, these two standards are different in that, in accordance with the PAL system, the phase of the burst signal is alternately reversed between 135 degree and -135 degree as compared with a color subcarrier, whereas, in accordance with the SECAM standard, the burst signal is frequency-modulated by a carrier wave, the frequency of which is switched every one line.

Conventionally, an intermittent magnetic recording apparatus which meets the PAL/SECAM standards has already been introduced in the market. The recording multiplying factor T/t of this apparatus is set to the multiple number of 8 for reasons of the above.

However, in case the recording multiplying factor T/t

is set to the multiple number of 8, several disadvantages such as a color disappearance or the like occur. These disadvantages are due to that the correlation of the burst phase, or of the carrier frequency, between the fields to be recorded adjacently on the magnetic tape is different between at intermittent recording and at normal recording that successively records the video signal without performing the intermittent recording.

Figs. 5 and 6 show the correlation of the frame, field, and line in accordance with the PAL and the SECAM standards, respectively.

As seen from these figures, one frame consists of two fields. As one frame includes 625 lines, one field comprises $625/2$ lines. A first frame "1" consists of a field 1A and a field 1B wherein a numeral "1" denotes a frame number, for example, and the field 1A includes lines from a first line to a 312.5th line.

As mentioned above, in the PAL/SECAM standards, the burst phase or the carrier frequency is periodically inverted or switched every one line. In Fig. 5, inside of each rectangular which corresponds to each line, the state of the burst phase or the carrier frequency is indicated by an arrow. For example, in the PAL standards, an arrow directing upward denotes a state in which the burst phase is 135 degree.

Meanwhile, symbols in both Figs. 5 and 6 such as I, II, III, or IV, are an identification code. These symbols are assigned to each field with a consideration of the burst phase or the carrier frequency. For instance, it will be understood that a first field of the identification code I is different from a third field of the identification code III in respect of the initial state of the burst phase or the carrier frequency of the first line, i.e., a burst phase correlation or a carrier frequency correlation. The identification code is the symbol that represents the characteristic of each field. That is to say, with regard to the burst phase or the carrier frequency, the first field with the code I and the second field with the code II, and the third field with the code III and the fourth field with the code IV respectively have the same correlation therebetween.

The regularity shown in the drawings controls the operation of a phase discriminating circuit of the PAL standard. That is, when the burst phase correlation of the video signal of the PAL standard is deteriorated, the phase discriminating circuit cannot perform an expected operation. With this result, a so-called color disappearance or a hue distortion is observed on a playback screen. Moreover, unless the successiveness of the lines to be recorded adjacently is maintained, an excessive line sweep will occur.

In the case of the intermittent magnetic recording for recording a field extracted at a given period in accordance with a necessary recording multiplying factor T/t , the burst phase correlation or the carrier frequency correlation is generally different from that at successive recording. The burst phase correlation or the carrier frequency correlation cannot effect an expected operation of the phase identification circuit of the PAL standard.

These disadvantages may differ according as how the necessary recording multiplying factor T/t is determined.

The recording multiplying factor T/t employed in the intermittent magnetic recording method which meets the PAL/SECAM standards is the multiple number of 8. Each of the multiple number of 8 is a number which belongs to the group of $4N + 4$ ($N = 1, 2, 3, \dots$).

When the recording multiplying factor T/t is set to $4N + 4$, the burst phase correlation or the carrier frequency correlation will become as shown in Fig. 7. What is illustrated in Fig. 7 is the correlation obtained in the case of $N = 1$. On this point, however, even in the case of $N > 2$, the similar correlation is established.

When the recording multiplying factor T/t is set to $4 \times 1 + 4 = 8$, a video signal is recorded on the tape in the order of a 1st field, a 9th field, and a 17th field... All of these

fields are indicated in the identification code I.

Therefore, the correlation of the lines between the fields to be recorded adjacently become discontinued, and such state is shown in Fig. 8. More specifically, a 0.5 line of the 313th line is recorded. As a result, the line interval is deteriorated, and causes an excessive line sweep of the horizontal synchronization when playing back. In addition, in such an apparatus as records one frame by the use of two heads alternately at an interval in the successive recording, only one head of the two is used for one field, whereas the remaining head is used for another field at the of intermittent recording.

Thus, in the conventional intermittent magnetic recording, there occur several disadvantages such as color disappearance, hue distortion or excessive line sweep.

SUMMARY OF THE INVENTION

The present invention is to provide a method and an apparatus capable of solving the above-mentioned unwanted phenomena and properly playing back a recorded video signal without causing the color disappearance, hue distortion, or excessive line sweep, or the like.

To achieve the above purpose, according to one aspect of the present invention, there is provided an intermittent



magnetic recording method comprising the steps of:

(a) periodically extracting one field from a video signal, quantity of which differs at every field and is periodically switched between two predetermined values at a field cycle of "n" (n : an integer of 1 or more), at a field cycle of $nN + 1$ (N: an integer of 1 or more); and

(b) recording the extracted field signal on a magnetic tape.

Thus, if one field is extracted at the field cycle of $nN + 1$, a phase and/or a frequency of the field to be recorded adjacently will be inverted in the same order as that at successive recording. This periodical switching of the phase and/or the frequency is due to the following reasons. When such field extraction is carried out, the number of fields originally existing between the fields to be recorded adjacently is nN . The duration of the nN fields includes N periods (n fields) in which period the phase and/or the frequency is switched. Accordingly, if the phase and/or the frequency of the field recorded at some point belongs to the first phase and/or the frequency group, a next field to be recorded will have a phase and/or a frequency after the first group.

With this result, in accordance with the conventional method, the unwanted phenomena due to the insuccessive



switching of the phase and/or the frequency at the playback will never occur.

The present invention is applicable to such standards of the video signals as PAL and SECAM. When a video signal which meets the PAL standard is recorded by means of the intermittent magnetic recording technique, the aforementioned parameter "n" is 4. As a result, the drawbacks of the conventional method will be prevented, that is, the color disappearance, hue distortion, and excessive line sweep, etc. The same parameter and similar consequent result apply to a video signal of the SECAM standard to be recorded by the intermittent magnetic recording technique.

In practice, the frequency-extraction of one field which is executed at the field cycle of $nN + 1$ in the present invention is attained by the following steps.

First, a video signal is separated from a vertical synchronization signal. This vertical synchronization signal (hereinafter called as v-sync signal) is included in order to secure the vertical synchronization of a screen, and it is possible to deem that the video signal of one field is supplied each time one v-sync signal is counted.

Next, this v-sync signal is then counted up to the number of $nN + 1$. This step is a feature of the present invention, that is, a step of setting a recording multiplying



factor.

Thereafter, the video signal of one field is extracted after this counting operation is completed.

Thus, the intermittent magnetic recording of the present invention is achieved with simple steps.

In other words, the present invention can be realized with the economical method.

Moreover, the above-mentioned intermittent magnetic recording method of the present invention can be effected with an intermittent magnetic recording apparatus, comprising:

(a) a recording means for recording a video signal quantity of which differs at every field and is periodically switched between two predetermined values at an n field cycle on a magnetic recording tape;

(b) a separating means for separating a vertical synchronization signal from the video signal; and

(c) a recording control means for recording the video signal of one field on the magnetic tape each time the v-sync signal in the number of $nN + 1$ arrives.

Further, it goes without saying that this apparatus is applicable for the video signal that meets either the PAL standard or the SECAM standard.

For the structural components of this apparatus, the recording means includes, for example, a rotating drum and a



rotating magnetic head. The rotating drum rotates at a given frequency in synchronization with the v-sync signal, and the rotating magnetic head records the video signal on the tape scanning the tape surface.

In addition, the recording control means further includes a counter, a driving instruction means and a record timing control means. The counter counts the number of the v-sync signals. The driving instruction means issues a drive instruction signal when the accumulated count reaches the number of $nN + 1$, namely, the counter completes its count. And the recording timing control means supplies the video signal of one field toward the recording means in accordance with the drive instruction signal.

Here, the drive instruction means may be composed of an RS flip-flop and the recording timing control means can also be formed in a switch, and being possible to simplify the structure of the apparatus.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of preferred embodiments of the invention, as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is view for explaining an intermittent magnetic

recording method in accordance with one embodiment of the present invention and for illustrating contents of a setting of a recording multiplying factor;

Fig. 2 is a block diagram for illustrating the structure of the intermittent magnetic recording apparatus which operates in accordance with the method shown in Fig. 1;

Fig. 3 is a timing chart illustrating an operation timing of the apparatus shown in Fig. 2;

Fig. 4 is a view for illustrating the concept of the recording multiplying factor;

Fig. 5 is a view for illustrating a correlation of a frame, a field, a line of PAL/SECAM standards;

Fig. 6 is a view for illustrating the correlation compressed in the direction of time axis;

Fig. 7 is a view for explaining unwanted phenomena with the conventional intermittent magnetic recording method of the PAL/SECAM standards, and more particularly, the discontinued correlation of a burst phase or a carrier frequency; and

Fig. 8 is a view for explaining unwanted phenomena with the conventional intermittent magnetic recording method of the PAL/SECAM standards, and more particularly a discontinuity of the line.

DETAILED DESCRIPTION OF THE EMBODIMENTS

In Fig. 1, there is disclosed an intermittent magnetic recording method in accordance with one embodiment of the present invention, and more particularly a correlation of a burst phase or a carrier frequency when a recording multiplying factor T/t is set to 5. For simplifying the description, there will be described the intermittent magnetic recording of the video signal which meets the PAL standard, and by merely replacing the "burst phase" into a "carrier frequency" in the explanation hereinbelow, the same description will apply to the recording of the signal which meets SECAM standard. Moreover, the multiplying factor T/t is not limited to 5, and the same explanation will be applied even if the multiplying factor is set to $4N + 1$, where N is an integer of 1 or more. Moreover, it may be possible that the multiplying factor T/t is not constant at one recording time. Namely, the recording density may be a combination of numbers which belong to a set of $4N + 1$. For instance, it may be possible to set the recording multiplying factor to a combination of numbers, which belong to the set of $4N + 1$, such as 5 at one field, 9 at a next field, and 13 at a field after next.

As shown in Fig. 1, in accordance with the present invention, one field is extracted and recorded at an interval of 5 fields in the order of 1, 6, 11, 16, and so forth. If the order of recording is expressed by the order of the

identification code, they will be I, II, III, IV, ... That is, the intermittent magnetic recording is performed with the same burst phase correlation as that at the successive recording.

As a result, unwanted phenomena such as color disappearance, hue distortion are prevented. In addition, since the successiveness of the line is maintained, the excessive line sweep will be eliminated.

The burst phase correlation that produces the above-mentioned is obtained by setting a field cycle for extraction, namely, setting the recording multiplying factor T/t .

When the recording multiplying factor T/t is set to either $4N + 2$ or $4N + 4$, the order of the identification codes will be a cyclic repetition of such a pair of symbols as I, III, I, III ... In addition, the successiveness of the line will not be maintained.

In addition, when the recording multiplying factor T/t is set to $4N + 3$, the order of the symbols will be IV, III, II, I...

Therefore, the only multiplying factor T/t that can realize the burst correlation the same as that at the successive recording and maintain the successiveness of the line is $4N + 1$.

With this method, if the intermittent magnetic recording is made on a magnetic tape for three-hour recording

use. it is possible to record the video signal for 15 hours which is obtained by a product of 3 and 5.

Still another advantage in accordance with the present invention is in that the recording multiplying factor T/t can be set to a number belonging to a multiple number of 8 with 1. Specifically, compared to the conventional art in which recording is made on a three-hour recording tape in the unit of one day, the present invention makes it possible to realize a 27-hour recording with the three-hour recording tape. This additional three hours will never cause any inconvenience to the usability.

Fig. 2 shows an apparatus of performing the intermittent magnetic recording method for a PAL signal show in Fig. 1. At an input terminal 1, the PAL signal is applied. This input terminal 1 is connected to a recording signal processing circuit 2. The processing circuit 2 is provided for converting an input video signal into a signal possible to be recorded on a magnetic tape 3, and this circuit 2 further comprises non-illustrated circuits such as a pre-emphasis circuit, an FM modulation circuit, a recording equalizer, and an amplifier, and the like.

An output from the recording signal processing circuit 2 is delivered to both of magnetic heads 5a, 5b by way of a changeover switch 4. The switch 4 further comprises three

terminals, that is, 4a, 4b, and 4c, and the switch 4 is designed in such a manner that the terminal 4c is switched and connected to either the 4a or the 4b. The terminal 4a is connected to the recording signal processing circuit 2, whereas the terminal 4b is grounded. At the terminal 4c, both the magnetic heads 5a and 5b are connected, and these heads are located to a predetermined position on the rotating drum 6. The rotating drum 6 is linked with a drum motor 7, and is driven by the same.

The foregoing input terminal 1 is also connected to a vertical synchronization signal separation circuit 8, which extracts a vertical synchronization signal (50 Hz) exclusively from the video signal and outputs the extracted signal. The output of the v-sync signal separation circuit 8, that is, a v-sync signal "a" is transferred to a drum controller 9, a field counter 10, and a reset terminal of an RS flip-flop 11.

At the drum controller 9, a signal of rotating velocity and angle of rotation detected from the drum motor 7 is inputted. The drum controller 9 performs a servo-control of the rotation of the drum motor 7 in such a manner that the v-sync signal from the drum motor 7 synchronizes with the detection signal from the drum motor 7. On the other hand, the field counter 10 counts a pulse included in the sync signal from the v-sync signal separation circuit 8, and is formed in

such a manner that values are accumulated each time the pulse is counted and the counter is again reset to 0 whenever the accumulated values reach predetermined count value. Furthermore, when the field counter 10 counts up to the predetermined value, a count-up signal "b" is issued.

This count-up signal "b" is then delivered to a set terminal of the RS flip-flop 11. An output "d" from the Q terminal of the RS flip-flop 11 is not only transferred to a capstan controller 12 as a capstan drive instruction signal but also transferred to the changeover switch 4 as a switch control signal. Upon receipt of the capstan drive instruction signal d, the capstan controller 12 accepts the detection signal of rotating velocity and rotation angle detected from the capstan motor 13, and performs a servo-control of the capstan motor 13 in response to this signal. The capstan motor 13 is linked with a capstan 14. Consequently, the capstan 14 is rotationally driven by the capstan motor 13 and applies a driving force to the magnetic tape 3.

Fig. 3 shows waveforms of signals at points shown in Fig. 2. In Fig. 3, there are illustrated waveforms of the v-sync signal "a" output from the v-sync signal circuit 8, the count-up signal "b" output from the field counter 10, and the output "d" from the Q terminal of the flip-flop 11.

A recording operation by the apparatus shown in Fig. 2.

namely, an intermittent magnetic recording operation having the recording multiplying factor $T/t = 4N + 1$ will now be described hereunder with reference to Fig. 3.

First, when the video signal is input from the input terminal 1, the v-sync signal "a" as shown in Fig. 3 is extracted by the v-sync signal separation circuit 8. This v-sync signal "a" is applied to the field counter 10, and the number of pulses of the signal "a" is counted. As mentioned before, when the field counter 10 counts each pulse and the accumulated count value reaches a predetermined value, the counter 10 issues the count-up signal "b" shown in Fig. 3. Now, in an nth field, assuming that the count-up signal "b" is output from the field counter 10, the RS flip-flop 11 is set at the leading edge of the count-up signal "b". Therefore, the output "d" from the Q terminal of the RS flip-flop 11 will become high as shown in Fig. 3. In response to the high level output, the capstan controller 12 starts to drive the capstan motor 13, and then the capstan motor 14 is driven. With this result, the tape 3 travels around the rotating drum 6.

Meanwhile, the output "d" from the Q terminal of the RS flip-flop 11 is also supplied to the changeover switch 4 as a switch control signal. This changeover switch 4 switches so as to connect between the terminals 4c and 4b when the output "d" is low, and to connect between the terminal 4c and 4a when the

output "d" is high. Accordingly, in the state the output "d" is high, the video signal processed by the recording signal processing circuit 2 is supplied to both the magnetic heads 5a and 5b. Consequently, the video signal of the nth field is recorded on the magnetic tape 3 which is traveling around the rotating drum 6.

After the nth field comes to an end and when the v-synch signal "a" rises as shown in Fig. 3, the RS flip-flop 11 is reset. With this result, the output "d" from the Q terminal of the RS flip-flop becomes low. In response to this low output the capstan controller 12 causes the capstan motor 13 to stop. In consequence, the magnetic tape 3 halts its travel. In other words, the tape 3 travels only during the period of the nth field, and the video signal of the nth field is merely recorded on the tape 3. Besides, in response to the output "d" from the Q terminal of the RS flip-flop 11, the changeover switch 4 is turned to the side of the terminal 4b, and the supply of the video signal to the magnetic heads 5a and 5c is stopped.

Thereafter, the field counter 10 is reset by the v-synch signal "a" of the nth field, and then restarts a counting operation from a v-synch signal "a" which corresponds to a next field. Then the field counter 10 will not produce an output of the count-up signal until five pulses, i.e., a v-synch signal

"a" in the number of $n + 5$ th is counted. Consequently, the RS flip-flop has not been reset between the $n + 1$ th field and the $n + 5$ th field, and the magnetic tape 3 has been stopped.

When the v-sync signal "a" of the $n + 5$ th field rises, the field counter 10 starts a counting operation and produces an output of the count-up signal "b" shown in Fig. 3. Thereby, the RS flip-flop is reset in response to this count-up signal "b", and the driving of the capstan motor 13 is started by the capstan controller 12.

In consequence, the magnetic tape 3 starts traveling. Concurrently, the changeover switch 4 is turned to the side of the terminal 4a, and the video signal from the recording signal processing circuit 2 is supplied to the magnetic heads 5a and 5b. Thereby the video signal of the $n + 5$ th field is recorded on the magnetic tape 3.

Meanwhile, since the magnetic tape 3 has been suspended between the $n + 1$ th field and the $n + 5$ th field, the video signal of the $n + 5$ th field is recorded on the field adjacent to the field 1 at which the video signal of the n th field is recorded.

When the v-sync signal "a" rises as shown in Fig. 3 after the $n + 5$ th field comes to an end, the RS flip-flop 11 is reset, and the traveling of the tape 3 is stopped. The magnetic tape 3 travels only the during of the $n + 5$ th field.

and the video signal of the $n + 5$ th field is merely recorded on the tape 3.

Following the above-mentioned operations, a series of the same operations are repeated, and the video signal is intermittently recorded at every 5 fields. Specifically, the video signal is recorded with the intermittent recording multiplying factor of 5.

Like the aforementioned embodiment, when the PAL signal is recorded with the intermittent recording medium having the multiplying factor of 5, the video signal on the tape 3 is arranged in the order of the field numbers such as I-II-III-IV as shown in Fig. 1 and the burst phase of the lines with odd numbers are inverted at every frame. Accordingly, it becomes possible to produce a proper playback screen without color disappearance, hue distortion, and excessive line sweep when playing back the video signal.



WHAT IS CLAIMED IS:

- (1) An intermittent magnetic recording method which is capable of recording a video signal on a magnetic tape by extracting one field from the video signal, quantity of which differs at every field and is periodically switched between two predetermined values at a field cycle of "n" field, where "n" an integer of 1 or more, at a field cycle of $nN + 1$, where N is an integer of 1 or more.
- (2) An intermittent magnetic recording method according to claim 1, wherein a standard of the video signal is PAL standard, and said field cycle "n" thereof is 4.
- (3) An intermittent magnetic recording method according to claim 2, wherein said method further comprising the steps of:
 - (a) separating a vertical synchronization signal from the video signal;
 - (b) counting said vertical synchronization signal up to the number of $nN + 1$; and
 - (c) extracting the video signal of one field after said counting operation is completed.
- (4) An intermittent magnetic recording method according to claim 1, wherein a standard of the video signal is SECAM standard, and said field cycle "n" thereof is 4.
- (5) An intermittent magnetic recording method according to claim 4, wherein said method further comprising the steps of:





(a) separating a vertical synchronization signal from the video signal;

(b) counting said vertical synchronization signal up to the number of $nN + 1$; and

(c) extracting the video signal of one field after said counting operation is completed.

(6) An intermittent magnetic recording apparatus comprising:

(a) a recording means for recording a video signal quantity of which differs at every field and is periodically switched between two predetermined values at a field cycle of n , where n is an integer of 1 or more, on a magnetic tape;

(b) a separating means for separating a vertical synchronization signal from the video signal; and

(c) a recording control means for recording the video signal of one field on a magnetic tape each time said vertical synchronization signal in the number of $nN + 1$ arrives.

(7) An intermittent magnetic recording apparatus according to claim 6, wherein a standard of the video signal is PAL standard, and said field cycle n thereof is 4.

(8) An intermittent magnetic recording apparatus according to claim 6, wherein a standard of the video signal is SECAM standard, and said field cycle n thereof is 4.

(9) An intermittent magnetic recording apparatus according to claim 6, said recording means comprising:





(a) a rotating drum for rotating at a given frequency in synchronization with said vertical synchronization signal; and

(b) a rotating magnetic head for recording the video signal by scanning on the surface of the magnetic tape positioned on the periphery of said rotating drum.

(10) An intermittent magnetic recording apparatus according to claim 6, wherein said recording control means comprising:

(a) a counter for counting the number of said vertical synchronization signals;

(b) a drive instruction means for issuing a drive instruction signal when accumulated count values reach the number of $nN + 1$; and

(c) a recording timing control means for supplying the video signal of one field in accordance with said drive instruction signal.

(11) An intermittent magnetic recording apparatus according to claim 10, wherein said drive instruction means is an RS flip-flop, and said recording timing control means is a switch.

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