IBM TECHNICAL DISCLOSURE BULLETIN. vol. 18, no. 6, November 1975, NEW YORK US pages 1726 - 1727; Lewis: "SERIAL DATA RECORDING"

ELECTRONICS. vol. 45, no. 23, 06 November 1972, NEW YORK US page 36 "How to update tapes without recopying"

Inventor: Odaka, Kentaro
c/o Sony Corporation
7-35 Kitashinagawa 6-chome
Shinagawa-ku Tokyo(JP)

(74) Representative: Ayers, Martyn Lewis Stanley et al
J.A. KEMP & CO.
14 South Square
Gray's Inn
London, WC1R 5EU (GB)

Description

The present invention relates to an apparatus and method for recording a digital signal, and more particularly to such an apparatus suitable for use in recording a digital signal transferred from a computer or the like.

Data stored in a hard disk or the like of a computer is practically transferred to and recorded by a data streamer (data-recorder) once a day so as to protect the data or back up the same.

For this operation or as the data recorder, analog audio tape recorders have been conventionally used in many cases. However, the analog tape recorders have disadvantages in that they need an excessive amount of a recording medium or magnetic tape for recording and operate at a quite low data transferring rate upon recording, so that it takes so much time to transfer and record such data information. Moreover, the analog tape recorders have problems such as the starting point of a desired portion of the recorded data information cannot be rapidly searched for, and so on.

Thus, to overcome the above-mentioned problems, it is thought to utilize a helical-scan type DAT (digital audio tape recorder) using a rotary head, that is, a so-called DAT as a data recorder which has been recently comercialized. Such data recorders utilizing a DAT are described in U.S. Patent Application No. 133,010 filed December 15, 1987, No. 177,624 filed April 5, 1988, No. 210,229 filed June 23, 1988 and No. 220,028 filed July 15, 1988, by the same assignee of the present application.

To utilize the DAT as a data recorder, data transferred from a host computer is transformed in accordance with a DAT format before recording. In the DAT format, one frame is made up of two oblique tracks formed by one rotation of two heads respectively having a different azimuth angle with each other. 16-bit PCM audio data, which has been interleaved, and auxiliary sub-data are recorded in this one frame area as a unit. In this recording event, there are formed in each track a main area for recording the PCM data and a sub-area for recording the sub-data.

With the DAT as described above, when another signal is to be recorded on a previously recorded recording medium or tape, previously recorded signals are erased by recording new signals thereover, that is, by a so-called overwriting, without using an erasing head. Therefore, if overwriting is not normally effected, for example, due to clogging of the head or the like, there is a fear that a part of the previously recorded signals remains unerased. Therefore, if overwriting is not normally effected, for example, by the fact that a tape is instantly detouched from the heads or due to clogging, previously recorded signals may remain unerased, which causes a data error referred to as "drop-in".

To attend to this data error, in the DAT format, an error detecting code is added to each of the main area and the sub-area of each track in which signals are recorded, so as to detect an unerased portion, if any, in the track as an error.

When data from a computer is recorded in a data recorder, the signal processing will be facilitated if any period is known at every predetermined amount of the data.

W0-80/01328, on which the precharacterising portions of claims 1 and 7 are based, discloses a method of recording data on a blank optical disk. A signal is recorded at the end of the last data recorded so that upon subsequent recording of further data, the last data is located and the recording head is moved beyond it by a predetermined amount so as to avoid new data overlapping the last data due to eccentricities of the disks motion.

In view of the foregoing, it is an object of the present invention to provide an apparatus for recording a digital signal which is capable of determining a data unit formed of a predetermined amount of data.

According to a first aspect of the present invention, there is provided an apparatus for recording a digital signal in tracks formed on a recording medium, comprising:

means for determining a unit formed of a predetermined plurality (number) of tracks;

means for recording a signal indicative of the last track of the unit;

means for first detecting said signal indicative of the last track of the unit prior to recording a further digital signal; and

means for recording the further digital signal on the basis of said detection; characterised by

adjacent units being initially recorded on the medium adjacent to each other, means for recording an indicating signal within a predetermined number of tracks less than said plurality, after said detection prior to overwriting, by means for overwriting, the digital signal, wherein upon reproduction of the signals recorded on the medium, the indicating signal is indicative of an entire data unit which does not need to be reproduced.

According to a second aspect of the present invention, there is provided a method for recording a digital signal in tracks formed on a recording medium, comprising the steps of:

determining a unit formed of a predetermind plurality (number) of tracks;

recording a signal indicative of the last track of the unit;

first detecting said signal indicative of the last track of the unit prior to recording a further digital signal; and

recording the further digital signal on the basis of the detection; characterized by

adjacent units being initially recorded on the medium adjacent to each other, recording an indicating signal within a predetermined number of tracks less than said plurality, after said detection prior to overwriting the digital signal, wherein upon reproduction of the signals recorded on the medium, the indicating signal is indicative of an entire data unit which does not need to be reproduced.

The above and other objects, features and advantages of the present invention will become apparent form the following detailed description of the preferred embodiment taken in conjunction with the accompanying drawings, throughout which like reference numerals designate like elements and parts.

Fig. 1 is a block diagram showing an embodiment of the present invention;

Fig. 2 is a diagram showing a DAT format;

Fig. 3 is a diagram showing the data arrangement in the main data block;

Fig. 4, which is formed of two separate parts Fig. 4A and 4B, is a diagram showing the data format of the main area in one frame;

Fig. 5 is a diagram showing the data arrangement of the logical frame number;

Fig. 6 is a diagram showing the data arrangement of the sub-code block;

Fig. 7 is a diagram showing the data arrangement of the packs in the sub-code block;

Fig. 8 is a flowchart showing a sequence of the error determinating method;

Fig. 9 is a table showing error determination bases;

Fig. 10 is a table showing contents of respective determinations;

Figs. 11A and 11B are diagrams used to explain the overwrite operation according to the present invention; and

Figs. 12A, 12B and 12C are designed used to explain the erasing methods according to the present invention.

One embodiment of the present invention will now be described with reference to the accompanying drawings.

Fig. 1 shows the whole arrangement of an embodiment according to the present invention in which a DAT is used as a data recorder. In Fig. 1 reference numeral 1 generally designates a DAT, 2 an interface bus, 3 a host computer and 4, 5 inner buses, respectively. The DAT 1 is mainly formed of a recording and reproducing section 6, a recording amplifier 7, a reproducing amplifier 8, a signal processing circuit 9, a RAM 10, a data controller 11, an interface board 12, a system controller 13, a servo and motor drive circuit 14 and so on.

The system controller 13, the signal processing circuit 9 and the data controller 11 are arranged to interchange among them predetermined signals such as an absolute frame number AFNO, check data, a mode indication, a logical frame number LFNO, a determination result by the check data, a data transfer instruction and so on.

The recording and reproducing section 6 is provided with a rotary head drum, though not shown, such that a magnetic tape is wrapped around the peripheral surface of the drum over an angular range of about 90° of head travel and transported by a capstan. The drum is provided with heads A and B mounted thereon respectively having a different azimuth angle with each other, in a manner that two oblique tracks are recorded on a reproduced from a tape per one rotation of the drum by the heads.

Digital data delivered from the host computer 3 through the buses 5, 2 and 4 is fed to the interface board 12 through which the digital data is subjected to predetermined signal processings in the data controller 11, the RAM 10, the signal processing circuit 9 and so on under the control of the system controller 13 to be converted i accordance with aforementioned DAT format. The DAT formatted data is then supplied through the recording amplified 7 to the recording and reproducing section 6 to be recorded on the magnetic tape by the heads A and B.

The signal recorded on the magnetic tape is reproduced by the heads A and B. The reproduced signal is supplied through the reproducing amplifier 8 to the signal processing circuit 9 wherein the signal is re-converted. The digital data therefrom is supplied through the data controller 11, the interface board 12 and the buses 4, 2 and 5 to the host computer 3.

In the above-mentioned apparatus, the DAT format according to which signals are recorded on a magnetic tape is as shown in Fig. 2.

In Fig. 2, two oblique tracks T_A and T_B are formed on a tape 15 by one rotation of the heads A and B from its lower side as indicated by an arrow a in Fig. 2. One frame is made up of these two tracks T_A and T_B. One track T_A or T_B comprises 196 blocks and one block is formed of 228 bits. Respective 34 blocks at the both end portions thereof are assigned to be the sub-areas and 128 blocks of the central portion thereof the main area.

The sub-areas are further divided into several areas. Specifically, from the lower end side of each track, the sub-areas are partitioned into a magin area, a preamble area for the PLL of the sub-code, a first sub-code area, a postamble area, an interblock gap area, a tracking (ATF) signal area, an interblock gap area, a preamle area for the PLL of data, an interblock gap area, an AFT signal area, an interblock gap area, a preamble area for the PLL of the sub-code area, a second sub-code area,

a postamble area, and a margin area. Among these areas, the first and second sub-code areas are respectively formed of eigth blocks, and the other areas are formed of a predetermined number of blocks. It should be noted that the scale of the respective areas in Fig. 4 is not exact.

The main area comprises 128 data blocks. Each of the blocks thereof comprises, as shown in Fig. 3, from its head, eight bits each of a synchronizing signal, a W_1 area for recording PCM-ID and so on, a block address area and a parity area and the remaining 256 bits of a main data area. When an audio signal is recorded, the main data area is loaded with a left (L) channel and a right (R) channel, each comprising 16 bit PCM data. The 16-bit data are interleaved and recorded with partities in the main areas of the two tracks T_A and T_B (one frame). Thus the main areas of one frame have a data capacity of approximately 5760 bytes. When the DAT is employed as a data recorder, the data transferred from the host computer 3 is converted into 16-bit data so as to be treated in the same manner as the above-mentioned audio PCM data and arranged in accordance with the format as shown in Fig. 4 and recorded in the main areas of one frame.

Let the above format be explained in more detail. In Fig. 4, the above-mentioned 5760 bytes are divided into words (0 - 1439) each formed of four bytes (32 bits). R-channel and L-channel is accordance with the DAT-formatted audio signal. The first three words (12 bytes) are assigned to be a synchronizing area in which all the bits of the first byte are set to "0", all the bits of the subsequent 10 bytes are set to "1", and all the bits of the last byte are set to "0".

Next four words (16 bytes) are assigned to be a header portion. 4 bits at the MSB side in the former half byte of the third word of the L-channel in this header portion are assigned to be a format ID for indicating the format of the data recorder, and 4 bits in the latter of the same are indefinite. The remaining three bytes of the third word are assigned to be logical frame number (LFNO) areas. By the LFNO, each made 8 bits there is provided a binary value indicative of the serial number 1 - 23 of a frame, wherein 23 frames are treated as a unit.

The seventh of 1438th words subsequent to the header portion are assigned to be a data area having a capacity of totally 5728 bytes, and data signals from the host computer 3 are sequentially recorded in these frames by four bytes.

The 1439th word is assigned to an error detecting code (EDC) area in which recorded in an error detecting code (EDC) for each of the data bit suquences formed of the data signals written in the header portion and the data area in the vertical direction.

As described above, the DAT format of the present embodiment is such that L-channel data and R-channel data are alternately recorded by two bytes in two tracks, wherein each track is generally identified, for example, by plus and minus (+ and -) azimuth angles of the heads A and B for forming the tracks which are marked on the both sides of Fig. 4. The EDC can be generated for the two tracks forming one frame in the above-mentioned manner that the EDC is generated for the data sequence formed of the data signals in the header portion and the data area in the vertical direction.

Therefore, according to this format, it is possible to determine whether there remain unerased portions or not by effecting the EDC operation. Specifically, if an unerased portion remains in one of the two tracks, every other data for generating the EDC are erroneous so that the EDC cannot be generated correctly. Thus, the unerased portion can be detected by checking the generated EDC values.

Next, the logical frame number LFNO will be explained with reference to Fig. 5.

As described above, the logical frame number LFNO is assigned to record the serial numbers 1 - 23 of a frame, for example, with 23 frames being as a unit. In other words, the frame numbers 1 to 23 repeat at every 23 frames. As illustrated in Fig. 5, the LFNO is formed of eight bits. The most significant bit of the LFNO is a last frame ID (LASTF-ID) indicative of the last frame in the unit, that is, the 23rd frame when the unit is formed of 23 frames. The next most significant bit is an ECC frame ID (ECCF-ID) indicative of an ECC frame for correcting errors. The remaining six bits represent the LFNO 1- 23 in binary combination. The number of frames in one unit can be selected arbitrarily from the range of 1 to 64 in place of the above-mentioned 23 frames. In such case the last frame in one unit can be identified by the LASTF-ID. The ECCF-ID may be recorded in a plurality of frames, instead of recorded only in one frame.

The use of such unit provided with the LFNO can clearly delimit data by a predetermined quantity, and accordingly the signal processing is facilitated. Further, since the number of frames in one unit can be appropriately selected by changing the maximum value of the LFNO, the signal processing can be effected more easily. Furthermore, data overwrite operation can be effected by using the LASTF-ID as described later.

Next, explanation will be given of the data arrangement of the first and second sub-code portions in the sub-area.

The first and second sub-code portions are respectively formed of eight sub-code blocks in each of which 2048 bits of data can be recorded.

Fig. 6 shows the constructions of the even-numbered subcode block (EVEN block) and the odd-numbered sub-code block (ODD block), in each of which a synchronizing signal, the areas W_1 and W_2 and a parity, respectively formed of eight bits, and 256 bits of sub-code data including a parity and located in this order. The sub-code data is divided into four packs formed of 64 (8 x 8) bits (eight symbols), respectively.

As shown in Fig. 6, the contents of W_1 and W_2 in the EVEN block are different from those in the ODD block, and the packs in the EVEN and ODD blocks are alternately numbered from "1" to "7". The eighth pack is assigned to record an error detecting code C_1.

In the EVEN block, the area W_1 consists of an ID area and a data ID area, respectively formed of four-bit, while the area W_2 consists of the upper one bit set as "1", a three-bit pack ID and a four-bit block address. On the other hand, in the ODD block, the area W_1 consists of a four-bit indefinite portion and a four-bit format ID, while the area W_2 consists of the upper one bit set as "1", the subsequent three bits all set at "0" and a four-bit block address. When the four-bit area ID in the area W_1 of the EVEN block is set at "0100", it is designated as an EOD-ID (end of data ID) which identifies the end of the tape.

The packs 1 - 7 are respectively divided into eight words of eight bits in which recorded are a variety of codes such as a code indicating the lead-in area of the record starting portion on a tape, a code indicating a lead-out area of the record terminating portion, a code indicating the recording date, an absolute frame number, a logical frame number and so on, with parities.

Fig. 7 shows the construction of the pack 3 as an example of one of these seven packs.

As can be seen from Fig. 7, the pack 3 consists of eight of eight-bit words PC1 - PC8. The upper four bits of the word PC1 are assigned to record a pack number ("0011" indicating the pack 3 in Fig. 7), and the lower four bits of the same a format ID. The word PC2 is indefinite. The upper four bits of the word PC3 are assigned to record an area ID indicative of the lead-in area or the lead-out area. A total 20 bit area formed of the lower four bits of the word PC3 and the words PC4 and PC5 is assigned to record the absolute frame number (AFNO). The AFNO is the serial number recorded in each corresponding frame in one volume of tape. A total 16-bit area formed of the subsequent words PC6 and PC7 is assigned to record a check data CD which relates to the present invention. The word PC8 is assigned to record a parity for the words PC1 - PC7.

The above 16-bit check data CD is the exclusive OR of all the data (transferred from the host computer 3) recorded in the main area located in one of the tracks T_A and T_B in which the pack 3 is provided. Alternatively, the check data CD may be an error detecting signal such as CRC for all the data recorded in the main area.

Check Data (+ azimuth) = L0 + R1 + L2 +R3 + ...+ R1439

Check Data (- azimuth) = R0 + L1 + R2 +L3 + ...+ L1439

The check may be recorded in superimposed fashion in the word PC1 and other indefinite portions in the words PC2 - PC7 to improve the reliability of data. In this case, since one track has respective eight blocks of the first and second sub-code portions and there are seven packs available in a pair of EVEN and ODD blocks, it is possible to record maximally 56 sets of the check data CD in one track.

The check data is utilized in the following occasions.

Upon reproduction, the check data read out from one track is compared with the exclusive OR of main data read out from the main portion of the same track. If, as the result of this comparison, the both data do not coincide with each other, it can be determined that the whole main area of the whole sub-area remains unerased (previously recorded check data CD also remains). On the other hand, if the both data coincide with each other, it can be determined that the whole main area and the whole sub-area are both correct or the both are erroneous. Next, it can be detected which of the main area of the sub-area is erroneous by the use of the LFNO and AFNO in the following manner.

Fig. 8 shows a sequence of such determination, wherein respective checking items at steps S1 - S4 provide determination bases as shown in Fig. 9, from which errors can be defined as shown in Fig. 10.

In Fig. 8, it is first examined at step S1 whether or not data recorded in the main area (hereinafter simply called "the main data") was corrected by the codes C_1 and C_2. If the correction was not possible, it is determined on the bases of the column C in Fig. 10 that there is a drop-out in the main data on the track, and a message indicative of the determination is transferred.

If it is detected at step S1 that the correction was carried out, the process proceeds to the next step S2 to examine the continuity of the LFNO in the main area. If the continuity is not found, it is determined on the basis of the column B in Fig. 10 that the overwrite was not correctly effected and hence unerased signals, which had been previously recorded, is reproduced, that is, a drop-in occured in the concerned track, and a message indicative of the determination is transferred.

If the continuity is found in the LFNO, the process terminates the check on the main area and proceeds to the next step S3 to check the sub-area. Specifically, the reproducibility of data in the packs of the sub-area is examined by the error correcting code C_1, the parities recorded in the packs, coincidence of data and so on. If these checks cannot be effected, it is determined on the basis of the row (5) in Fig. 10 that a drop-out occurred in data in the sub-area (sub-data) and the main data is correct.

If the reproducibility check has been effected, the process proceeds to the next step S4 wherein the continuity of the AFNO and the main data are checked, the latter by the use of the check data CD, and the determination based shown in Fig. 9 are provided from the respective check results. Thus, the determinations in the column A of Fig. 10 can be obtained from the bases of Fig. 9.

The contents of respective determination are as follows:

- A - (1) The main data is correct.
- A - (2) Drop-in occurred in both of the main data and sub-data.
- A - (3) Drop-in occurred in the main data. The AFNO was continuous eventually.
- A - (4) Drop-in occurred in the sub-data. The AFNO is made to self-run and the main data is regarded to be correct.
- A - (5) Drop-in occurred in the sub-data. The AFNO is made to self-run and the main data is regarded to be correct.

Incidentally, a flag may be generated when the drop-in is detected by the check data CD, whereby the error correction can be effected by an error correction code ECC on the basis of this flag. Also, the above-mentioned error detection by the check data CD may be effected plural times to prevent mis-reading of the check data CD and data in the main area.

According to the present invention, since the predetermined amount of data can be clearly delimited by the unit. The LFNO may be arbitrarily selected from the range of 1 to 64 to change the above-mentioned predetermined amount of data, that is, the unit length, thereby making it possible to facilitate the data processing. Further, the last frame of each unit can be detected by the LAST-ID.

Next, a method of the overwrite operation will be explained with reference to Figs. 11A and 11B.

In Fig. 11A, data (1), (2), (3), (4) .... are recorded on the tape 15 at every data unit. In this case, there is not provided the indicating signal (amble portion) between the adjacent units so that the units are located adjacent to each other. In the present embodiment, one unit is assumed to be formed of 23 frames, and the aforementioned LASTF-ID is recorded in the 23rd frame of each unit.

When new data is overwritten on the data (3) on the tape 15, as shown in Fig. 11B, the LASTF-ID in the data (2) is first detected. Within one to ten frames after the detection of the LASTF-ID, the indicating signal (amble portion) is recorded in several frames of the main area. Then, after the amble portion, new data ③, ④ .... are adjacently recorded by unit. In this event, the LASTF-ID is also recorded in each of the units.

When the tape 15 on which the data have been overwritten as described above and shown in Fig. 11B is reproduced, the data (1), (2) and (3) are succesively read out. However, since the indicating signal (amble portion) is reproduced in the middle of the data (3), it is understood that this data (3) may be removed. The data ③, ④.... read out subsequent to the indicating signal (amble portion) of the data (3) are taken in as effective data.

As described above, since it is not necessary to record the indicating signal (amble portion) unlike the prior art when the first data (1), (2), (3), (4) .... are recorded on the tape 15, the data transfer rate as well as the recording capacity of the tape 15 upon recording will never be decreased. Also, when the overwrite operation is effected, only a portion of the previously recorded data (3) and only several frames of the indicating signal (amble portion) are formed before the head position of the data ③ which is firstly recorded in the overwrite operation, so that neither the transfer rate nor the recording capacity of tape is largely decreased. It is further possible to protect data located near the append point from being destroyed.

It will therefore be understood that data can be overwritten without decreasing the data transfer rate nor the recording capacity of the recording medium.

Next, a data erasing method according to the present embodiment will be explained with reference to Figs. 12A, 12B and 12C.

Fig. 12A illustrates a recording pattern formed on the tape 15 before a data erasure. As can be seen from Fig. 12A, one backup operation was effected to record the data 1 - 4 and 300 frames of the aforementioned EOD-ID (see Fig. 6) after the end of the data 4, while previously recorded data remain subsequent to the EOD-ID.

Assume in the tape 15 of Fig. 12A, for example, that the recorded data 1 and 2 are maintained and the data recorded after the data 3 are to be erased. There can be thought the following two operations for such erasure:

(1) erasure indicating that all the data recorded after the data 3 is unnecessary (hereinafter referred to as "unnecessity erasure"); and

(2) erasing all the data recorded after the data area 3 (hereinafter referred to as "complete erasure").

A first command signal is transferred from the host computer when the unnecessity erasure is required, while a second command signal is transferred from the host computer when the complete erasure is required.

These two operatins will hereinafter be explained in detail with reference to Figs. 12B and 12C.

(1) Unnecessity erasure

When the data recorder receives the first command signal, as shown in Fig. 12B, one to two frames or several frames of the indicating signal (amble portion) are formed at the head of the data 3. The indicating signal (amble portion) is formed of dummy data, for example, all set to "0" or the like. Next, the aforementioned EOD-ID is recorded in the sub-area over 300 frames of area.

Thus, when the tape 15 shown in Fig. 12B is reproduced, the indicating signal (amble portion) is first detected, and next the EOD-ID is detected, whereby it can be understood that a portion of the data 3 subsequent to the EOD-ID and all the data thereafter are all unnecessary.

(2) Complete erasure

When the second command signal is generated, the EOD-ID is first recorded in 300 frames of the head portion of the data 3 and subsequent thereto the indicating signal (amble portion) is formed in all the remaining area, as shown in Fig. 12C. Several frames of the indicating signal (amble portion) may be formed before the EOD-ID recorded in the data 3.

When the tape 15 of Fig. 12C is reproduced, the EOD-ID is detected and next the indicating signal (amble portion) is detected, whereby it can be understood that the data subsequent to the EOD-ID has been erased.

The amble portion is formed of the aforementioned LFNO whose constituent bits are all set at "0" or the aforementioned AFNO and the check data CD whose constituent bits are all set at "0", or the both.

According to the above described erasing method, the contents of the erasing operations upon erasure can be distinguished by the first and second command signals and the contents of erasure can be detected by examining the recorded pattern formed upon reproduction. It is further possible according to the erasing method to substantially invalidate the written data without destroying the DAT format and without using an erasing head.

As described above, since the signal such as the EOD-ID or the like which substantially invalidate the data recorded subsequent thereto is recorded in a predetermined position of the sub-area, the main area or the like of the data format in accordance with the erasing command signal, the data can be substantially erased without using the erasing head while the predetermined data format such as the DAT format or the like is maintained.

Claims

1. An apparatus for recording a digital signal in tracks formed on a recording medium (15), comprising:
   means for determining a unit formed of a predetermined plurality (number) of tracks;
   means for recording a signal (LASTF-ID) indicative of the last track of the unit;
   means for first detecting said signal indicative of the last track of the unit prior to recording a further digital signal; and
   means for recording the further digital signal on the basis of said detection; characterised by
   adjacent units being initially recorded on the medium adjacent to each other, means for recording an indicating signal (Amble) within a predetermined number of tracks less than said plurality, after said detection prior to overwriting, by means for overwriting, the digital signal, wherein upon reproduction of the signals recorded on the medium, the indicating signal (Amble) is indicative of an entire data unit which does not need to be reproduced.

2. An apparatus for recording a digital signal according to claim 1, wherein said signal indicative of the last track of the unit is recorded in a main data area.

3. An apparatus for recording a digital signal according to claim 1 or 2 further including means for recording a number indicative of the sequence of the tracks in said unit.

4. An apparatus for recording a digital signal according to claim 1, 2 or 3 further including a rotary head type tape recorder (6).

5. An apparatus for recording a digital signal according to any preceding claim further including means for recording a signal indicative of invalidity of the predetermined digital signal unit recorded thereafter.

6. An apparatus for recording a digital signal according to claim 5, wherein said signal indica-

(2) erasing all the data recorded after the data area 3 (hereinafter referred to as "complete erasure").

A first command signal is transferred from the host computer when the unnecessity erasure is required, while a second command signal is transferred from the host computer when the complete erasure is required.

These two operatins will hereinafter be explained in detail with reference to Figs. 12B and 12C.

(1) Unnecessity erasure

When the data recorder receives the first command signal, as shown in Fig. 12B, one to two frames or several frames of the indicating signal (amble portion) are formed at the head of the data 3. The indicating signal (amble portion) is formed of dummy data, for example, all set to "0" or the like. Next, the aforementioned EOD-ID is recorded in the sub-area over 300 frames of area.

Thus, when the tape 15 shown in Fig. 12B is reproduced, the indicating signal (amble portion) is first detected, and next the EOD-ID is detected, whereby it can be understood that a portion of the data 3 subsequent to the EOD-ID and all the data thereafter are all unnecessary.

(2) Complete erasure

When the second command signal is generated, the EOD-ID is first recorded in 300 frames of the head portion of the data 3 and subsequent thereto the indicating signal (amble portion) is formed in all the remaining area, as shown in Fig. 12C. Several frames of the indicating signal (amble portion) may be formed before the EOD-ID recorded in the data 3.

When the tape 15 of Fig. 12C is reproduced, the EOD-ID is detected and next the indicating signal (amble portion) is detected, whereby it can be understood that the data subsequent to the EOD-ID has been erased.

The amble portion is formed of the aforementioned LFNO whose constituent bits are all set at "0" or the aforementioned AFNO and the check data CD whose constituent bits are all set at "0", or the both.

According to the above described erasing method, the contents of the erasing operations upon erasure can be distinguished by the first and second command signals and the contents of erasure can be detected by examining the recorded pattern formed upon reproduction. It is further possible according to the erasing method to substantially invalidate the written data without destroying the DAT format and without using an erasing head.

As described above, since the signal such as the EOD-ID or the like which substantially invalidate the data recorded subsequent thereto is recorded in a predetermined position of the sub-area, the main area or the like of the data format in accordance with the erasing command signal, the data can be substantially erased without using the erasing head while the predetermined data format such as the DAT format or the like is maintained.

Claims

1. An apparatus for recording a digital signal in tracks formed on a recording medium (15), comprising:
means for determining a unit formed of a predetermined plurality (number) of tracks;
means for recording a signal (LASTF-ID) indicative of the last track of the unit;
means for first detecting said signal indicative of the last track of the unit prior to recording a further digital signal; and
means for recording the further digital signal on the basis of said detection; characterised by
adjacent units being initially recorded on the medium adjacent to each other, means for recording an indicating signal (Amble) within a predetermined number of tracks less than said plurality, after said detection prior to overwriting, by means for overwriting, the digital signal, wherein upon reproduction of the signals recorded on the medium, the indicating signal (Amble) is indicative of an entire data unit which does not need to be reproduced.

2. An apparatus for recording a digital signal according to claim 1, wherein said signal indicative of the last track of the unit is recorded in a main data area.

3. An apparatus for recording a digital signal according to claim 1 or 2 further including means for recording a number indicative of the sequence of the tracks in said unit.

4. An apparatus for recording a digital signal according to claim 1, 2 or 3 further including a rotary head type tape recorder (6).

5. An apparatus for recording a digital signal according to any preceding claim further including means for recording a signal indicative of invalidity of the predetermined digital signal unit recorded thereafter.

6. An apparatus for recording a digital signal according to claim 5, wherein said signal indica-

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tive of invalidity of the predetermined digital signal unit is recorded in a sub-data area.

7. A method for recording a digital signal in tracks formed on a recording medium (15), comprising the steps of:

determining a unit formed of a predetermined plurality (number) of tracks;

recording a signal (LASTF-ID) indicative of the last track of the unit;

first detecting said signal indicative of the last track of the unit prior to recording a further digital signal; and

recording the further digital signal on the basis of the detection; characterised by

adjacent units being initially recorded on the medium adjacent to each other, recording an indicating signal (Amble) within a predetermined number of tracks less than said plurality, after said detection prior to overwriting the digital signal, wherein upon reproduction of the signals recorded on the medium, the indicating signal (Amble) is indicative of an entire data unit which does not need to be reproduced.

8. A method for recording a digital signal according to claim 7, wherein said signal indicative of the last track of the unit is recorded in a main data area.

9. A method for recording a digital signal according to claim 7 or 8 further including the step of recording a number indicative of sequence of the tracks in said unit.

10. A method for recording a digital signal according to claim 7, 8 or 9 further including the step of using a rotary head type tape recorder (6).

11. A method for recording a digital signal according to any one of claims 7 to 10 further including the step of recording a signal indicative of invalidity of the predetermined digital signal unit recorded thereafter.

12. A method for recording a digital signal according to claim 11, wherein said signal indicative of invalidity of the predetermined digital signal unit is recorded in a sub-data area.

Patentansprüche

1. Vorrichtung zum Aufzeichnen eines digitalen Signals in Spuren, die auf einem Aufzeichnungsmedium (15) gebildet sind, mit

Mitteln zum Bestimmen einer Einheit, die aus einer vorgegebenen Anzahl (Nummer) von Spuren besteht;

Mitteln zum Aufzeichnen eines Signals (LASTF-ID), das auf die letzte Spur der Einheit hinweist;

Mitteln zum ersten Ermitteln des Signals, das auf die letzte Spur der Einheit hinweist vor dem Aufzeichnen eines weiteren digitalen Signals; und

Mitteln zum Aufzeichnen des weiteren digitalen Signals auf der Grundlage dieser Ermittlung;

gekennzeichnet durch

benachbarte Einheiten, die anfänglich auf dem Medium zueinander benachbart aufgezeichnet sind,

Mittel zum Aufzeichnen eines Hinweissignals (Ampel) innerhalb einer vorgegebenen Nummer von Spuren, die kleiner ist als die genannte Anzahl, nach der Ermittlung vor einem Überschreiben durch Mittel für ein Überschreiben, des digitalen Signals, wobei bei einer Reproduktion der auf dem Medium aufgezeichneten Signale das Hinweissignal (Ampel) auf eine vollständige Dateneinheit hinweist, die nicht reproduziert zu werden braucht.

2. Vorrichtung zum Aufzeichnen eines digitalen Signals nach Anspruch 1, wobei das Signal, das auf die letzte Spur der Einheit hinweist, in einem Hauptdatenbereich aufgezeichnet ist.

3. Vorrichtung zum Aufzeichnen eines digitalen Signals nach Anspruch 1 oder 2, die weiter Mittel zum Aufzeichnen einer Nummer aufweist, die auf die Reihenfolge der Spuren in der Einheit hinweist.

4. Vorrichtung zum Aufzeichnen eines digitalen Signals nach Anspruch 1, 2 oder 3, die weiter einen Rotationskopf- Bandrecorder (6) aufweist.

5. Vorrichtung zum Aufzeichnen eines digitalen Signals nach einem der vorhergehenden Ansprüche, die weiter Mittel zum Aufzeichnen eines Signals aufweist, das auf eine Ungültigkeit der vorbestimmten digitalen Signaleinheit hinweist, die danach bespielt ist.

6. Vorrichtung zum Aufzeichnen eines digitalen Signals nach Anspruch 5, wobei das Signal, das auf die Ungültigkeit der vorgegebenen Signaleinheit hinweist, in einem Subdatenbereich aufgezeichnet ist.

7. Verfahren zum Aufzeichnen eines digitalen Signals in Spuren, die auf einem Aufzeichnungsmedium (15) gebildet sind, mit folgenden Schritten:

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Bestimmen einer Einheit, die aus einer vorgegebenen Anzahl (Nummer) von Spuren gebildet ist;

Aufzeichnen eines Signals (LASTF-ID), das die letzte Spur der Einheit anzeigt;

erstes Ermitteln des Signals, das auf die letzte Spur der Einheit hinweist, bevor ein weiteres digitales Signal aufgezeichnet wird; und

Aufzeichnen des weiteren digitalen Signals auf der Grundlage der Ermittlung;

gekennzeichnet durch

benachbarte Einheiten, die anfänglich auf dem Medium einander benachbart aufgezeichnet sind, Aufzeichnen eines Hinweissignals (Ampel) innerhalb einer vorgegebenen Nummer von Spuren, die kleiner als die genannte Anzahl sind, nach der Ermittlung vor einem Überschreiben des digitalen Signals, wobei bei einer Reproduktion der auf dem Medium aufgezeichneten Signale das Hinweissignal (Ampel) auf eine vollständige Dateneinheit hinweist, die nicht reproduziert zu werden braucht.

8. Verfahren zum Aufzeichnen eines digitalen Signals nach Anspruch 7, wobei das Signal, das auf die letzte Spur der Einheit hinweist, in einem Hauptdatenbereich aufgezeichnet wird.

9. Verfahren zum Aufzeichnen eines digitalen Signals nach Anspruch 7 oder 8, weiter mit dem Schritt, eine Nummer aufzuzeichnen, die auf eine Reihenfolge von Spuren der Einheit hinweist.

10. Verfahren zum Aufzeichnen eines digitalen Signals nach Anspruch 7, 8 oder 9, weiter mit dem Schritt, einen Rotationskopf-Bandrecorder (6) zu verwenden.

11. Verfahren zum Aufzeichnen eines digitalen Signals nach einem der Ansprüche 7 bis 10, weiter mit dem Schritt, ein Signal aufzuzeichnen, das auf eine Ungültigkeit der vorgegebenen digitalen Signaleinheit, die danach bespielt wurde, hinweist.

12. Verfahren zum Aufzeichnen eines digitalen Signals nach Anspruch 11, wobei das Signal, das auf eine Ungültigkeit der vorgegebenen digitalen Signaleinheit hinweist, in einem Subdatenbereich aufgezeichnet wird.

Revendications

1. Dispositif pour enregistrer un signal numérique sur des pistes formées sur un support d'enregistrement (15), comprenant ;

un moyen pour déterminer une unité constituée d'une pluralité (nombre) prédéterminée de pistes ;

un moyen pour enregistrer un signal (LASTF-ID) indiquant la dernière piste de l'unité ;

un moyen pour détecter en premier ledit signal indiquant la dernière piste de l'unité avant d'enregistrer un autre signal numérique ; et,

un moyen pour enregistrer l'autre signal numérique selon ladite détection ;

caractérisé par

des unités voisines initialement enregistrées sur le support les unes à côtés des autres, un moyen pour enregistrer un signal indicateur (Position de synchronisation) à l'intérieur d'un nombre prédéterminé de pistes inférieur à ladite pluralité, après ladite détection précédant une superposition d'écriture, par un moyen de superposition d'écriture, du signal numérique, où, lors de la reproduction des signaux enregistrés sur le support, le signal indicateur (Position de synchronisation) indique une unité de données entière qu'il n'est pas nécessaire de reproduire.

2. Dispositif pour enregistrer un signal numérique selon la revendication 1, dans lequel ledit signal indiquant la dernière piste de l'unité est enregistré dans une zone de données principale.

3. Dispositif pour enregistrer un signal numérique selon l'une quelconque des revendications 1 et 2, incluant en outre un moyen pour enregistrer un nombre indiquant la suite des pistes dans ladite unité.

4. Dispositif pour enregistrer un signal numérique selon l'une quelconque des revendications 1 à 3, incluant en outre un enregistreur sur bande du type à tête rotative (6).

5. Dispositif pour enregistrer un signal numérique selon l'une quelconque des revendications 1 à 4, incluant en outre un moyen pour enregistrer un signal indiquant l'invalidité de l'unité prédéterminée de signal numérique enregistrée à la suite.

6. Dispositif pour enregistrer un signal numérique selon la revendication 5, dans lequel ledit signal indiquant une invalidité de l'unité prédéterminée de signal numérique est enregistré dans une sous-zone de données.

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7. Procédé pour enregistrer un signal numérique sur des pistes formées sur un support d'enregistrement (15), comprenant les étapes qui consistent à :

déterminer une unité constituée d'une pluralité (nombre) prédéterminée de pistes ;

enregistrer un signal (LASTF-ID) indiquant la dernière piste de l'unité ;

détecter en premier ledit signal indiquant la dernière piste de l'unité avant d'enregistrer un autre signal numérique ; et, à

enregistrer l'autre signal numérique selon la détection

caractérisé par

des unités voisines initialement enregistrées sur le support les unes à côté des autres, l'enregistrement d'un signal indicateur (Position de synchronisation) à l'intérieur d'un nombre prédéterminé de pistes inférieur à ladite pluralité, après ladite détection précédant une superposition d'écriture du signal numérique, où, lors de la reproduction des signaux enregistrés sur le support, le signal indicateur (Position de synchronisation) indique une unité de données entière qu'il n'est pas nécessaire de reproduire.

8. Procédé pour enregistrer un signal numérique selon la revendication 7, dans lequel ledit signal indiquant la dernière piste de l'unité est enregistré dans une zone de données principale.

9. Procédé pour enregistrer un signal numérique selon l'une quelconque des revendications 7 et 8, incluant en outre l'étape qui consiste à enregistrer un nombre indicateur de la suite des pistes dans ladite unité.

10. Procédé pour enregistrer un signal numérique selon l'une quelconque des revendication 7 à 9, incluant en outre l'étape qui consiste à utiliser un enregistreur sur bande du type à tête rotative (6).

11. procédé pour enregistrer un signal numérique selon l'une quelconque des revendications 7 à 10, incluant en outre l'étape qui consiste à enregistrer un signal indiquant une invalidité de l'unité prédéterminée de signal numérique enregistrée à la suite.

12. Procédé pour enregistrer un signal numérique selon la revendication 11, dans lequel ledit signal indiquant une invalidité de l'unité prédéterminée de signal numérique est enregistrée dans une sous-zone de données.