Description

The present invention relates to a method and apparatus for recording a digital information signal which are suitable for use in the recording of a digital information signal such as an audio PCM signal or the like on a recording medium, particularly, on a magnetic tape.

There has been proposed a digital tape recorder which records an audio PCM signal as parallel multitracks on a magnetic tape enclosed in a cassette casing by fixed heads. In case of recording and reproducing the audio PCM signal on and from the multitracks, there is a case where a fairly long burst error is generated in the reproduced signals from the adjacent tracks which are included in a part of width of the magnetic tape. This phenomen is caused due to scratches in the longitudinal direction of the magnetic tape or to unstable contact between the magnetic tape and the magnetic heads due to the defective magnetic tape running system. When this burst error exceeds the correcting capability of the error correction codes which are used, the erroneous words are concealed.

As an error concealment, a method of interpolating by the mean value of the values of the correct words before and behind the erroneous word is used. However, if the correct words do not exist before and behind the erroneous word due to a long burst error, the mean value interpolation cannot be used. In such a case, the reproduced audio signal is subjected to preceding value holding or muting.

For digital tape recorders of such a multitrack type, there has been considered a recording method whereby the 16-bit linear quantized two-channel audio PCM signal derived at a sampling rate of 44.1 KHz is recorded at about 1.4 M bits/second on twenty tracks of the magnetic tape which is running at a tape speed of 4.76 cm/sec.

There has been considered another recording method whereby the 16-bit linear quantized two-channel audio PCM signal in the sampling rate of 68 KHz is recorded as the recording data of about 1.8 M bits/second on twenty tracks of the magnetic tape which is running at a tape speed of 5.18 cm/sec (hereinafter, referred to as 2M mode).

Further, another recording method has been considered whereby the 12-bit non-linear quantized two-channel audio PCM signal derived by a lower sampling rate of, for example, 32 KHz is recorded on the magnetic tape at about 0.9 M bits/second so as not to substantially cause any trouble in the recording and reproduction in the audible frequency band (hereinafter, referred to as 1M mode).

These recording methods are set in accordance with the particular end use or the like. In the recording method called the 1M mode, the amount of data which is recorded is one half as compared with that in another recording mode called the 2M mode, in which the number of tracks of recorded data is selected as twenty, the tape speed can be reduced to half (2.6 cm/sec) of the 2M mode, thereby enabling a longer recording time to be obtained. On the contrary, if the tape speed is set to be equal to that in the 2M mode, the same amount of data can be recorded on the ten tracks. If the number of tracks is reduced to half, the track pitch can be doubled. Therefore, this makes it possible to easily perform the tracking operation upon reproduction. It is considered that this recording method using the 10-tracks in the 1M mode will come into wide use before the recording method using the 20-tracks.

However, when superiority of the performance of the 20-tracks type is considered, there is a risk such that the 10-tracks type will have been neglected as an old-fashioned method.

Therefore, it is a requirement that the magnetic tape recorded by the 1M-mode method using ten tracks can be compatibly reproduced by the 2M-mode tape recorder using twenty tracks. This compatibility is needed to be satisfied as well even with respect to not only the track pattern but also the error correction codes.

Generally, in case of performing the error correction encoding process, if one symbol consists of a number of information bits, the encoding circuit becomes complicated and the time required for the encoding process becomes long. Therefore, one word (for example, 16 bits) is divided into the most significant eight bits and the least significant eight bits, and the error correction codes, e.g., Reed Solomon codes are constituted using these eight bits as one symbol.

In case of recording one word by dividing it into the symbols each consisting of eight bits in this way, it is necessary that both two symbols forming the same single word are the correct data upon reproduction. Even if one of these two symbols is the correct data, when the other symbol is the erroneous data, the correct one word cannot be obtained. Thus, it is generally required that the symbols forming the same single word are included in a common series of error correction codes. However, in the case where the interleaving process ist also performed for improvement of the error correction capability, the recording positions of these two symbols are positions with a weak error correlation such as being in separate tracks. Thus, there is practically a problem such that only one of the two symbols forming a word is found to have an error.

Method and apparatus for communicating digital information words by error-correction and cod-

ing decoding is known from the British Patent Application GB-A-2 060 227. According to the disclosure the information words are separated into a sequence of odd information words and a sequence of even information words and the separated odd and even information word sequences are time-displaced from each other by a patentee mind amount. The odd information words are encoded in a error-correcting code, and the even information words are separately encoded in a similar error-correcting code. The encoded time-displaced odd and even information words are combined into a transmission block which is transmitted or recorded. The information words are encoded by generating a respective error-correcting word in response to the odd and even information word sequences. The information and error-correcting words of the two sequences are selectively delayed to form two sub-blocks of interleaved words. An error-correcting word is generated from the two sub-blocks and this word and the two sub-blocks are combined to form the transmission block. If an information-word containes an uncorrectable error a correct information word is approximated by interpolating adjacent decoded odd or even information words so as to approximate a correct even or odd information word as the case may be. It is important to emphasize that the odd/even interleaving is performed with respect to the longitudinal direction of the respective track.

A PCM tape recording and reproducing apparatus having a dropout-immune data recording format is known from the European Patent Application EP 82 108 375. This application discloses a PCM tape recording and reproducing apparatus for an audio signal by using multitrack heads, comprising a frame interleaving device with a high dropout-immunity function. The frame interleaving device comprises a distributer for distributing continuous interleaved input data between a plurality of tracks formed by splitting a magnetic tape, a data framing circuit for forming a frame out of data to be distributed to each of the tracks and for providing the frame with a synchronization signal at the top of the frame and with an error detection code at the end of the frame. The apparatus according to the disclosure further comprises a delay circuit for delaying data associated with a track by at least one frame. Further, the recording apparatus works in such a manner, that continuous words contained in one channel are recorded on nearest tracks.

It is the objective of the present invention to provide a method and an apparatus for recording a digital information signal in which even long burst errors can be corrected, which exceeds the correcting capability of the used error correcting codes and which are caused in the reproduced signals from a few adjacent tracks.

According to the present invention the method for recording a digital information signal in which a digital information signal is recorded on a plurality of parallel tracks which are formed in the longitudinal direction of a recording medium comprising the steps of separating a time series of the digital information signal into a plurality of even-numbered words and a plurality of odd-numbered words, performing an error correcting coding process with regard to a plurality of words so that error correcting codes are generated with regard to adjacent even-numbered words and adjacent odd-numbered words separately, is characterized by recording said adjacent even-numbered words and odd-numbered words, respectively, on different tracks which are separated more than n tracks from each other, n being the number of signal channels with respect to the widthwised direction of said recording medium.

On the other hand according to the present invention the apparatus for recording a digital information signal in which a digital information signal is recorded on a plurality of parallel tracks which are formed on the longitudinal direction of a recording medium comprising means for separating a time series of said digital information signal into a plurality of even-numbered words and a plurality of odd-numbered words means for performing an error correcting coding process with regard to a plurality of words so that said error correcting codes are generated with regard to adjacent even-numbered words an adjacent odd-numbered word separately, is characterized by means for recording said adjacent even-numbered words and odd-numbered words, respectively, on different tracks which are separated more than n tracks from each other, n being the number of signal channels with respect to the widthwise direction of said recording medium.

Therefore, even in the case of a long burst error which is generated due to scratches in the longitudinal direction of a magnetic tape or defective contact between the magnetic tape and the magnetic head due to the turn-over or cupping of the magnetic tape, also like, the erroneous word can be interpolated by the mean value of the correct words adjacent to the erroneous word.

Fig. 1 is a tape pattern diagram showing track arrangements in the 20-tracks mode and 10-tracks mode in a digital audio tape recorder;

Fig. 2 is a block diagram showing the main part of a recording system of a digital tape recorder showing one embodiment of the present invention;

Fig. 3 is a data format diagram showing a data process in a 12-16 converter in Fig. 2;

Fig. 4 is a block diagram showing an encoding section and a track distributor in Fig. 2;

Fig. 5 is a schematic diagram showing an arrangement of one block of a recording data;

Figs. 6 to 8 are schematic diagrams which are used for explaining a recording format in case of the 20-tracks mode;

Fig. 9 is a schematic diagram showing a recording format in case of the 10-tracks mode corresponding to Fig. 7; and

Fig. 10 is a block diagram shoving an example of an arrangement of the track distributor.

One embodiment in the case where the present invention is applied to a digital tape recorder will now be described hereinbelow with reference to the drawings.

Fig. 1A shows an arrangement of tracks of a digital tape recorder which can selectively record on and reproduce from twenty tracks, respectively. Tracks in the forward path are formed at positions indicated at T1, T2, ..., T20 in one of the areas of a magnetic tape 60 divided by a longitudinal center line C by means of twenty thin film heads arranged in the width-wise direction of the magnetic tape in correspondence to the twenty tracks. By reversing a tape cassette, tracks in the backward path are symmetrically formed in the other area relative to the center line C.

Fig. 1B shows an arrangement of tracks of a digital tape recorder which can selectively record on and reproduce from ten tracks. As shown in Fig. 1B, a track width and track pitch are approximately twice as large as those in case of twenty tracks, so that the degree of accuracy regarding the locations where the magnetic heads are attached and the degree of tracking accuracy may be reduced.

In this case assuming that a digital information signal is recorded in the track arrangement shown in Fig. 1B in order to enable the magnetic tape so recorded to be also reproduced by a tape recorder having the track arrangement shown in Fig. 1A, the locations in both track arrangements must be aligned.

Fig. 2 is a block diagram showing an overall recording circuit in which a two-channel audio PCM signal of non-linearly quantized twelve bits in a sampling rate of 32 kHz is supplied to this recording circuit. This audio PCM signal is supplied to an encoding section 30 through a 12-16 converter indicated at 20. Outputs of the encoding section 30 are supplied to a track distributor 40. Recording data corresponding to ten tracks are outputted from the track distributor 40 and are recorded on the magnetic tape by recording heads 50. This encoding section 30 is the same of the encoding section which would be used if recording on twenty tracks. The error correcting processes in the 1M and 2M modes are the same.

The 12-16 converter 20 divides the 12-bit input data into the 16-bit time slots and can process the 12-bit input data in a similar manner as the 16-bit quantized data at the sampling rate of 48 kHz, which is the desired input to the encoding section 30. The track distributor 40 serves to distribute the output data of twenty tracks that was processed in the encoding section 30 to the recording heads 50 of ten tracks. This track distributor 40 is, for example, a buffer memory and converts data which should be recorded on two tracks to the data which can be recorded together on one track.

The encoding section 30 performs the error correction coding of, e.g., CIRC codes (cross interleaved Reed Solomon codes). Namely, the encoding section 30 is constituted by delay element group 4 for performing the even-odd interleaving and a C2 encoder 6 and delay element group 7 for performing the interleaving and a C1 encoder 10.

The converting process of the 12-16 converter 20 will now be described with reference to Fig. 3, in which line A shows a series of two symbols (indicated together with suffixes A and B) each of which has six bits and which are obtained by dividing each of the words (12 bits) L'_0, L'_1, ..., L'_7 of the audio PCM signal in one channel into two parts. This data series is combined into sets each consisting of four symbols which as shown in line B of Fig.3 are four even numbered words and which have the suffixes of A or B. These sets, each having four symbols, having a length of 24 bits as a whole are respectively constituted by the symbols included in the even numbered words and all having the same suffixes, A or B. The odd numbered words are likewise combined into sets, each of which consists of four symbols and having a length of 24 bits.

As shown in line C of Fig.3, these sets (24 bits) each consisting of four 6-bit symbols are converted into sets each consisting of three eight-bits symbols. More specifically, 24 bits are divided into three parts each consisting of eight bits and each part can be regarded as an 8-bit symbol. As shown in line D of Fig. 3, these 8-bits symbols ($L_{0,A}$; $L_{2,A}$; ...; $L_{5,B}$) after conversion are rearranged to the original sequence and are inputted to the encoding section 30. The execution of this bit conversion enables the even-odd interleaving to be performed just as in the case where one word consists of sixteen bits, thereby preventing reduction of the error correcting capability. The C2 encoder 6 performs the encoding process of the error correction codes C2 for every 16 symbols. Since the foregoing bit conversion is carried out on a three-symbol unit basis, the fraction of one symbol is caused. However, since the information symbols in one block consist of 480 symbols, this fraction is not forced out of one block. Therefore, this makes it possible to prevent the processing cycle from becoming to long by preventing the decoding of

the results of adjacent blocks.

Fig. 4 shows a detailed arrangement of the encoding section 30. Fig. 4A shows the input side and the signal processes are performed in accordance with the sequence of Fig. 4B, Fig. 4C and Fig. 4D.

In Fig. 4A, a reference numeral 1 denotes input symbols of the audio PCM signal to be recorded. Each of eight words per each channel, namely, (L_{8n}, L_{8n+1}, ..., L_{8n+7} in the left channel) and (R_{8n}, R_{8n+1}, ..., R_{8n+7} in the right channel) is divided every two symbols, and the total 32 symbols are synchronously inputted. As shown in Fig. 4A, the symbols of W_{16n+i} (where, i = 0, 1, 4, 5, 8, 9, 12, 13) denote the symbols of the even-number designated words. And the symbols of W_{16n+j} (where, j = 2, 3, 6, 7, 10, 11, 14, 15) indicate the symbols of the oddnumber designated words. In addition, the symbols to which the suffix A is added denote the most significant 8-bits of one word. The symbols to which the suffix B is added represent the least significant 8-bits of one word.

The above-mentioned input symbols are supplied to a delay element group 2. This delay element group 2 is constituted by sixteen delay elements for delaying only the symbols with the suffix B. The outputs of the delay element group 2 are supplied to a switching circuit 3. The switching circuit 3 alternately selects the inputted 16 symbols having the suffix A and the 16 symbols having the suffix B, which were delayed by one symbol amount, and outputs the selected symbols, thereby permitting the C2 encoder that is the following stage to operate on a time-sharing basis.

The outputs of the switching circuit 3 are supplied to the delay element group 4. The delay element group 4 supplies the symbols $W_{16n+i,A}$ or $W_{16n+i,B}$ of the even-numbered words to the C2 encoder 6 (Fig. 4B) without being delayed, and meanwhile it supplies the symbols $W_{16n+j,A}$ or $W_{16n+j,B}$ of the odd-numbered words to the C2 encoder 6 after being delayed by amount of D_0. Due to this delay element group 4, the symbols of the even-numbered words and the symbols of the odd-numbered words which are adjacent each other are recorded at the positions which are away from each other by an amount D_0 in the longitudinal direction of a magnetic tape. This process is referred to as even-odd interleaving in the longitudinal direction. The amount D_0 is selected to be, for example, equal to a length of 900 symbols.

Signal lines 5 as the outputs of the delay element group 4 are exchanged and connected to the C2 encoder 6. After the signal lines 5 are exchanged, the symbols of the odd-numbered words and the symbols of the even-numbered words are also alternately located. Fig. 4B shows sixteen symbols inputs to the C2 encoder 6 in which only symbols having the suffix A are selected by the switching circuit 3.

The C2 encoder 6 serves to perform the encoding process of the (20, 16) Reed Solomon codes C2. The C2 encoder 6 outputs twenty symbols consisting of four parity symbols of Q_{4n}, Q_{4n+1}, Q_{4n+2}, and Q_{4n+3} and sixteen information symbols. In the (20,16) Reed-Solomon Code 2 the distance between the error correction codes C2 is (d = 5). On the other hand, the outputs of the C2 on the Galois field encoder 6 are constituted in a manner such that the parity symbols Q_{4n}, ..., Q_{4n+3} are respectively arranged before every four information symbols.

The outputs of the C2 encoder 6 are supplied to the delay element group 7 as shown in Fig. 4B. Assuming that a unit delay amount is D_1, the delay element group 7 delays each of the twenty symbols by each of the delay amounts of 0, D_1, $2D_1$, ..., and $19D_1$ such that these delay amounts are increased sequentially by D_1. Due to this delay element group 7, the twenty symbols forming the same code series from the C2 encoder 6 are interleaved so as to be recorded with the distance of D_1 in the longitudinal direction of the magnetic tape. The amount of delay D_1 is set to, for example, be equivalent in lenght to 30 symbols.

The outputs of the delay element group 7 are supplied to a shift register circuit group 8. The shift register circuit group 8 has twenty shift registers of (8 bits x 30 stages), in which each stage has eight parallel output lines. The parallel outputs of the shift register circuit group 8 are supplied to the C1 encoder 10 through a switching circuit 9. The stitching circuit 9 sequentially selects the thirty symbols stored in each of the twenty shift registers and supplies them to the C1 encoder 10.

In this embodiment, the 30 symbols fetched from each shift register are included in one block and the encoding process of the error correction codes C1 is performed on this block unit basis. The (32, 30) Reed Solomon codes are used as the error correction codes C1, in which distance between the error correction codes C1 on the Galois field is (d = 3). At the outputs of the C1 encoder 10, 32 symbols including two parity symbols (indicated by P) appear. The symbols shown in Fig. 4B are generated when the switching circuit 9 selects, as illustrated, the outputs of the shift registers in which parity symbols Q_{4n}, Q_{4n-4}, ..., Q_{4n-116} are stored.

The 32 symbols which are outputted from the C1 encoder 10 are supplied to a shift register circuit group 12 through a switching circuit 11 as shown in rig. 4C. The shift register circuit group 12 has twenty shift registers of (8 bits x 32 stages + 32 bits). Namely, each shift register in the shift register circuit group 12 has 288 bits which are

equal to the length of one block. The parallel inputs for adding a block sync signal and the like are supplied to the 32 bits which are first fetched as a serial output of the shift register. Fig. 4C shows an arrangement for this addition with respect to only one shift register; arrangements regarding the others are omitted in the diagram.

A flag signal indicative of the control information necessary for process of data in each block or each track is supplied to a terminal 13. For instance, the flag signal indicates the number of bits of a sampled word, sampling frequency, on/off of pre-emphasis, auto-reverse mode or not, discrimination of the 20-track mode or 10-track mode, discrimination of two channels or four channels, and the like of the audio PCM signal recorded. Track addresses representative of track numbers are supplied to a terminal 14. Block addresses are supplied to a terminal 15 and a block sync signal is supplied to a terminal 16. These flag signal, track addresses and block addresses are supplied to the shift registers and a CRC encoder 17, so that the encoding process for error detection is performed. The redundant code (called the CRC code) of these CRC codes is also supplied to the shift registers. Fig. 5 shows a data arrangement of one block which is serially outputted from each shift register in the shift register circuit group 12.

The 8-bit block sync signal is arranged at the beginning of one block, then the 4-bit flag signal, 2-bit track address, 8-bit block address, and 12-bit CRC code are arranged sequentially, with number thereof being 32 bits. The track address may serve to discriminate a few adjacent tracks. After these 32 bits, thirty information symbols (240 bits) are located. Two symbols of the paritys P of the error correction codes C1 for these information symbols are arranged at the last in the one block. The data is recorded on the magnetic tape using this one block (288 bits) as a unit.

As shown in Fig. 4D, signal lines 18 led from the respective shift registers in the foregoing shift register circuit group 12 are subjected to the exchanging process and are supplied to a recording circuit. In the tape recorder having twenty tracks (see Fig. 1A), the above signal lines 18 are supplied directly to the channel encoder after they were exchanged. However, because this embodiment relates to the tape recorder of the ten-tracks (see Fig. 1B), the outputs of the signal lines 18 must be first time-shared multiplexed by the track distributor 40 so as to have the proper number of outputs for the ten tracks.

That is, the outputs of the adjacent two signal lines are combined to one. The track distributor 40 consists of switching circuits 41 and buffer memories 42. Each switching circuit 41 selects the signals which are on the adjacent odd-numbered and even-numbered signal lines 18 in accordance with the transmission timing of the shift register circuit group 12, thereby allowing them to be sequentially stored into a front stage section 42A and a rear stage section 42B of each buffer memory 42. The contents of these front and rear stage sections 42A and 42B are serially outputted and supplied to a channel encoder or modulator 48 corresponding to each track. The channel encoder 48 has ten digital modulators which are equal to the number of tracks to be recorded. The outputs of the channel encoder 48 are supplied to the recording heads 50 through a recording amplifier group 49. The recording heads 50 are constituted by, for instance, thin film magnetic heads having ten gaps corresponding to the tracks respectively. The recording is performed on ten tracks which are numbered sequentially from the upper edge of the magnetic tape.

Although in this embodiment the above-mentioned delay processes, exchanging processes of the signal lines, processes in the shift registers in the encoding section 30, and time-shared multiplexing processes by the switching circuits 41 and buffer memories 42 are described as being carried out by discrete circuit components, the necessary functions could also be executed by a random access memory (RAM), which is controlled by a microprogram.

The foregoing encoding processes will then be described while comparing the 20-track mode with the 10-track mode. The data which is fetched on the signal line 18 as the outputs of the shift register circuit group 12 in the 20-track mode is fundamentally the same as the data appearing as the outputs of the C2 encoder 6 if the interleaving in the longitudinal direction of the tape by the delay element group 7 is ignored. More specifically, when the twenty signal lines 18 are numbered sequentially from the top, the parity symbols Q of the error correction codes C2 are fetched on the respective 1st, 6th, 11th, and 16th signal lines, and the symbols of the even numbered words are fetched on the respective eight 3rd, 5th, 8th, 10th, 13th, 15th, 18th, and 20th signal lines. Further, the symbols of the odd numbered words are fetched on the respective 2nd, 4th, 7th, 9th, 12th, 14th, 17th, and 19th signal lines.

On the other hand, by interchanging those signal lines 18 it permits the in case of the 20-track mode, shown in Fig. 7, the parity symbols Q of the error correction codes C2 to be recorded on the 1st to 4th tracks near the upper edge, and the symbols of the odd numbered words to be recorded on the next 5th to 12th tracks, and the symbols of the even numbered words to be recorded on the 13th to 20th tracks near the lower edge.

In this way, by exchanging the signal lines 18, the symbols of the odd numbered words are recorded on the eight tracks located on the upper side in the direction of a width of the magnetic tape, while the symbols of the even numbered words are recorded on the eight tracks located on the lower side. Thus, the even-odd interleaving in the longitudinal direction can be performed. Since the parity symbols Q are redundant data that have lower significance than the information data, they are recorded on the tracks near the edge where errors easily occur due to the turn-over, damage-or the like of the edge.

Fig. 6 shows the data recorded on the magnetic tape. The encoding process of the error correction codes C1 is performed for every one block of the C2 parity symbols and the blocks consisting of the information symbols with the C1 parities P of two symbols being added thereto. Therefore, twenty blocks arranged in the direction of a width of the tape are constituted by the C2 parities Q of (30 x 4 = 120 symbols), information symbols of (30 x 16 = 480 symbols) and C1 parities P of (2 x 20 = 40 symbols).

On the other hand, since two symbols constituting one word are delayed by amount of one symbol by the delay element group 2, these two symbols are recorded as adjacent symbols in the same block. The error correction encoding processes are performed for the sixteen symbols having the suffix of A and for the sixteen symbols having the suffix of B, respectively. In Fig. 6, a C2 series (A) and a C2 series (B) as indicated by oblique lines are produced. For example, in Fig. 6, four symbols indicated by Δ are (Q_{4n}; Q_{4n+4}; $W_{16n+2-16D0,A}$; $W_{16n+2-16D0,B}$).The Q_{4n} and $W_{16n+2-16D0,A}$ are included in the C2 series (A) and the other two symbols are included in the C2 series (B).

As shown in Fig. 8, when it is assumed that the 16 symbols with the suffix of A among the 32 symbols corresponding to the eight successive words per channel of the audio PCM signal are represented by D_0, D_1, ..., D_{15}, respectively, are these 16 symbols are recorded on the magnetic tape at the locations shown in Fig. 7. The symbols of the odd-number designated words are delayed by the delay element group 4 (unit delay amount is D_0) in the encoding section 30, so that the symbols D_j (j = 2, 3, 6, 7, 10, 11, 14, 15) of the odd-number designated words are recorded at positions behind the even-numbered words designated by the symbols D_i (i = 0, 1, 4, 5, 8, 9, 12, 13). In this embodiment, the time difference D_0 between them is set to thirty blocks.

Due to the exchanging of the signal lines 5, the lines connecting the twenty symbols which form the common C2 series (A) become the folded lines as shown in Fig. 7. In the two C2 series (A) as illustrated, the symbols to which the signs of the symbols D_i and D_j are not added denote the other symbols which are outputted from the delay element group 4. One C2 series (A) is distributed so as to be recorded in the intervals corresponding to twenty blocks in the longitudinal direction of the tape. Therefore, the guard space corresponding to ten blocks in the longitudinal direction of the tape is interposed so that the even-odd interleaving is performed in the longitudinal direction of the tape on which the sets of the symbols D_i and the sets of the symbols D_j are recorded.

Due to the exchanging processes of the signal lines 18, the parities Q of the C2 series are recorded on the 1st to 4th tracks, the symbols D_j are recorded on the 5th to 12th tracks, the symbols D_i are recorded on the 13th to 20th tracks, and the interleaving in the direction of a width is performed. Thus the C2 series (B) which is formed by the symbols to which the suffix of B is added as shown in Fig. 8 can be represented by parallel folded lines after one symbol of the C2 series (A) shown in Fig. 7. Fig. 6 shows, therefore, a concrete diagram of the first two blocks passed by those parallel folded lines, as shown in Fig. 7 and especially tracks numbered 1 to 4.

In the tape recorder having ten tracks in the 1M mode, as described before, the twenty outputs of the encoding section 30 are subjected to the time-shared multiplexing processes by the track distributor 40 and are recorded on the ten tracks. Therefore, the data is recorded in a recording pattern as shown in Fig. 9, such that the tracks with the recording pattern of Fig. 7 are thinned out every other track and the data Q_1, Q_3, D_8, D_9, and the like included in these thinned out tracks are shifted respectively, onto the tracks just preceding those tracks. Namely, the data existing on the 2ith (i = 1, 2, ..., 10) tracks may be shifted onto the (2i-1)th (i = 1, 2, ..., 10) tracks and the (2i-1)th tracks may be numbered like (i = 1, 2, ..., 10).

Figs. 9 shows the C2 series (A) which is formed by the even-numbered words of the symbols to which the suffix A is added as shown in Fig. 8. The C2 series (A) by the symbols of the odd-numbered words is formed after thirty blocks similarly to Fig. 7, although it is not shown. Consequently, even in this embodiment of the ten-tracks pattern, the even-odd interleaving in the widthwise direction of the tape and the even-odd interleaving in the longitudinal direction of the tape are carried out.

The data recorded on the ten tracks in the 1M mode is reproduced from the magnetic tape 60 and is supplied to a data arrangement converter through a reproducing amplifier and a channel decoder. The data format of this data corresponding

to the ten tracks is converted to the data corresponding to the twenty tracks. The converted data is supplied to a reproducing decoder for performing the processes opposite to those in the encoding section 30. This reproducing decoder has the same arrangement as the reproducing decoder which is used in the digital tape recorder of the twenty tracks in the 2M mode, so that it performs the error correcting and deinterleaving processes with respect to the data corresponding to the twenty tracks. Since the two error correction codes C1 and C2 are employed the error correcting operation or error detecting operation is first executed by means of the error correction codes C1. The error correction by the error correction codes C2 is performed using an error pointer indicative of the result of this error detection. The erroneous words including the symbols which cannot be error-corrected are subjected to the mean value interpolation by the error correcting circuit. These processes are quite the same with regard to both digital tape recorders having ten and twenty tracks.

The principal part of the hardware in the digital tape recorder in the 10-track mode in this embodiment is common to that of the digital tape recorder of the 20-track mode. Therefore, as shown in Fig. 10, to realize this hardware as an LSI, there are provided a switch 45 to bypass the section of the track distributor 40 and a switch 46 to lead the even-numbered encoding outputs to the recording circuits regarding even-numbered heads 20T2, 20T4, ... of the tape recorder having the twenty tracks. When the tape recorder having the 20 tracks operates in the 2M mode in which the time-sharing multiplexing is not needed, the switches 45 and 46 are connected.

Claims

1. A method of recording a digital information signal in which a digital information signal is recorded on a plurality of parallel tracks (T1, T2, T3, ...) which are formed in the longitudinal direction of a recording medium (60),

comprising the step of:

separating a time series of said digital information signal into a plurality of even-numbered words (L_{8n}, R_{8n}, L_{8n+2}, R_{8n+2}, ...) and a plurality of odd-numbered words (L_{8n+1}, R_{8n+1}, L_{8n+3}, R_{8n+3} ...);

performing an error correction coding process with regard to a plurality of words (L, R) so that error correction codes (Q) are generated with regard to adjacent even-numbered words (L_{8n}, L_{8n+2}, ...) and adjacent odd-numbered words (L_{8n+1}, L_{8n+3}, ...) separately;

characterized by

recording said adjacent even-numbered word (L_{8n}, L_{8n+2}, ...) and odd-numbered word (L_{8n+1}, L_{8n+3}, ...), respectively, on different tracks (T1, T2, T3, ...) which are separated more than n tracks from each other, n being the number of signal channels with respect to the widthwise direction of said recording medium (60).

2. A method according to claim 1 in which the plurality of parallel tracks (T1, T2, T3, ...) is formed by n parallel tracks (T1, T2, ... T_n) characterized by

an encoding step of performing error detection and said correction coding processes with respect to the input digital information signal and forming data which can be distributed onto 2n tracks (T1, T2, ... T2n); and a time-shared multiplexing step of receiving outputs in said encoding step and converting said outputs to data which can be recorded on said n tracks (T1, T2, T3, ...).

3. A method according to claim 1 or 2, characterized by dividing one word (L, R) of the digital information signal into a plurality of symbols (W) and recording the word (L, R) on the recording medium (60);

performing the error correction coding process using said symbol (W) as a unit; and specifying in a manner such that said plurality of symbols (W) constituting one word (L, R) of said digital information signal are recorded at positions having a strong error correlation.

4. A method according to one of claims 1 to 3, characterized by

recording the symbols ($W_{16n+2,A}$; $W_{16n+2,B}$; $W_{16n+3,A}$; $W_{16n+3,B}$; ...) of the odd-numbered words (L_{8n+1}, R_{8n+1}, ...) in an upper area in the direction of the width of the recording medium (60), and

recording the symbols ($W_{16n,A}$; $W_{16n,B}$; $W_{16n+1,A}$; $W_{16n+1,B}$; ...) of the even-numbered words (L_{8n}, R_{8n}, ...) in a lower area in the direction of the width of the recording medium (60) or vice versa.

5. A method according to claim 4, characterized by

recording parity symbols (Q) generated by the encoding step in an area above the upper area in the direction of the width of the recording medium (60), said area above the upper area being near an edge of the recording medium (60).

6. A method according to one of claims 1 to 5, characterized by

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to the ten tracks is converted to the data corresponding to the twenty tracks. The converted data is supplied to a reproducing decoder for performing the processes opposite to those in the encoding section 30. This reproducing decoder has the same arrangement as the reproducing decoder which is used in the digital tape recorder of the twenty tracks in the 2M mode, so that it performs the error correcting and deinterleaving processes with respect to the data corresponding to the twenty tracks. Since the two error correction codes C1 and C2 are employed the error correcting operation or error detecting operation is first executed by means of the error correction codes C1. The error correction by the error correction codes C2 is performed using an error pointer indicative of the result of this error detection. The erroneous words including the symbols which cannot be error-corrected are subjected to the mean value interpolation by the error correcting circuit. These processes are quite the same with regard to both digital tape recorders having ten and twenty tracks.

The principal part of the hardware in the digital tape recorder in the 10-track mode in this embodiment is common to that of the digital tape recorder of the 20-track mode. Therefore, as shown in Fig. 10, to realize this hardware as an LSI, there are provided a switch 45 to bypass the section of the track distributor 40 and a switch 46 to lead the even-numbered encoding outputs to the recording circuits regarding even-numbered heads 20T2, 20T4, ... of the tape recorder having the twenty tracks. When the tape recorder having the 20 tracks operates in the 2M mode in which the time-sharing multiplexing is not needed, the switches 45 and 46 are connected.

Claims

1. A method of recording a digital information signal in which a digital information signal is recorded on a plurality of parallel tracks (T1, T2, T3, ...) which are formed in the longitudinal direction of a recording medium (60),

comprising the step of:

separating a time series of said digital information signal into a plurality of even-numbered words (L_{8n}, R_{8n}, L_{8n+2}, R_{8n+2}, ...) and a plurality of odd-numbered words (L_{8n+1}, R_{8n+1}, L_{8n+3}, R_{8n+3} ...);

performing an error correction coding process with regard to a plurality of words (L, R) so that error correction codes (Q) are generated with regard to adjacent even-numbered words (L_{8n}, L_{8n+2}, ...) and adjacent odd-numbered words (L_{8n+1}, L_{8n+3}, ...) separately;

characterized by

recording said adjacent even-numbered word (L_{8n}, L_{8n+2}, ...) and odd-numbered word (L_{8n+1}, L_{8n+3}, ...), respectively, on different tracks (T1, T2, T3, ...) which are separated more than n tracks from each other, n being the number of signal channels with respect to the widthwise direction of said recording medium (60).

2. A method according to claim 1 in which the plurality of parallel tracks (T1, T2, T3, ...) is formed by n parallel tracks (T1, T2, ... T_n) characterized by

an encoding step of performing error detection and said correction coding processes with respect to the input digital information signal and forming data which can be distributed onto 2n tracks (T1, T2, ... T2n); and a time-shared multiplexing step of receiving outputs in said encoding step and converting said outputs to data which can be recorded on said n tracks (T1, T2, T3, ...).

3. A method according to claim 1 or 2, characterized by dividing one word (L, R) of the digital information signal into a plurality of symbols (W) and recording the word (L, R) on the recording medium (60);

performing the error correction coding process using said symbol (W) as a unit; and specifying in a manner such that said plurality of symbols (W) constituting one word (L, R) of said digital information signal are recorded at positions having a strong error correlation.

4. A method according to one of claims 1 to 3, characterized by

recording the symbols ($W_{16n+2,A}$; $W_{16n+2,B}$; $W_{16n+3,A}$; $W_{16n+3,B}$; ...) of the odd-numbered words (L_{8n+1}, R_{8n+1}, ...) in an upper area in the direction of the width of the recording medium (60), and

recording the symbols ($W_{16n,A}$; $W_{16n,B}$; $W_{16n+1,A}$; $W_{16n+1,B}$; ...) of the even-numbered words (L_{8n}, R_{8n}, ...) in a lower area in the direction of the width of the recording medium (60) or vice versa.

5. A method according to claim 4, characterized by

recording parity symbols (Q) generated by the encoding step in an area above the upper area in the direction of the width of the recording medium (60), said area above the upper area being near an edge of the recording medium (60).

6. A method according to one of claims 1 to 5, characterized by

using the cross-interleaved Reed Solomon codes in the coding process step.

7. A method according to one of claims 1 to 6, characterized by

dividing said digital information signal having words (L, R) of a given bit length into data of another bit length which are encoded in said coding process step.

8. A method according to claim 2, characterized by shifting data existing on the (2i)th, (i = 1,2,...n), tracks (T2I) in the time-shared multiplexing step onto the (2i-1)th, (i = 1,2,...n) tracks (T2i-1), respectively.

9. An apparatus for recording a digital information signal in which a digital information signal is recorded on a plurality of parallel tracks (T1, T2, T3, ...) which are formed in the longitudinal direction of a recording medium (60), comprising:

means (20) for separating a time series of said digital information signal into a plurality of even-numbered words (L_{8n}, R_{8n}, L_{8n+2}, R_{8n+2}, ...) and a plurality of odd-numbered words (L_{8n+1}, R_{8n+1}, L_{8n+3}, R_{8n+3}, ...);

means (6) for performing an error correction coding process with regard to a plurality of words (L, R) so that said error correction codes (Q) are generated with regard to adjacent even-numbered words (L_{8n}, L_{8n+2}, ...) and adjacent odd-numbered words (L_{8n+1}, L_{8n+3}, ...) separately;

characterized by

means (7, 40, 50) for recording said adjacent even-numbered words (L_{8n}, L_{8n+2}, ...) and odd-numbered words (L_{8n+1}, L_{8n+3}, ...), respectively, on different tracks (T1, T2, T3, ...) which are separated more than n tracks from each other, n being the number of signal channels with respect to the widthwise direction of said recording medium (60).

10. An apparatus according to claim 9 in which the digital information signal is recorded on n parallel tracks (T1, ..., Tn), characterized by

encoding means (17) for performing error detection and said correction coding processes with respect to the input digital information signal and forming data which can be distributed onto 2n tracks (T1, T2, ..., T2n); and time-shared multiplexing means (40) for receiving outputs of said encoding means and converting said outputs to data which can be recorded on said n tracks (T1, T2, ..., T_n).

11. An apparatus according to claim 9 or 10, characterized by means (3) for dividing one word (L, R) of the digital information signal into a plurality of symbols (W) and recording on the recording medium (60),

means (6) for performing the error correction coding process using said symbol (W) as an unit; and means (7, 8) for specifying in a manner such that said plurality of symbols (W) constituting one word (L, R) of said digital information signal are recorded at positions having a strong error correlation.

12. An apparatus according to one of claims 9 to 11, characterized by

means (7, 40, 50) for recording the symbols (W_{16n+2}, A; $W_{16n+2,B}$; $W_{16n+3,A}$; $W_{16n+3,B}$; ...) of said odd-numbered words (L_{8n+1}, R_{8n+1}, ...) in an upper area in the widthwise direction of said recording medium (60) and for recording the symbols ($W_{16n,A}$; $W_{16n,B}$; $W_{16n+1,A}$; $W_{16n+1,B}$; ...) of said even-numbered words (L_{8n}, R_{8n}, ...) in a lower area in the widthwise direction of said recording medium (60) or vice versa.

13. An apparatus according to claim 12, characterized by

means (7, 40, 50) for recording parity symbols (Q) generated by said encoding means (6) in an area above the upper area in the widthwise direction of said recording medium (60), said area above the upper area being near an edge of said recording medium (60).

14. An apparatus according to one of claims 9 to 13, characterized by a cross-interleaved Reed Solomon coding means (6, 10).

15. An apparatus according to one of claims 9 to 14, characterized by

converter means (20) for dividing said digital information signal having words (L, R) of a given bit length into data of another bit length which are inputted into said encoding means (6).

16. An apparatus according to claim 10, characterized by means (40) for shifting data existing on the (2i)th, (i = 1,2...n), tracks (T2I) in the time-shared multiplexing step onto the (2i-1)th, (i = 1,2,...n), tracks (T2i-1), respectively.

Patentansprüche

1. Verfahren zum Aufzeichnen eines digitalen Informationssignals, bei dem das Signal in einer Mehrzahl von in Längsrichtung eines Aufzeich-

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nungsmediums (60) ausgebildeten parallelen Spuren (T1, T2, T3, ...) aufgezeichnet wird,

mit den Verfahrenschritten:

Trennen einer Zeitreihe des digitalen Informationssignals in eine Mehrzahl von geradzahlig numerierten Wörtern (L_{8n}, R_{8n}, L_{8n+2}, R_{8n+2}, ...) und eine Mehrzahl von ungeradzahlig numerierten Wörtern (L_{8n+1}, R_{8n+1}, L_{8n+3}, R_{8n+3}, ...) und

Durchführen eines Fehlerkorrekturkodierprozesses bezüglich einer Mehrzahl von Wörtern (L, R) in einer solchen Weise, daß Fehlerkorrekturkodes (Q) bezüglich benachbarter geradzahlig numerierter Wörter (L_{8n}, L_{8n+2}, ...) und benachbarter ungeradzahlig numerierter Wörter (L_{8n+1}, L_{8n+3}, ...) getrennt erzeugt werden,

gekennzeichnet durch

das Aufzeichnen der benachbarten geradzahlig numerierten Wörter (L_{8n}, R_{8n}, L_{8n+2}, R_{8n+2}, ...) bzw. ungeradzahlig numerierten Wörter (L_{8n+1}, L_{8n+3}, ...) in verschiedenen Spuren (T1, T2, T3, ...), die um mehr als n Spuren voneinander getrennt sind, wobei n die Anzahl der Signalkanöle in Breitenrichtung des Aufzeichnungsmediums (60) ist.

2. Verfahren nach Anspruch 1, bei dem die Mehrzahl von parallelen Spuren (T1, T2, T3, ...) aus n parallelen Spuren (T1, T2, ... Tn) besteht,

gekennzeichnet durch

einen Kodierschritt zur Durchführung einer Fehlererfassung und des genannten Korrekturkodierprozesses in bezug auf das digitale Eingangsinformationssignal und zur Bildung von Daten, die auf 2n Spuren (T1, T2, ... T2n) verteilt werden können, und

einen Verfahrenschritt der zeitgeteilten Multiplexierung der in dem Kodierschritt empfangenen Ausgangssignale und der Umwandlung dieser Ausgangssignale in Daten, die in n Spuren (T1, T2, T3, ...) aufgezeichnet werden können.

3. Verfahren nach Anspruch 1 oder 2,

gekennzeichnet durch

das Aufteilen eines Wortes (L, R) des digitalen Informationssignals in eine Mehrzahl von Symbolen (W) und das Aufzeichnen des Wortes (L, R) auf dem Aufzeichnungsmedium (60),

die Durchführung des Fehlerkorrekturkodierprozesses unter Verwendung des Symbols (W) als Einheit und

das Spezifizieren in einer solchen Weise, daß die Mehrzahl von Symbolen (W), die ein Wort (L, R) des digitalen Informationssignals bilden, in Positionen aufgezeichnet werden, die eine strenge Fehlerkorrelation aufweisen.

4. Verfahren nach einem der Ansprüche 1 bis 3,

gekennzeichnet durch

das Aufzeichnen der Symbole ($W_{16+2,A}$; $W_{16n+2,B}$; $W_{16n+3,A}$; $W_{16n+3,B}$; ...) der ungeradzahlig numerierten Wörter (L_{8n+1}, R_{8n+1}, ...) in einem in Breitenrichtung des Aufzeichnungsmediums (60) oberen Bereich und

das Aufzeichnen der Symbole ($W_{16n,A}$; $W_{16n,B}$; $W_{16n+1,A}$; $W_{16n+1,B}$; ...) der geradzahlig numerierten Wörter (L_{8n}, R_{8n}, ...) in einem in Breitenrichtung des Aufzeichnungsmediums (60) unteren Bereich oder umgekehrt.

5. Verfahren nach Anspruch 4,

gekennzeichnet durch

das Aufzeichnen von in dem Kodierschritt erzeugten Paritätssymbolen (Q) in einem Bereich, der über dem in Breitenrichtung des Aufzeichnungsmediums (60) oberen Bereich liegt, wobei dieser über dem oberen Bereich liegende Bereich in der Nähe der Kante des Aufzeichnungsmediums (60) liegt.

6. Verfahren nach einem der Ansprüche 1 bis 5,

gekennzeichnet durch

die Verwendung der kreuzverschachtelten Reed-Solomon-Kodes in dem Kodierschritt.

7. Verfahren nach einem der Ansprüche 1 bis 6,

gekennzeichnet durch

das Aufteilen des digitalen Informationssignals, das Wörter (L, R) einer gegebenen Bitlänge besitzt, in Daten einer anderen Bitlänge, die in dem genannten Kodierschritt kodiert werden.

8. Verfahren nach Anspruch 2,

dadurch gekennzeichnet,

daß in dem Verfahrenschritt der zeitgeteilten Multiplexierung in den (2i)-ten Spuren (T2i) (i = 1, 2, ...n) vorhandene Daten jeweils in die (21-n)-ten Spuren (T2i-n) (i = 1, 2, ...n) verschoben werden.

9. Vorrichtung zum Aufzeichnen eines digitalen Informationssignals, bei der das Signal in einer Mehrzahl von in Längsrichtung eines Aufzeichnungsmediums (60) ausgebildeten parallelen Spuren (T1, T2, T3, ...) aufgezeichnet wird,

mit Mitteln (20) zum Trennen einer Zeitreihe des digitalen Informationssignals in eine Mehrzahl von geradzahlig numerierten Wörtern (L_{8n}, R_{8n}, L_{8n+2}, R_{8n+2}, ...) und eine Mehrzahl von ungeradzahlig numerierten Wörtern (L_{8n+1}, R_{8n+1}, L_{8n+3}, R_{8n+3}, ...),

und mit Mitteln (6) zum Durchführen eines Fehlerkorrekturkodierprozesses bezüglich einer Mehrzahl von Wörtern (L, R) in einer solchen

Weise, daß die Fehlerkorrekturkodes (Q) bezüglich benachbarter geradzahlig numerierter Wörter (L_{8n}, L_{8n+2}, ...) und benachbarter ungeradzahlig numerierter Wörter (L_{8n+1}, L_{8n+3}, ...) getrennt erzeugt werden,

gekennzeichnet durch

Mittel (7, 40, 50) zum Aufzeichnen der benachbarten geradzahlig numerierten Wörter (L_{8n}, R_{8n}, L_{8n+2}, R_{8n+2}, ...) bzw. ungeradzahlig numerierten Wörter (L_{8n+1}, L_{8n+3}, ...) in verschiedenen Spuren (T1, T2, T3, ...), die um mehr als n Spuren voneinander getrennt sind, wobei n die Anzahl der Signalkanäle in Breitenrichtung des Aufzeichnungsmediums (60) ist.

10. Vorrichtung nach Anspruch 9, bei der das digitale Informationssignal in n parallelen Spuren (T1, T2, ... Tn) aufgezeichnet wird,

gekennzeichnet durch

eine Kodiereinrichtung (17) zur Fehlererfassung und zur Durchführung des genannten Korrekturkodierprozesses in Bezug auf das digitale Eingangsinformationssignal und zur Bildung von Daten, die auf 2n Spuren (T1, T2, ... T2n) verteilt werden können, und

Mittel (40) zur Zeitmultiplexbildung zur Aufnahme der Ausgangssignale der Kodiereinrichtung und zur Umwandlung dieser Ausgangssignale in Daten, die in n Spuren (T1, T2, T3, ...) aufgezeichnet werden können.

11. Vorrichtung nach Anspruch 9 oder 10,

gekennzeichnet durch

Mittel (3) zum Aufteilen eines Wortes (L, R) des digitalen Informationssignals in eine Mehrzahl von Symbolen (W) und zum Aufzeichnen des Wortes auf dem Aufzeichnungsmedium (60),

Mittel (6) zur Durchführung des Fehlerkorrekturkodierprozesses unter Verwendung des Symbols (W) als Einheit und

Mittel (7, 8) zum Spezifizieren in einer solchen Weise, daß die Mehrzahl von Symbolen (W), die ein Wort (L, R) des digitalen Informationssignals bilden, in Positionen aufgezeichnet werden, die eine strenge Fehlerkorrelation aufweisen.

12. Vorrichtung nach einem der Ansprüche 9 bis 11,

gekennzeichnet durch

Mittel (7, 40 , 50) zum Aufzeichnen der Symbole ($W_{16n+2,A}$; $W_{16n+2,B}$; $W_{16n+3,A}$; $W_{16n+3,B}$; ...) der ungeradzahlig numerierten Wörter (L_{8n+1}, R_{8n+1}, ...) in einem in Breitenrichtung des Aufzeichnungsmediums (60) oberen Bereich und zum Aufzeichnen der Symbole ($W_{16n,A}$; $W_{16n,B}$; $W_{16n+1,A}$; $W_{16n+1,B}$; ...) der geradzahlig numerierten Wörter (L_{8n}, R_{8n}, ...) in einem in Breitenrichtung des Aufzeichnungsmediums (60) unteren Bereich oder umgekehrt.

13. Vorrichtung nach Anspruch 12,

gekennzeichnet durch

Mittel (7, 40 , 50) zum Aufzeichnen von von der Kodiereinrichtung (6) erzeugten Paritätssymbolen (Q) in einem Bereich, der über dem in Breitenrichtung des Aufzeichnungsmediums (60) oberen Bereich liegt, wobei dieser über dem oberen Bereich liegende Bereich in der Nähe der Kante des Aufzeichnungsmediums (60) liegt.

14. Vorrichtung nach einem der Ansprüche 9 bis 13,

gekennzeichnet durch

eine mit den kreuzverschachtelten Reed-Solomon-Kodes arbeitende Kodiereinrichtung.

15. Verfahren nach einem der Ansprüche 9 bis 14,

gekennzeichnet durch

eine Wandlereinrichtung (20) zum Aufteilen des digitalen Informationssignals, das Wörter (L, R) einer gegebenen Bitlänge besitzt, in Daten einer anderen Bitlänge, die in dem genannten Kodierschritt kodiert werden.

16. Verfahren nach Anspruch 10,

gekennzeichnet durch

Mittel (40) zum Verschieben von in den (2i)-ten Spuren (T2i) (i = 1, 2, ...n) vorhandenen Daten jeweils in die (2i-n)-ten Spuren (T2i-n) (i = 1, 2, ...n) in dem Verfahrenschritt der zeitgeteilten Multiplexierung.

Revendications

1. Procédé d'enregistrement d'un signal d'information numérique dans lequel un signal d'information numérique est enregistré sur une pluralité de pistes parallèles (T1, T2, T3, ...) qui sont formées suivant la direction longitudinale d'un support d'enregistrement (60),

comprenant les étapes de :

séparation d'une série temporelle dudit signal d'information numérique en une pluralité de mots porteurs de numéros pairs (L_{8n}, R_{8n}, L_{8n+2}, R_{8n+2}, ...) et en une pluralité de mots porteurs de numéros impairs (L_{8n+1}, R_{8n+1}, $L8_{n+3}$, R_{8n+3}, ...) ;

réalisation d'un processus de codage de correction d'erreur relativement à une pluralité de mots (L, R) de telle sorte que des codes de correction d'erreur (Q) soient générés relative-

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ment à des mots porteurs de numéros pairs adjacents (L_{8n}, L_{8n+2}, ...) et relativement à des mots porteurs de numéros impairs adjacents (L_{8n+1}, L_{8n+3}, ...) de façon séparée.

caractérisé par :

l'enregistrement respectivement dudit mot porteur de numéro pair (L_{8n}, L_{8n+2}, ...) et dudit numéro porteur de numéro impair (L_{8n+1}, L_{8n+3}, ...) sur différentes pistes (T1, T2, T3, ...) qui sont séparées de plus de n pistes les unes des autres, n étant le nombre de canaux de signal relativement à la direction de largeur dudit support d'enregistrement (60).

2. Procédé selon la revendication 1, dans lequel la pluralité de pistes parallèles (T1, T2, T3, ...) sont formées au moyen de n pistes parallèles (T1, T2, ..., T_n), caractérisé par :

une étape de codage pour réaliser une détection d'erreur et lesdits processus de codage de correction relativement au signal d'information numérique d'entrée et pour former des données qui peuvent être distribuées sur 2n pistes (T1, T2, ..., T2n) ; et une étape de multiplexage temps partagé pour recevoir des sorties dans ladite étape de codage et pour convertir lesdites sorties en données qui peuvent être enregistrées sur lesdites n pistes (T1, T2, T3, ...).

3. Procédé selon la revendication 1 ou 2, caractérisé par la division d'un mot (L, R) du signal d'information numérique en une pluralité de symboles (W) et par l'enregistrement du mot (L, R) sur le support d'enregistrement (60) ; par la réalisation du processus de codage de correction d'erreur en utilisant ledit symbole (W) en tant qu'unité ; et par sa spécification d'une manière telle que ladite pluralité de symboles (W) constituant un mot (L, R) dudit signal d'information numérique soient enregistrés en des positions présentant une corrélation d'erreur forte.

4. Procédé selon l'une quelconque des revendications 1 à 3, caractérisé par :

l'enregistrement des symboles ($W_{16n+2, A}$; $W_{16n+2, B}$; $W_{16n+3, A}$; $W_{16n+3, B}$; ...) des mots porteurs de numéros impairs (L_{8n+1}, R_{8n+1}, ...) dans une zone supérieure suivant la direction de la largeur du support d'enregistrement (60) ; et

l'enregistrement des symboles ($W_{16n, A}$; $W_{16n, B}$; $W_{16n+1, A}$; $W_{16n+1, B}$; ...) des mots porteurs de numéros pairs (L_{8n}, R_{8n}, ...) dans une zone inférieure suivant la direction de la largeur du support d'enregistrement (60) ou vice versa.

5. Procédé selon la revendication 4, caractérisé par l'enregistrement de symboles de parité (Q) générés par l'étape de codage dans une zone au-dessus de la zone supérieure suivant la direction de la largeur du support d'enregistrement (60), ladite zone au-dessus de la zone supérieure étant à proximité d'un bord du support d'enregistrement (60).

6. Procédé selon l'une quelconque des revendications 1 à 5, caractérisé par l'utilisation des codes Reed Solomon entrelacés croisés lors de l'étape de processus de codage.

7. Procédé selon l'une quelconque des revendications 1 à 6, caractérisé par la division dudit signal d'information numérique comportant des mots (L, R) d'une longueur binaire donnée en données d'une autre longueur binaire qui sont codées lors de ladite étape de processus de codage.

8. Procédé selon la revendication 2, caractérisé par le décalage des données existant sur la (2i)-ièmes (i = 1, 2, ..., n) pistes (T2i) lors de l'étape de multiplexage temps partagé sur respectivement les (2i-1)-ièmes (i = 1, 2, ...n) pistes (T2i-1).

9. Appareil pour enregistrer un signal d'information numérique dans lequel un signal d'information numérique est enregistré sur une pluralité de pistes parallèles (T1, T2, T3, ...) qui sont formées suivant la direction longitudinale d'un support d'enregistrement (60), comprenant :

un moyen (20) pour séparer une série temporelle dudit signal d'information numérique en une pluralité de mots porteurs de numéros pairs (L_{8n}, R_{8n}, L_{8n+2}, R_{8n+2}, ...) et en une pluralité de mots porteurs de numéros impairs (L_{8n+1}, R_{8n+1}, L_{8n+3}, R_{8n+3}, ...) ;

un moyen (6) pour réaliser un processus de codage de correction d'erreur relativement à une pluralité de mots (L, R) de telle sorte que lesdits codes de correction d'erreur (Q) soient générés relativement à des mots porteurs de numéros pars adjacents (L_{8n}, L_{8n+2}, ...) et à des mots porteurs de numéros impairs adjacents (L_{8n+1}, L_{8n+3}, ...), de façon séparée,

caractérisé par :

un moyen (7, 40, 50) pour enregistrer respectivement lesdits mots porteurs de numéros pairs adjacents (L_{8n}, L_{8n+2}, ...) et lesdits mots porteurs de numéros impairs adjacents (L_{8n+1},L_{8n+3}, ...) sur différentes pistes (T1, T2, T3, ...) qui sont séparées de plus de n pistes les unes des autres, n étant le nombre de

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canaux de signal relativement à la direction de largeur dudit support d'enregistrement (60).

10. Appareil selon la revendication 9, dans lequel le signal d'information numérique est enregistré sur n pistes parallèles (T1, ..., Tn), caractérisé par :

un moyen de codage (17) pour réaliser une détection d'erreur et lesdits processus de codage de correction relativement au signal d'information numérique entré et pour former des données qui peuvent être distribuées sur 2n pistes (T1, T2, ..., T2n) ; et un moyen de multiplexage temps partagé (40) pour recevoir des sorties dudit moyen de codage et pour convertir lesdites sorties an données qui peuvent être enregistrées sur lesdites n pistes (T1, T2, ..., Tn).

11. Appareil selon la revendication 9 ou 10, caractérisé par un moyen (3) pour diviser un mot (L, R) du signal d'information numérique en une pluralité de symboles (W) et pour les enregistrer sur le support d'enregistrement (60) ;

un moyen (6) pour réaliser le processus de codage de correction d'erreur en utilisant ledit symbole (W) en tant qu'unité ; et un moyen (7, 8) pour le spécifier selon une manière telle que ladite pluralité de symboles (W) constituant un mot (L, R) dudit signal d'information numérique soient enregistrés en des positions présentant une corrélation d'erreur forte.

12. Appareil selon l'une quelconque des revendications 9 à 11, caractérisé par un moyen (7, 40, 50) pour enregistrer les symboles ($W_{16n+2, A}$; $W_{16n+2, B}$; $W_{16n+3, A}$; $W_{16n+3, B}$; ...) desdits mots porteurs de numéros impairs (L_{8n+1}, R_{8n+1}, ...) dans une zone supérieure suivant la direction de la largeur dudit support d'enregistrement (60) et pour enregistrer les symboles ($W_{16n, A}$; $W_{16n, B}$; $W_{16n+1, A}$; $W_{16n+1, B}$; ...) desdits mots porteurs de numéros pars (L_{8n}, R_{8n}, ...) dans une zone inférieure suivant la direction de la largeur dudit support d'enregistrement (60) ou vice versa.

13. Appareil selon la revendication 12, caractérisé par un moyen (7, 40, 50) pour enregistrer des symboles de parité (Q) générés par ledit moyen de codage (6) dans une zone au-dessus de la zone supérieure suivant la direction de la largeur dudit support d'enregistrement (60), ladite zone au-dessus de la zone supérieure étant à proximité d'un bord dudit support d'enregistrement (60).

14. Appareil selon l'une quelconque des revendications 9 à 13, caractérisé par un moyen de codage Reed Solomon entrelacé croisé (6, 10).

15. Appareil selon l'une quelconque des revendications 9 à 14, caractérisé par un moyen de convertisseur (20) pour diviser ledit signal d'information numérique comportant des mots (L, R) d'une longueur binaire donnée en données d'une autre longueur binaire qui sont entrées dans ledit moyen de codage (6).

16. Appareil selon la revendication 10, caractérisé par un moyen (40) pour décaler respectivement des données existant sur les (2i)-ièmes (i = 1, 2, ...n) pistes (T2i) lors de l'étape de multiplexage temps partagé sur les (2i-1)-ièmes (i = 1, 2, ...n) pistes (T2i-1).