A recording medium comprises an audio stream capable of being replaced with an after-recorded audio stream and audio attribute information (e.g., bit rate information indicative of a bit rate of the audio stream). In the recording medium, a plurality of audio...
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streams may be stored. At least one of the audio streams may be the audio stream capable of being replaced with an after-recorded audio stream. The audio stream capable of being replaced with an after-recorded audio stream may be an audio stream which is provided for an audio stream carrying original audio data and having the same audio attribute as the audio stream carrying original audio data. A recorder includes a checking mechanism for checking in-advance the possibility of after-recording operation of the recorder of the audio stream to be after-recorded with reference to the bit rate information of the audio attribute information.
ABSTRACT

A recording medium comprises an audio stream capable of being replaced with an after-recorded audio stream and audio attribute information (e.g., bit rate information indicative of a bit rate of the audio stream). In the recording medium, a plurality of audio streams may be stored. At least one of the audio streams may be the audio stream capable of being replaced with an after-recorded audio stream. The audio stream capable of being replaced with an after-recorded audio stream may be an audio stream which is provided for an audio stream carrying original audio data and having the same audio attribute as the audio stream carrying original audio data. A recorder includes a checking mechanism for checking in-advance the possibility of after-recording operation of the recorder of the audio stream to be after-recorded with reference to the bit rate information of the audio attribute information.
INFORMATION RECORDING MEDIUM, APPARATUS AND METHOD FOR PERFORMING AFTER-RECORDING ON A RECORDING MEDIUM

FIELD OF THE INVENTION

The present invention relates to the field of recording media such as high capacity, high speed optical discs; particularly to a recording medium that can perform after-recording, an apparatus and a method for recording thereto.

BACKGROUND

In the field of writable optical discs having an upper bound of approximately 650 MB, a DVD-RAM phase change type disc having a capacity of several GB has been developed. Moreover, in addition to the practical use of Moving Picture Experts Group coding (MPEG, MPEG2, etc.), which is the coding standard of digital AV data, DVD-RAM discs are expected to be a standard recording and reproducing media in the AV field as well as in computer applications. It is expected that the DVD-RAM will spread as the media of choice in place of magnetic tape media, which is currently the conventional AV recording media.

In recent years, an enhancement in the density of a writable optical disc has been developed to make it possible to record video data as well as computer and audio data.

For example, a convexo-concavo shaped guide groove has conventionally been formed on the signal recording face of the optical disc. While a signal has conventionally been recorded on only a land portion or a groove portion, it has become possible to record the signal on both the land and groove portions by a land-groove recording method. Consequently, the recording density has been enhanced by approximately a multiple of two (see Japanese Patent Laid-Open Publication No. 8-7282, for example). Moreover,
there has also been devised and practically used a zone CLV (constant linear velocity recording) method in which the control of a CLV method (an enhancement in the recording density) can be simplified and easily used (see Japanese Patent Laid-Open Publication No. 7-93873, for example).

Potential future problems pertain to how to record AV data including video data using an optical disc intended to have an increase in capacity, and how to implement higher performance (over conventional AV apparatus) and enable new functions.

A large capacity writable optical disc can become a mainstream optical disk for AV recording and for reproduction in place of a conventional tape. The conversion of recording media from a tape to a disc has various influences on the function and performance of AV apparatus. The conversion to a disc improves random access performance. If the tape is subjected to random access, it is usually necessary to take time on the order of several minutes to accommodate rewinding. This is extraordinarily slow compared with a seek time (20-60 ms or less) for optical disc media. Accordingly, a tape cannot practically act as a random access device.

Fig. 34 is a block diagram showing a drive device of a DVD recorder. In Fig. 34, reference numeral 11 denotes an optical pick-up for reading the data on a disc, reference numeral 12 denotes an ECC (error correcting code) processing section, reference numeral 13 denotes a track buffer, reference numeral 14 denotes a switch for switching the input and output to and from the track buffer, reference numeral 15 denotes an encoder, and reference numeral 16 denotes a decoder. Reference numeral 17 denotes an enlarged part of the disc.

As shown by reference numeral 17, data are recorded on the DVD-RAM disc with 1 sector = 2KB as a minimum unit. Moreover, an error correcting process is executed by the ECC processing section 12 with 16 sectors = 1 ECC block.
The track buffer shown by reference numeral 13 serves to record the AV data with a variable bit rate in order to record the AV data on the DVD-RAM disc more efficiently. While a read/write rate Va (Va in the drawing) from/to the DVD-RAM is at a fixed rate, the AV data changes a bit rate Vb (Vb in the drawing) according to the complexity of the contents of the DVD-RAM (a video image, for example). The track buffer 13 serves to absorb a difference in bit rate. However, this is not required if the AV data is set to the fixed bit rate as in a video CD.

By utilizing the track buffer 13 effectively, the AV data can be discretely provided on the disc.

Fig. 35A is a diagram showing an address space on a disc. In the case where the AV data are separately recorded in continuous regions [a1-a2] and [a3-a4], the AV data can be continuously reproduced by supplying data stored in the track buffer 13 to the decoder 16 while a seek is being carried out from a2 to a3. A status obtained at this time is shown in Fig. 35B.

The AV data read from a1 are input to the track buffer 13 and output from the track buffer 13 at a time t1. The data are stored in the track buffer 13 by a rate difference (Va - Vb) between an input rate (Va) to the track buffer 13 and an output rate (Vb) from the track buffer 13. This process continues up to a2 (time t2). The amount of data stored in track buffer 13 for this period of time (the amount represented by B (t2)) is sufficient for B (t2) to be consumed to continuously supply the decoder 16 until a time t3 corresponding to a data reading start point a3. If a constant amount of data ([a1, a2]) to be read before the seek or more are kept, the AV data can be continuously supplied even if the seek is generated.

The above example is based on a case where data are read from the DVD-RAM (playback); however, the operations are similar in a case where data is written to the DVD-RAM (picture recording).
If a constant amount (or more) of data are continuously recorded on the DVD-RAM as described above, continuous reproduction/picture recording can be carried out even if the AV data are distributed and recorded on the disc.

As described earlier, AV data to be recorded on the DVD-RAM use an international standard referred to as MPEG (ISO/IEC13818).

Even a DVD-RAM having a large capacity of several GBs does not always have sufficient capacity for recording non-compressed digital AV data. Therefore, a method for compressing and recording AV data is required. As a method for compressing AV data, the MPEG (ISO/IEC13818) standard is widely used. In recent years, LSI technology has improved such that MPEG codec (expansion/compression LSI) has been put into practical use. Consequently, a DVD recorder can implement MPEG expansion/compression.

MPEG coding has the following two features in order to implement efficient data compression.

The first feature is that a compression method using a time correlation characteristic between frames is introduced in addition to a compression method using a space frequency characteristic, which has conventionally been carried out in the compression of motion picture data. In MPEG, each frame (which will be also referred to as a picture in the MPEG) is classified into three parts: an "I" picture (intra-frame coding picture), a "P" picture (a picture using intra-frame coding and a reference relationship in the past) and a "B" picture (a picture using intra-frame coding and reference relationships in the past and future).

Fig. 36 is a diagram showing a relationship among the I, P and B pictures. As shown in Fig. 36, the P picture refers to the last I or P picture in the past, and the B picture refers to the closest I or P picture in the past and future. As shown in Fig. 36, moreover, since the B picture refers to the I or P picture in the future, the display order of each picture and the order (coding order) on the compressed data may be coincident with each other.
The second feature of MPEG is that the coding amount can be assigned dynamically for each picture in accordance with the complexity of the picture. The decoder of the MPEG comprises an input buffer that can assign a large coding amount to a complex picture, which is hard to compress by storing data in the decoder buffer in advance.

Audio data used by the DVD-RAM can be selected for use from three parts: MPEG audio for carrying out data compression; Dolby digital (AC-3); and non-compressed LPCM. While Dolby digital and LPCM have a fixed bit rate, MPEG audio has a variable bit rate and has a size that is not as great as the size of a video stream but can be selected from multiple sizes in an audio frame unit.

AV data are multiplexed into one stream by a method referred to as an MPEG system. Fig. 37 is a diagram showing the structure of the MPEG system. The reference numeral 41 denotes a packet header, the reference numeral 42 denotes a packet header, and the reference numeral 43 denotes a payload. The MPEG system has a hierarchical structure that is referred to as a pack and a packet. The packet comprises the packet header 42 and the payload 43. The AV data are divided per proper size from the head, and are stored in the payload 43. The packet header 42 stores a stream ID for identifying stored data, a decoding time stamp (DTS) of data (the DTS is omitted if the decoding and the display are carried out at the same time as in the audio data) and a presentation time stamp (PTS) of the data.

The ID, DTS and PTS are included in the payload with a precision of 90 kHz where they are recorded as information related to AV data stored in the payload 43. The pack is a unit having a plurality of packets together. In the case of a DVD-RAM, one pack is used for every packet. Therefore, the pack comprises the pack header 41 and the packet having the packet header 42 and the payload 43. The pack header stores a System Clock Reference (SCR) represented with a precision of 27 MHz a time that data in the pack are input to the decoder buffer. In a DVD-RAM, such an MPEG system stream is recorded by using one pack as one sector (= 2048 B).
Next, a description of a decoder for decoding the above-mentioned MPEG system stream will be provided. Fig. 38 shows a decoder model (P-STD) of the MPEG system decoder. The reference numeral 51 denotes an STC (System Time Clock) acting as a reference time in the decoder. The reference numeral 52 denotes a demultiplexer for decoding or demultiplexing a system stream. The reference numeral 53 denotes an input buffer of a video decoder. The reference numeral 54 denotes a video decoder. The reference numeral 55 denotes a reorder buffer for temporarily storing the I and P pictures to absorb a difference between the data order and the display order which is made between the I and P pictures and the B picture as described above. The reference numeral 56 denotes a switch for adjusting the order of the outputs of the I and P pictures stored in the reorder buffer and the B picture. The reference numeral 57 denotes an input buffer of an audio decoder. The reference numeral 58 denotes an audio decoder.

Such an MPEG system decoder serves to process the above-mentioned MPEG system stream in the following manner. At a time when the STC 51 is coincident with the SCR described in the pack header, the demultiplexer 52 inputs the same pack. The demultiplexer 52 serves to interpret a stream ID in the packet header and to transfer the data of the payload to the decoder buffer for each stream. Moreover, the demultiplexer 52 fetches the PTS and the DTS in the packet header. The video decoder 54 fetches picture data from the video buffer 53 at a time when the STC 51 is coincident with the DTS to carry out a decode processing, and stores the I and P pictures in the reorder buffer 55 and displays the B picture.

While the I and P pictures are decoded by the video decoder 54, the switch 56 is connected to the reorder buffer 55 to output a previous I or P picture in the reorder buffer 55. While the B picture is decoding, the switch 56 is connected to the video decoder 54. The audio decoder 58 fetches and decodes data for one audio frame from the audio buffer 57 at a time when the STC 51
and the PTS (there is no DTS in cast of audio) are coincident with each other in the same manner as the video decoder 54.

Next, a description of a method for multiplexing the MPEG system stream with reference to Figs. 39A-39D will be provided. Fig. 39A shows a video frame, Fig. 39B shows a status in the video buffer, Fig. 39C shows the MPEG system stream, and Fig. 39D shows audio data. An axis of abscissa indicates a time base which is common to each drawing, and each drawing is represented on the same time base. As shown in Fig. 39B, an axis of ordinate indicates a buffer usage (the data storage amount of the video buffer), and a thick line in the drawing indicates a transition of the buffer usage on a time basis. Furthermore, the gradient of the thick line is equivalent to the bit rate of the video, and indicates that data are input to the buffer at a constant rate. A reduction in the buffer usage at a constant interval indicates that the data are decoded. The intersection of an oblique dotted line and the time basis indicates a time at which the data transfer of the video frame to the video buffer is started.

Hereinafter, a complex image A in the video data will be described as an example. Since an image A requires a large amount of coding as shown in Fig. 39B, the data transfer to the video buffer should be started at a time t1 indicated in the drawing in place of the decoding time of the image A (A time from the data input start time t1 until the decoding time will be referred to as vbv_delay). As a result, the AV data are multiplexed in the position (time) of the video pack shown in an oblique line. In contrast, the transfer of the audio data that does not require dynamic coding does not need to be made particularly earlier than the decode time. For this reason, generally, the multiplexing is carried out shortly before the decode time.

Accordingly, the video data and the audio data that are reproduced at the same time are multiplexed in the state in which the video data are preceded. In MPEG coding, a time when data can be stored in the buffer is restricted, and all the data except still picture data are defined in such a way that they should be output from the buffer to the decoder within one second after they are input to
the buffer. For this reason, a shift of the multiplexing of the video data and the audio data is at most one second (however, strictly speaking, there is a further shift by the reorder of the video data).

While the video was followed by the audio in this example, the audio can also be followed by the video. When a simple picture having a high compression ratio is prepared for the video data and the audio data are transferred unnecessarily quickly, such data can be created intentionally. However, the precedence can be given within one second at most, based on the restrictions of the MPEG as discussed above.

Fig. 40 is a diagram illustrating a relationship between a tape and a tape recorder (recording head). As shown, recording areas for video data and audio data are separately provided in parallel along a tape running direction. Therefore, it is simple to record audio data independently. In a conventional analog video tape recorder, reproduction and recording can be carried out simultaneously with one head since delay time from reproduction to recording is almost zero.

DVD-RAM has the following problem in relation to next generation AV recording:

- "after-recording" operations in DVD recorders pertain to MPEG streams (AV data) to be recorded by the DVD recorder and to the differences between the mechanisms used for a video recorder and for a DVD recorder cause many compatibility problems.

In a conventional video recorder each of the video and audio channels are independently recorded on a tape. The after-recording operation of audio can easily be carried out because there is no delay from playback to sound recording. In the DVD recorder, however, video and audio are recorded in one multiplexed stream. One optical pick-up is used for reading and writing operations. A time difference between playback to recording occurs, since one track buffer is provided for implementing a variable bit rate. Even though two
optical pick-ups are provided, they should be operated independently. However, even if they are independently operated, the recording and playback operations cannot be carried out at the same time in the DVD-RAM due to a changing rotating speed for each zone where a region to be accessed by each of the pick-ups is provided across different zones.

A time stamp for AV synchronous playback is conventionally used on the MPEG stream. Therefore, in the case where a time stamp to be given to an audio stream to be recorded later is inconsistent with a time stamp given to an existing stream, a decoder will not operate normally in some cases. For example, in the case where an SCR given to a video pack in the existing stream and an SCR given to an audio pack recorded later have the same time, two data to be processed on the time of the SCR by the decoder are simultaneously present. Consequently, the decoder cannot be normally operated and a "hang up" problem can occur. DVD-RAM can store audio streams in various types of format but the DVD recorder does not know whether it can apply after-record operation to a DVD-RAM on which data has been recorded by other recorders. Therefore, the stream must be analyzed at the start of any data recording operations.

SUMMARY OF INVENTION

Embodiments of the present invention enable an information recording medium to determine the possibility of after-recording on the information recording medium. Further embodiments of the present invention are directed to an apparatus and a method for recording data to such a recording medium.

In accordance with one aspect of the present invention there is provided an information recording medium comprising an area for storing at least one video object and an area for storing management information wherein: the at least one video object includes a video stream obtained by coding a video signal, a first audio stream obtained by coding a first audio signal and a second audio stream obtained by coding a second audio signal; wherein the management
information includes: status information indicating whether or not the second audio stream is provided for an after-recording operation and further indicating whether or not after-recording data is present in the second audio stream when the second audio stream is provided for the after-recording operation; a bit rate of the second audio stream; a number of audio streams; and a coding mode of the second audio stream.

In accordance with another aspect of the present invention there is provided an information recording medium comprising a first area for storing at least one video object and a second area for storing management information wherein: the at least one video object includes a video stream obtained by coding a video signal, a first audio stream obtained by coding a first audio signal and a second audio stream obtained by coding a second audio signal, wherein the management information includes: status information indicating whether or not the second audio stream is provided for an after-recording operation, and whether or not after-recording data is present in the second audio stream when the second audio stream is provided for the after-recording operation; a bit rate information of the first audio stream and a bit rate information of the second audio stream; and a coding mode of the first audio stream and a coding mode of the second audio stream; wherein the first and second audio streams have the same bit rate information and the same coding mode when the second audio stream is provided for the after-recording operation.

In accordance with yet another aspect of the present invention there is provided an information recording medium comprising a first area for storing at least one video object and a second area for storing management information, wherein: the at least one video object includes a video stream obtained by coding a video signal, a first audio stream obtained by coding a first audio signal and a second audio stream obtained by coding a second audio signal; wherein the management information comprises first and second management information segments the first management information segment including at least one stream of information having a specified number, the at least one
stream of information including a bit rate of the first audio stream, a bit rate of the
second audio stream, a number of audio streams included in the at least one
video object, a coding mode of the first audio stream, and a coding mode of the
second audio stream, wherein the second management information segment is
for storing a video management information for the at least one video object, the
video management information including a status information and the specified
number, the status information for indicating whether or not the second audio
stream is provided for an after-recording operation and whether or not after-
recording data is present in the second audio stream when the second audio
stream is provided for the after-recording operation; and wherein the specified
number is for designating one of the at least one stream of information.

In accordance with still yet another aspect of the present invention there is
provided an information recording medium comprising a first area for storing at
least one video object and a second area for storing management information,
wherein: the at least one video object includes a video stream obtained by
coding a video signal, a first audio stream obtained by coding a first audio signal
and a second audio stream obtained by coding a second audio signal, and
wherein the management information comprises: a status information for
indicating whether or not the second audio stream is provided for an after-
recording operation and for further indicating whether or not after-recording data
is present in the second audio stream when the second audio stream is provided
for the after-recording operation; and a bit rate of the second audio stream;
wherein the first audio stream and the second audio stream differ by a stream
number are the same.

In accordance with still yet another aspect of the present invention there is
provided an apparatus comprising the information recording medium (as defined
above) operating in conjunction with an information recording apparatus, the
information recording apparatus for performing the after-recording operation on
the second audio stream, the information recording apparatus comprising:
checking means for checking in advance whether or not the information
recording apparatus can perform the after-recording operation on the second audio stream based on at least the status information and the bit rate of the second audio stream; and starting means for starting the after-recording operation.

In accordance with still yet another aspect of the present invention there is provided a method for performing an after-recording operation on the second audio stream recorded on the information recording medium (as defined above) by using an information recording apparatus, the method comprising the steps of: checking in advance of the after-recording operation whether or not the information recording apparatus can perform the after-recording operation on the second audio stream based on at least the status information and the bit rate included in the management information; and starting the after-recording operation.

In one embodiment of the present invention, a recording medium comprises an audio stream capable of being replaced with an after-recorded audio stream and an audio attribute information including bit rate information indicative of a bit rate of the audio stream. In the recording medium, a plurality of audio streams may be stored. At least one of the plurality of audio streams may be the audio stream capable of being replaced with an after-recorded audio stream. The audio stream capable of being replaced with an after-recorded audio stream may be an audio stream which is provided for an audio stream carrying original audio data and having a same audio attribute as the audio stream carrying original audio data.

In another embodiment of the present invention, an apparatus is provided for performing after-recording to an audio stream recorded on a recording medium. The apparatus comprises checking means for checking a possibility of after-recording operation to a recorder before an after-recording operation starts, and an operation section for performing the after-recording operation.
In another embodiment of the present invention, a method is provided for performing after-recording to an audio stream recorded on a recording medium according to the present invention by using a recording apparatus. The method comprises the steps of referring to the bit rate information in the audio attribute information to determine whether or not the apparatus is able to encode an audio stream to be after-recorded at a bit rate of a bit rate information, and deciding if an apparatus can perform after-recording when the apparatus is determined to be able to encode the audio stream at the bit rate.

In another embodiment of the present invention, it is possible to determine whether or not an after-recording operation to an audio stream can be performed. Therefore, a recorder, for example, gives warning to a user when the recorder does not have enough ability to process the audio stream for after-recording.

**BRIEF DESCRIPTION OF THE DRAWINGS**

Fig. 1 is a diagram showing a logical structure of a disc according to an embodiment of the present invention;

Fig. 2 is a diagram showing a structure in an AV file for a motion picture or movie data;

Fig. 3 is a diagram showing a structure in an AV file for a still picture;

Fig. 4 is a diagram showing a relationship between AV data and management information;

Fig. 5 is a diagram showing the structure of RTR_VMGI;

Fig. 6 is a diagram showing the structure of RTR_VMGI;

Fig. 7 is a diagram illustrating VERN and TM_ZONE formats;

Fig. 8 is a diagram showing the structure of PL_SRP;
Fig. 9 is a diagram illustrating PL_TY and PL_CREATE formats;

Fig. 10 is a diagram illustrating a PTM recording format;

Fig. 11 is a diagram illustrating an S_VOB_ENTN recording format;

Fig. 12 is a diagram showing the structure of M_AVFIT;

Fig. 13 is a diagram illustrating V_ATR and A_ATR formats;

Fig. 14 is a diagram illustrating SP_ATR and SP_PLT formats for a motion picture;

Fig. 15 is a diagram showing the structure of M_AVFI;

Fig. 16 is a diagram showing the structure of M_VOBI;

Fig. 17 is a diagram illustrating a VOB_TY format;

Fig. 18 is a diagram showing the structure of TMAPI;

Fig. 19 is a diagram illustrating a VOBU_ENT format;

Fig. 20 is a diagram showing the structure of S_AVFIT;

Fig. 21 is a diagram illustrating V_ATR and OA_ATR formats;

Fig. 22 is a diagram illustrating SP_ATR and SP_PLT formats for a still picture;

Fig. 23 is a diagram showing the structure of S_AVFI;

Fig. 24 is a diagram showing the structure of S_VOB_ENT;

Fig. 25 is a diagram illustrating an SVOB_ENT_TY format;

Fig. 26 is a diagram showing the structure of UD_PGCIT;

Fig. 27 is a diagram showing the structure of TXTDT_MG;
Fig. 28 is a diagram showing the structure of PGCI;
Fig. 29 is a diagram illustrating a PG_TY format;
Fig. 30 is a diagram showing the structure of CI;
Fig. 31 is a diagram illustrating a C_TY format;

Fig. 32 is a diagram showing the structure of C_EPI;
Fig. 33 is a diagram illustrating an EP_TY1 format;
Fig. 34 is a block diagram showing the drive device of a DVD recorder;
Fig. 35A is a diagram showing an address space on a disc;
Fig. 35B is a chart showing a data storage amount in a track buffer;

Fig. 36 is a picture correlation diagram in an MPEG video stream;
Fig. 37 is a diagram showing the structure of an MPEG system stream;
Fig. 38 is a diagram showing the structure of an MPEG system decoder (P-STD);

Fig. 39A is a diagram showing video data;

Fig. 39B is a chart showing a video buffer usage;
Fig. 39C is a diagram showing the MPEG system stream;
Fig. 39D is a diagram showing audio data;

Fig. 40 is a diagram showing the structure of a recording band on a tape;
Fig. 41A is a diagram illustrating the directory structure;

Fig. 41 B is a diagram illustrating physical allocation on the disc;
Fig. 42A is a diagram illustrating the management information;
Fig. 42B is a diagram illustrating the structure of stream data;

Fig. 43 is a diagram illustrating the structure of MPEG stream including band area for after-recording date;

Fig. 44 is a diagram illustrating a way of inserting after-recording data into the MPEG stream;

Fig. 45 is a diagram illustrating a partial after-recording;

Fig. 46 is a diagram illustrating a way of restoring after-recorded audio stream;

Fig. 47 is a state transition diagram of audio stream;

Fig. 48 is a block diagram of DVD recorder according to an embodiment of the present invention;

Fig. 49 is a block diagram of the encoder;

Fig. 50 is a block diagram of DVD recorder with four track buffers;

Fig. 51 is a diagram illustrating after-recording operation in the encoder;

Fig. 52A is a timing chart of track buffers;

Fig. 52B is a diagram showing data area including data stored in track buffers;

Fig. 53 is a diagram illustrating the structure of system controller according to an embodiment of the present invention;

Fig. 54 is a flowchart of process on after-recording or dubbing by DVD recorder in accordance with an embodiment of the present invention;

Fig. 55 is a flowchart of checking routine for checking the possibility of after-recording operation in the after-recording process; and
Fig. 56 is a flowchart of a checking routine for checking an attribute of an audio stream in the after-recording possibility checking routine.

**DETAILED DESCRIPTION**

The present invention will be described in detail by using a DVD recorder and a DVD-RAM according to embodiments of the present invention.

First Embodiment

*Logical Structure on DVD-RAM*

The logical structure on the DVD-RAM will be described with reference to Figs. 41A and 41B. Fig. 41A shows a data structure on a disc as seen through a file system, and Fig. 41B shows a physical sector address on a disc.

The head portion of the physical sector address has a lead-in region that stores a reference signal necessary for stabilizing a servomechanism and an identification signal with other media. A data region is provided following the lead-in region. In this portion, logically effective data are recorded. Finally, a lead-out region is provided and stores the same reference signal as in the lead-in region. Management information for the file system, which is also referred to as volume information, is recorded on the head of the data region. Since the file system is not directly related to aspects of the present invention, further details are not provided.

Through the file system, the data in the disc can be dealt with as a directory or as a file as shown in Fig. 41A. All the data to be dealt with by the DVD recorder are put on a VIDEO_RT directory under a ROOT directory as shown in Fig. 41A. A file to be dealt with by the DVD recorder is roughly classified into two kinds: one management information file and at least one AV file (ordinarily, a plurality of files).
Management Information File

The contents of the management information file will be described with reference to Fig. 42A.

The management information file is roughly divided into a VOB table and a PGC table. VOB (Video Object) means a program stream of MPEG. PGC defines the playback order of Cell, which uses any partial section (or all sections) in the VOB as one logical playback unit. In particular, the VOB is a unit that is as significant as the MPEG, and the PGC is a unit with which a player plays back.

The VOB table stores the number of VOBs (Number_of_VOBs) and each VOB information therein. The VOB information comprises a corresponding AV file name (AV_File_Name), a VOB identifier in the disc (VOB_ID), a start address in the AV file (VOB_Start_Address), an end address in the AV file (VOB_End_Address), a playback time length of the VOB (VOB_Playback_Time) and an attribute information of the stream (VOB_Attribute).

A stream attribute information field comprises a video attribute (Video_Attribute), a first audio stream attribute (Audio0_Attribute) and a second audio stream attribute (Audio1_Attribute). The audio stream attribute information comprises an audio coding mode (Coding_Mode), an application flag (Application_Flag), a quantization coefficient (Quantization), a sampling frequency (Sampling_Frequency) and the number of audio channels (Number_of_channels).

The PGC table includes the number of PGCs (Number_of_PGCs) and each PGC information therein. The PGC information comprises the number of Cells (Number_of_Cells) in the PGC and each Cell information. The cell information comprises a corresponding VOB_ID, a playback start time in the VOB (Cell_Start_Time), a playback time in the VOB (Cell_Playback_Time), a playback start address in the VOB (Cell_Start_Address), a playback end address in the VOB (Cell_End_Address), an audio flag (Audio_Flag) for specifying that audio signal played back in the Cell is an original audio or an after-recording
audio. The cell information further comprises Cell_Start_Address and Cell_End_Address for the after-recording audio.

**AV File**

An AV file will be described with reference to Fig. 42B.

The AV file includes at least one VOB (ordinarily, a plurality of VOBs). The VOB is continuously recorded in the AV file. The VOB in the AV file is managed by the VOB information of the above-mentioned management information file. A player can access the VOB by first accessing the management information file to read out the start and end addresses of the VOB.

Moreover, the Cell is defined as a logical playback unit in the VOB. The Cell is the partial playback section (or the whole sections) of the VOB and can be freely set by a user. By the Cell, it is possible to edit AV data simply without actual operation of the AV data. In the same manner as the VOB, an access information about the Cell is managed by the Cell information in the management information file. The player can access the Cell by first accessing the management information file to read out the start and end addresses of the Cell.

The address information of the Cell is based on the VOB and the address information of the VOB is based on the AV file. Therefore, the player actually accesses the AV file by adding the address information of the VOB to the address information of the Cell to calculate address information in the AV file.

**Structure of VOB**

Fig. 43 is a diagram showing the structure of the VOB according to an embodiment of the present invention.

Two audio streams are set to an audio stream #1 and an audio stream #2, respectively. As shown in Fig. 43, the same audio stream is stored in the audio stream #1 and the audio stream #2.
The audio streams are not simply identical as streams but are identical in pack and packet units. The value of SCRs (System Clock References) of a pack header, the value of stream numbers of a packet header and the value of original_or_copy are different. However, other fields, for example, PST and the like have the same values. The contents of a payload are identical.

The fields of original_or_copy are different in order to explicitly indicate, in the streams, that the stream #1 is an original stream and the stream #2 is a dummy stream for the after-recording operation. The flags may have the same values.

By putting two such audio streams in the VOB, one of the original audio data can remain even if one of the audio streams is recorded by the after-recording operation as shown in Fig. 44.

The two audio streams are used because a recording region for the after-recording operation (i.e., a recording band) is maintained. In addition, if the attribute of the audio stream is to be after-recorded (i.e., a recording mode and a bit rate are set identical to that of the audio stream recorded in a dummy) then the pack and the packet header become completely identical and the after-recording operation can be carried out simply by exchanging the contents of the payload.

Even though the system encoder of the MPEG should carry out the multiplexing operation of the audio pack so that an audio buffer neither underflows nor overflows, the multiplexing operation can be omitted on the after-recording operation.

When the after-recording operation is to be carried out in various coding modes and bit rates, the audio pack should be replaced not only to ensure a band but also to prevent the overflow and underflow of the audio buffer. Therefore, it is difficult to ensure the replacement of the audio pack between sets having different algorithms.
In the present embodiment, the SCR and the PTS are not changed in the same coding mode and the same bit rate but data are rewritten in a pack unit such that only the contents of the audio payload are replaced.

While the contents of the pack header and the packet header including the SOR and the PTS may be rewritten, it is apparent that the completed stream should satisfy the conditions of the MPEG stream.

The reason why the same audio data are to be recorded in stream #1 and stream #2 will be described with reference to Fig. 45.

For example, in the case where a part of the VOB is to be after-recorded, when the data recorded as the stream #2 is silent or has insignificant contents, insignificant data and significant data are switched between each other on the boundary between an after-recorded portion and a non-after-recorded portion.

Since the DVD recorder has only one audio decoder, streams #1 and #2 cannot be played back at the same time. Accordingly, when the partial after-recording operation is to be carried out, it is necessary to designate the audio stream to be played back to a decoder to switch the audio stream from original data to after-recorded data or from after-recorded data to original data on the boundary portion. The audio stream to be played back is generally designated by control from the host side, that is, a microprocessor. Therefore, it is difficult to designate the switching in a frame unit.

By recording the same audio data as the original on the dummy audio stream as shown in Fig. 45, it is also possible to continuously play back on the boundary portion where the partial after-recording operation is executed.

The problem of a partial after-recording operation can be solved when the audio streams are not completely identical but have the same contents (i.e., data having the same contents as analog data during the playback).
When the user wants to turn back the after-recorded audio data (i.e., erase the audio data) after the partial after-recording operation, it is necessary to record some data again because the overwritten data cannot be turned back. When the silent audio stream is to be recorded, the problem of the partial after-recording operation is caused when the user tries the after-recording operation again in the partial section of the silent audio stream section.

In the case where the two identical audio streams are used in the pack and packet units except the SCR and the stream number as shown in Fig. 46, an original state can be restored by copying data in the packet unit from stream #1 to stream #2. At this time, the stream number in the packet header should be modified.

*State of Audio Stream #2*

Fig. 47 is a diagram showing the state of stream #2 recorded for the after-recording operation described above. The state of stream #2 is divided into "same audio stream", "stream having the same audio contents" "after-recorded stream" and "individual stream". As described above, it is possible to carry out the after-recording operation from the same audio stream and the stream having the same audio contents. In contrast, it is possible to return only to the same audio stream (i.e., it is possible to return from the after-recorded audio stream to the same stream).

The after-recorded stream can be regarded as an independent stream. In the independent stream (for example, the audio stream #2 in which silent data are recorded), the after-recording operation can be carried out for the whole VOB. However, the partial after-recording operation of the VOB causes the above-mentioned problem.

The above-mentioned state is managed in an Application Flag on the DVD-RAM disc.
Structure of DVD recorder

The structure of the DVD recorder will be described with reference to Fig. 48.

The DVD recorder comprises a user interface 7801, a system controller 7802, an input section 7803, an encoder 7804, an output section 7805, a decoder 7806, a track buffer 7807 and a drive 7808. The user interface 7801 transfers data displayed to the user or accepts a request from the user. The system controller 7802 serves to perform management and control. The input section 7803 includes an AD converter for processing video and audio data. The output section 7805 outputs a video and audio data. The decoder 7806 decodes an MPEG stream.

Recording Operation of DVD recorder

The recording operation of the DVD recorder will be described.

The user interface 7801 first accepts a request from the user. The user interface 7801 transmits the request from the user to the system controller 7802. The system controller 7802 interprets the request from the user and gives a process request to each module. When the user requests picture recording, the system controller 7802 gives an encoding request to the encoder 7804.

The encoder 7804 carries out video encoding, audio encoding and system encoding for video and audio information sent from the input section 7803, and transfers the encoded data to the track buffer 7807.

Next, the system controller 7802 gives, to the drive 7808, a request for writing data stored in the track buffer, and the drive 7808 fetches data from the track buffer and records the fetched data in the DVD-RAM.

The user's "stop" request is transmitted to the system controller 7802 through the user interface 7801. The system controller 7802 gives a request for encoding stoppage to the encoder 7804, and the encoder 7804 stops an
encoding process when the data are completely encoded and informs the
system controller 7802 of encoding termination.

Then, the system controller 7802 gives a request for a writing termination
to the drive 7808, and the drive 7808 stops reading and writing data to the
5 DVD-RAM when the track buffer 7807 becomes empty.

Finally, the system controller 7802 modifies the AV file information, clip
sequence information and file system information for the recorded VOB and
records them in the DVD-RAM through the drive 7808. In particular, a value of
Application Flag is recorded as the same audio stream.

10 For the recording operation, the two audio streams are inserted into the
outputting VOB in the encoder 7804, while one audio data is input.

A process of inserting the two audio streams will be described with
reference to Fig. 49. Fig. 49 is a diagram showing the structure of the encoder.
The encoder comprises a video encoder 7804a, an audio encoder 7804b and a
system multiplexer 7804c.

15 The video encoder 7804a encodes an input video signal into an MPEG
video stream. The audio encoder 7804b encodes an input audio signal into an
audio stream. At this time, there is one audio stream. The multiplexer 7804c
then performs packing, packetizing and multiplexing of the video stream and the
audio stream. In the multiplexing process, copying is carried out in an audio
pack unit and the multiplexing is executed for the two audio streams.

20 The audio stream may be copied in a form of a packet, or in a form of a
payload immediately before the packetizing process. As described above, the
two audio streams are inserted into the VOB.
After-recording operation of the DVD recorder

Input and output of the AV data: data are read or written in a unit called an AV block. The AV block indicates the continuous recording region shown in Fig. 35. When the continuous recording region is much greater than a continuous recording length necessary for seeking the continuous recording region, it may be divided into small regions as AV blocks.

Subsequently, the track buffer 7807 is divided into track buffer1 and track buffer3 to be used for playback and track buffer2 and track buffer4 to be used for recording. This operating state is illustrated in Fig. 50.

The input and output of the track buffer will be described in time series with reference to Fig. 52. An example will be description in the case where the VOB includes four AV blocks A, B, C and D as shown in Fig. 52B.

Fig. 52A is a diagram representing the buffer storage amount of the track buffers 1, 2, 3 and 4 on a time base. At track buffer1 (TB1) and track buffer3 (TB3), the data storage amount is increased because data are input from the drive, that is, data are read out for playback from the DVD-RAM and the data storage amount is decreased because data are supplied to the decoder.

In contrast, at track buffer2 (TB2) and track buffer4 (TB4), the data storage amount is increased because data are input from the encoder after the after-recording operation, that is, data are recorded (overwritten) on the DVD-RAM and the data storage amount is decreased because data are supplied to the drive for recording in the DVD-RAM.

During period T1 the AV block A is read out on track buffer1 and the after-recording operation starts immediately after the data are read out. During period Ta, the after-recording operation is carried out for the AV block A. The after-recorded data of the AV block A are recorded on TB2. Therefore, the storage amount of the TB2 is increased during the period Ta.
The drive reads the next AV block B immediately after the period T1. AV block A and AV block B are not present on the same continuous recording region, and therefore AV block B is read out after the seeking of a head (period T2).

After the after-recording operation of the AV block A is ended, the after-recording operation of the AV block B then starts (period Tb). The data of the AV block B stored in track buffer3 are supplied to the decoder. The data after-recorded through the encoder are stored in the track buffer4 during the period Tb.

Immediately after the after-recording operation of AV block A is ended, the drive overwrites the after-recorded data of AV block A stored in the track buffer2 onto the AV block A (period T3). When the overwriting process on AV block A is completed, the drive then reads out AV block C. The read data on AV block C are stored in the track buffer1 (period T4). By repeating the above-mentioned operation, the after-recording process can be carried out.

A description of a process flow in the DVD recorder is provided below.

The user's request for the after-recording operation is transmitted to the system controller 7802 through the user interface 7801. The system controller 7802 gives to the drive 7808 a request for reading out the VOB to be after-recorded.

The drive 7808 reads out the VOB to be after-recorded from the DVD-RAM in an AV block unit and records the read VOB in the track buffer1. At the same time, the system controller 7802 gives a request for the after-recording process to the encoder 7804.
The encoder 7804 performs audio-encoding of audio data input from input section 7803, reads out an audio pack including audio stream #2 in the stream sent from the decoder, replaces a payload with the encoded after-recording audio stream, and records the after-recording audio stream in track buffer2 (see Fig. 51).

When the after-recording process of the AV data stored in track buffer1 is completed, the encoder 7804 consecutively starts the after-recording process of the AV data recorded in track buffer3 and notifies system controller 7802 that the after-recording process of track buffer1 is ended. The system controller 7802 gives a request to the drive 7808 to write the data of track buffer 2. The drive 7808 then overwrites and records the data of track buffer 2 on the DVD-RAM after the completion of writing into the track buffer3.

By sequentially carrying out the processes for track buffer1, track buffer2, track buffer3 and track buffer4 as described above, the after-recording operation can be executed. When the VOB is completely read out from the DVD-RAM, the drive 7808 informs the system controller 7802 of termination of the VOB reading process.

The system controller 7802 gives a request for termination of after-recording to the encoder 7804. The encoder 7804 carries out the after-recording process until the after-recording processes of all the audio data remaining in track buffer1 and track buffer3 are terminated. The encoder 7804 informs system controller 7802 of the after-recording termination when the after recording processes of all the data are completed.

The system controller 7802 then gives a request for a writing end process to the drive 7808. The drive 7808 overwrites and records all the VOB data remaining in track buffer2 and track buffer4 on the DVD-RAM disc and informs the system controller 7802 that the after-recording process is completed after the completion of recording operation.
The system controller 7802 changes the Application Flag to "after-recorded" and carries out the recording operation on the DVD-RAM through the drive 7808 again.

*Playback (Reproduction) Operation of DVD recorder*

The playback operation of the DVD recorder will be described.

The user's request for a playback process is transmitted to the system controller 7802 through the user interface 7801. The system controller 7802 gives a request for reading the VOB to the drive 7808, and the drive 7808 reads out the VOB data from the DVD-RAM and transfers the VOB data to the track buffer 7807.

The system controller 7802 then gives a request for playing back the VOB to the decoder 7806, and the decoder 7806 reads out data from the track buffer 7807, decodes the read data and outputs the decoded data through the output section 7805.

When the VOB is completely read out, the drive 7808 informs the system controller 7802 of termination of the reading process, and the system controller 7802 gives a request for ending the playback to the decoder 7806. The decoder 7806 carries out the reading and decoding operations of the data until the data of the track buffer 7807 becomes empty, and informs the system controller 7802 of the end of the playback operation after the completion of decoding process for all data.

In the case where the user gives a request for switching the audio stream (i.e., a request for playing back the audio stream #2) the system controller 7802 informs the user through the user interface 7801 that the switching is not possible, without playing back the audio stream #2 when the value of the Application Flag indicates the same audio streams or the same audio contents.
When the same audio streams or the same audio contents are recorded in the audio stream #2, an error message is displayed for the user. This prevents the user from thinking that the switching is failed or the DVD recorder is out of order, because the user performing the switching operation of the audio stream expects the playback of an audio stream different from the audio stream #1. However, the same audio is played back in this case even if audio stream to be played back is switched to the audio stream #2.

While the audio stream #2 has been a dummy audio stream for the after-recording operation in the present embodiment, the audio stream #1 may be the dummy audio stream for the after-recording operation.

The payloads in the packets between the two audio streams have been coincident with each other in the present embodiment. The sizes of the audio data to be packetized may be different from each other, and may be identical to the audio streams recorded in the completed VOB or have the same contents as the audio streams recorded in the completed VOB.

Restrictions may be placed on the audio pack of the audio stream #1 (such as it always being before audio stream #2 or audio stream #2 immediately after audio stream #1). By using such restrictions, it is easy to find the audio pack of the audio stream #2 during the after-recording operation. Moreover, restrictions can stipulate that audio stream #2 precede audio stream #1.

There are four possible values of the Application Flag: “the same audio stream”, “the stream having same audio contents”, “the after-recorded stream” and “the individual stream”. The “same audio stream” and the “same audio contents” may be dealt with as one state, the “after-recorded stream” and the “individual stream” may be dealt with as another state. Also the “same audio stream”, the “stream having same audio contents” and the “after-recorded stream” may be dealt with as one state.
Although four track buffers have been provided in the description of the after-recording operation, the AV data may be overwritten on track buffers by sharing track buffer1 and track buffer2, and by sharing track buffer3 and track buffer4, respectively.

5 Second Embodiment

Different from a conventional tape media, a DVD can carry out recording in various audio stream formats. This makes it difficult to perform after-recording operations in a DVD recorder.

In particular, the audio stream that can be recorded in the DVD has three kinds of formats of AC-3, MPEG audio and linear PCM. Moreover, there are various modes such as recording channel numbers, a recording bit rate and the like in individual formats.

A general audio encoder can rarely operate with all encoding modes, channel numbers and bit rates, and can typically operate with only a mode suitable for each merchandise target. In other words, when the after-recording operation is applied to the disc on which data have been recorded by another DVD recorder, the after-recording operation should actually start or the recorded audio stream should be analyzed in order to decide whether the after-recording operation is operable or not.

A DVD and DVD recorder of the present embodiment have basically the same structure as in the first embodiment, and are characterized by a method of having management information on the disc and the operation of a recorder for performing the after-recording process. In describing the second embodiment the focus is on the differences over the first embodiment.

Logical Structure of DVD - RAM

The logical structure of the DVD-RAM will be described with reference to Fig. 1. Fig. 1 shows a physical sector address on a disk and a data structure on the disk as seen through a file system.
The data to be dealt with by the DVD recorder are put on a DVD_RTR directory immediately under a ROOT directory as shown in Fig. 1. The file to be dealt with by the DVD recorder is roughly divided into 2 kinds of files: one management information file and at least one AV file (ordinary a plurality of AV files). The AV file stores an RTR_MOV.VRO file for storing a motion picture and an RTR_STO.VRO file for storing a still picture and audio data which are recorded at the same time with the motion picture or the still picture.

Fig. 2 is a diagram showing the structure of the RTR_MOV.VRO file having a motion picture. As shown in Fig. 2, M_VOB (Movie Video Object), which is the program stream of MPEG, is provided in the RTR_MOV.VRO file in order of picture recording.

The M_VOB comprises a VOBU (Video Object Unit) in which one unit is 0.4 to 1.0 second based on a video reproducing time, the VOBU comprises V_PCK (Video Pack) A_PCK (Audio Pack) and SP_PCK (Sub-picture Pack). Each pack is constituted in a 2 KB unit.

Video data in the VOBU also comprises at least one GOP (Group of Pictures). The GOP is the decode unit of the MPEG video and includes a plurality of P pictures and B pictures with the I pictures in a head.

Fig. 3 is a diagram showing the structure of the RTR_STO.VRO file in which a still picture and audio data are recorded. As shown in Fig. 3, S_VOB (Still Picture Video Object), which is an MPEG program stream for the still picture, is recorded in the RTR_STO.VRO file in order of picture recording.

A difference between the M_VOB and the S_VOB is that motion picture data and audio data are not mutually multiplexed but rather audio data (Audio part) are successively recorded after the still picture data (Video part), in addition to the recording of the still picture data in place of the motion picture data. Moreover, the S_VOB is constituted by one VOBU. The VOBU comprises the V_P0K the A_P0K and the SP_P0K.
AV data and Management Information

Description of the relationship between the M_VOB and S_VOB with reference to Fig. 4 and management information is detailed below.

AV data have two kinds of data: M_VOB for a motion picture and S_VOB for a still picture. Each M_VOB has management information M_VOBI. Attribute information of the corresponding M_VOB is recorded in M_VOBI. In case of the S_VOB, when management is carried out for each S_VOB, the amount of the management information gets increased. Therefore, management information S_VOGI is provided for each group S_VOG having a lump of S_VOBs. S_VOGI stores the attribute information of a corresponding SVOB group.

The data of the MPEG stream has no linearity between a time and a data amount. As described above, a compression method uses a time correlation characteristic and compression using a variable length coding method, which is referred to as VBR, are executed in order to implement highly efficient compression in the MPEG stream. Therefore, the time and the data amount (address information) do not uniquely correspond to each other. The M_VOBI has a filter (TMAP) for converting a time and an address. The S_VOGI has a filter (SVOB Entries) for converting still picture number and an address in the group.

Description of the management information of a playback sequence is provided below.

The playback sequence is defined as a sequence (PGC) of a cell indicative of a partial or whole interval of the M_VOB and the S_VOG. The playback sequence has two parts: an original PGC and a user-defined PGC. The original PGC refers to all the AV data in the disc. The user-defined PGC defines a playback order of AV data which the user selects in the disc (plural definitions can be obtained). The original PGC is also called a program set (Program Set), and includes a layer that is called a program (Program) having a plurality of cells logically bundled therebetween. The user-defined PGC is also
called a play list (Play List) and includes no Program therebetween differently from the original PGC.

*Management Information File*

The contents of the management information file “RTR. IFO” will be described with reference to Figs. 5 to 33.

"RTR_VMG" (Fig. 5): Management information referred to as RTR_VMG (Real Time Recording Video Management) is recorded in the RTR. IFO file. The RTR_VMG comprises seven tables of RTR_VMGI, M_AVFIT, S_AVFIT, ORG_PGCII, UD_PGCIT TXTDT_MG and MNFIT.

"RTR_VMGI" (Fig. 6): RTR_VMGI (Real Time Recording Video Management Information) comprises VMGI_MAT and PL_SRPT.

"VMGI MAT" (Fig. 6): VMGIMT (Video Management Information Management Table) stores the following information as information related to the whole disc. A player and a recorder can first read the VMGI_MAT to roughly obtain structural information of the disc.

VMG_ID (Video Management Identifier): VMG_ID stores an identifier “DVD_RTR_VMG0” indicating that video recording data are recorded in this disc.

RTR_VMG_CAO (RTR_VMG EA End Address): The end address of the RTR_VMG is recorded therein.

VMGI_EA (VMGI End Address): The end address of the VMGI is recorded therein.

VERN (Version Number): The version number of a recording format of the video recording data is recorded in accordance with a format shown in Fig. 7.

TM_ZONE (Time Zone): Recorded therein is a time zone to be used by all date and time information recorded in this disc. As shown in Fig. 7, TM_ZONE comprises TZ_TY (time zone type) and TZ_OFFSET (time zone offset). TZ_TY
indicates which time is used for a reference of date information: Greenwich Mean Time or a standard time for each region. TZ_OFFSET records a time difference between the date and the Greenwich Mean Time.

STILL_TM (Still Time): A static time length obtained when displaying a recorded soundless still picture.

CHRS (Character Set Code for Primary Text): A character set code for a primary text which will be described below is recorded therein.

M_AVFIT_SA (M_AVFIT Start Address): Start address of M_AVFIT is recorded therein. When M_AVFIT is accessed a seek is carried out up to this start address.

S_AVFIT_SA (S_AVFIT Start Address): Start address of S_AVFIT is recorded therein. When S_AVFIT is accessed a seek is carried out up to this start address.

ORG_PGCI_SA (ORG_PGCI Start Address): Start address of ORG_PGCI is recorded therein. When ORG_PGCI is accessed a seek is carried out up to this start address.

UD_PGCIT_SA (UD_PGCIT Start Address): Start address of UD_PGCIT is recorded therein. When UD_PGCIT is accessed a seek is carried out up to this start address.

TXTDT_MG_SA (TXTDT_MG Start Address): Start address of TXTDT_MG is recorded therein. When TXTDT_MG is accessed a seek is carried out up to this start address.

MNFIT_SA (MNFIT Start Address): Start address of MNFIT is recorded therein. When MNFIT is accessed a seek is carried out up to this start address.

"PL_SRPT" (Fig. 8): PL_SRPT (Play List Search Pointer Table) is a table comprising PL_SRPT_I and n PL_SRPs. "PL_SRPT_I" (Fig. 8): PL_SRPT_I (Play List Search Pointer Table Information) stores the following information for accessing to PL_SR. PL_SRPT_Ns (Number of PL_SR): Number of
PL_SRPs is recorded therein. PL_SRPT_EA (PL_SRPT End Address): End address of PL_SRPT is recorded therein. "PL_SRPT" (Fig. 8): The following information for giving access to the user-defined PGG, which is actual data of the play list, is recorded in PL_SRPT (Play List Search Pointer). PL_TY (Play List Type): Any of the following values is recorded as a value for identifying the type of a play list in accordance with a description format shown in Fig. 9: 000Gb: only motion pictures; 0001b: only still pictures; and 0010b: hybrid of motion pictures and still pictures.

PGCN (PGC Number): PGC number corresponding to the play list is recorded therein. The PGC number indicates the recording order of PGC information in UD_PGCIT which will be described below.

PL_CREATE_TM (Play List Recording Date): Information about the date and time at which the play list was created is recorded therein in accordance with the description format shown in Fig. 9.

PRM_TXTI (Primary Text Information): Text information indicative of the contents of the play list is recorded therein. For example, in the case where a television program is picture recorded, the name of the program is recorded. Moreover, the primary text information is constituted by a field for the ASCII code and a field of a character code set specified by the above-mentioned CHRS.

IT_TXT_SRPN (IT_TXT_SRP Number): When information indicative of the contents of the play list are optionally recorded as IT_TXT in addition to the above-mentioned primary text, the IT_TXT_SRP number is recorded as link information to the IT_TXT to be recorded in the TXTDT_MG. The IT_TXT_SRP number indicates the recording order in TXTDT_MG that will be described below.

THM_PTRI (Thumb Nail Pointer Information): Thumb nail information which is representative of the play list is described. "THM_PTRI" (Fig. 8): In THM_PTRI is recorded the following information indicative of the position of a thumb nail.
CN (Cell Number): Cell number of a cell including a thumb nail is recorded therein. The cell number indicates the recording order of cell information in the UD_PGC1 to which the play list corresponds.

THM_PT (Thumb Nail Point): When a cell indicated by the above-mentioned CN is a motion picture cell, the display time of a video frame to be used as a thumb nail is recorded in accordance with a PTM description format shown in Fig. 10. The PTM is given in accordance with the reference time of a time stamp described in the MPEG program stream.

When the cell indicated by the above-mentioned CN is a still picture cell, the still picture VOB entry number of a still picture to be used as the thumb nail is recorded in accordance with an S_VOB_ENTN description format shown in Fig. 11. The still picture VOB entry number indicates the recording order of the still picture VOB entry in a still picture VOB group indicated by this cell.

"M_AVFIT" (Fig. 12): M_AVFIT (Motion picture AV File Information Table) stores management information corresponding to motion picture AV file "RTR_MOV.VRO" and comprises M_AVFITI, M_VOB_STI and M_AVFI.

"M_AVFITI" (Fig. 12): M_AVFITI (Motion picture AV File Information Table Information) stores the following information necessary for giving access to M_VOB_STI and M_AVFI. M_AVFINs (Number of Motion picture AV File Information): Number of fields of succeeding AVFI information is indicated therein. When the value is "0", no AVFI exists, while when the value is "1", an AVFI exists. Moreover, the presence of the AVFI also corresponds to that of RTR_MOV.VRO that is the AV file for motion pictures.

M_VOB_STI_Ns (Number of M_VOB_STI): Number of fields of succeeding M_VOB_STI is indicated therein. M_AVFIT EA (M_AVFIT End Address): The end address of M_AVFIT is recorded therein. "M_VOBSTI" (Fig. 12): M_VOB_STI (Movie VOB Stream Information) stores the following information as the stream information of movie VOB.
V_ATR (Video Attribute): The following video attribute information is recorded in accordance with a format shown in Fig. 13:

Any one of the following values for identifying a video compression mode is recorded therein: 00b: MPEG-I; or 01b: MPEG-2.

Any one of the following values for identifying a television system is recorded therein: 00b: 525/60(NTSC); or 01b : 625/50 (PAL).

Any one of the following values for identifying a resolution ratio is recorded therein: 00b: 4 x 3; or 01b: 16x9.

Recorded on line21_switch_1 is any one of the following values for identifying that closed caption data for a field1 are recorded or not in a video stream: 1b: Recorded; or 0b: Not recorded.

Recorded on line21_switch_2 is any one of the following values for identifying that closed caption data for a field2 are recorded or not in the video stream: 1b: Recorded or 0b: Not recorded.

Any one of the following values for identifying a video resolution is recorded therein: 000b : 720 x 480 (NTSC), 720 x 576 (PAL); 001b : 702 x 480 (NTSC), 702 x 576 (PAL); 010b : 352 x 480 (NTSC), 352 x 576 (PAL); 011b : 352 x240(NTSC), 352 x288(PAL); 100b : 544 x 480 (NTSC), 544 x 576 (PAL); 101 b : 480 x 480 (NTSC), 480 x 576 (PAL).

Number of audio streams (AST_Ns) recorded in corresponding VOB is recorded therein. Number of sub-picture streams (SPST_Ns) recorded in corresponding VOB is recorded therein.

The following audio attribute information (A_ATRO) corresponding to an audio stream 0 (corresponding to the audio stream #1 described above) is recorded in accordance with a format shown in Fig. 13.
Any one of the following values for identifying an audio compressing method is recorded: 000b: Dolby AC-3; 001b: MPEG audio having no extended stream; 010b MPEG audio having an extended stream; or 011b: linear PCM.

Any one of the following values for identifying application flag information is recorded therein: 00b: No application; 01b: Mixed audio channel number; 10b: With auxiliary voice.

When using the MPEG audio, any one of the following values for identifying the presence of DRC (Dynamic Range Control) information is recorded therein: 00b: DRC data are not included in the MPEG stream; or 01b: DRC data are included in the MPEG stream.

When using the LPCM audio, the following value for identifying the Quantization is recorded therein: 00b: 16 bits.

The following value for identifying a sampling frequency is recorded therein: 00b 48 kHz. Any one of the following values for identifying the number of audio channels is recorded therein: 0000b: one channel (monophonic); 0001b: two channels (stereo); 0010b: three channels; 0011b: four channels; 0100b: five channels; 0101b: six channels; 0110b: seven channels; 0111b: eight channels; 1001b: two channels (dual monophonic).

Any one of the following values for identifying a bit rate is recorded therein: 0000 0001b: 64kbps; 0000 0010b: 89kbps; 0000 0011b: 96kbps; 0000 0100b: 112kbps; 0000 0101b: 128kbps; 0000 0110b: 160kbps; 0000 0111b: 192kbps; 0000 1000b: 224kbps; 0000 1001b: 256kbps; 0000 1010b: 320kbps; 0000 1011b: 384kbps; 0000 1100b: 448kbps; 0000 1101b: 768kbps; or 0000 1110b 1536kbps.
Only the bit rate of a basic stream excluding an extended stream is recorded when the corresponding audio stream is the MPEG audio stream having the extended stream. The reason is that the extended stream cannot be expressed by the above-mentioned fixed bit rate because it carries out the compression using the variable length coding method.

The audio attribute information (A_ATRI) corresponding to an audio stream 1 (corresponding to the above described audio stream #2 provided for after-recording) is recorded in accordance with a format shown in Fig. 13. Individual fields are the same as the above-mentioned A_ATRO.

The sub-picture attribute information (SP_ATR) is recorded in accordance with a format as shown in Fig. 14.

Any one of the following values for identifying application information is recorded therein: 00b: No application; 01b: Subtitles; or 10b: Animation.

Color palette information for a sub-picture (SP_PLT) is recorded in accordance with the format shown in Fig. 14.

M_AVFI (Motion picture AV File Information) comprises information necessary for giving access to movie VOB (M_VOB), M_AVFI_GI, M_VOBI_SRP and M_VOBI (Fig. 15).

M_VOBI_SRP_Ns is recorded in M_AVFI_GI (Motion picture AV File Information General Information) (Fig. 15). Number of M_VOBI_SRP (Number of Movie VOB Information Search Pointer) is recorded therein. M_VOBI_SRP (Movie VOB Information Search Pointer) stores address information for accessing each M_VOB (Fig. 15).

The start address of M_VOB (Movie VOB Information Start Address) is recorded therein. The indicated address herein can be used in seeking operation for accessing the VOB information. M_VOB (Movie VOB Information) comprises management information of movie VOB, M_VOB_GI, SMLI, AGAPI, TMAPI and CP_MNGI (Fig. 16). M_VOB_GI (Movie VOB General Information)
stores the following information as the general information of the Movie VOB (Fig. 16).

The attribute information (VOB_TY) of VOB is recorded therein in accordance with a format shown in Fig. 17.

Any one of the following values for identifying the status (TE) of the VOB is recorded therein: 0b: Normal status; or 1b: Temporary erasing status.

Any one of the following values for identifying the status (A0_STATUS) of an audio stream 0 is recorded therein: 00b: Original status; or 01b: Rewritten status.

Any one of the following values for identifying the status (A1_STATUS) of an audio stream 1 is recorded therein: 00b: Original status; 01b: Rewritten status; 10b: Dummy status for after-recording; or 11b: After-recorded status.

Any one of the following values for identifying analog copy signal (APS) control preventing information is recorded therein: 00b: No APS; 01b: Type 1; 10b: or Type 2; 11b: Type 3.

Any one of the following values for identifying (SML_FLG) whether or not the VOB is seamlessly reproduced together with the VOB present just before: 0b: Seamless reproduction is impossible; or 1b: Seamless reproduction is possible.

Recorded therein is any one of the following values (A0_GAP_LOC) indicative of the presence of an audio reproducing gap in the audio stream 0 and VOBU having an audio reproducing gap interval multiplexed: 00b: No audio reproducing gap; 01b: Audio reproducing gaps are multiplexed to a head VOBU; 10b: Audio reproducing gaps are multiplexed to a second VOBU; or 11b: Audio reproducing gaps are multiplexed to a third VOB.
Recorded therein is any one of the following values (A1\_GAP\_LOC) indicative of the presence of an audio reproducing gap in the audio stream 1 and VOBU having an audio reproducing gap interval multiplexed: 00b: No audio reproducing gap; 01b: Audio reproducing gaps are multiplexed to a head VOBU; 10b: Audio reproducing gaps are multiplexed to a second VOBU; or 11b: Audio reproducing gaps are multiplexed to a third VOBU.

The date and time on which the VOB was recorded (VOB\_REC\_TM (VOB recording date and time)) is recorded therein in the same format as in the PL\_CREATE\_TM shown in Fig. 9. The recording date and time indicate the recording date and time of the display video frame of the VOB head. The VOB\_REC\_TM should also be corrected when the VOB head video frame is changed by edit or partial erasure. When the recording date and time are to be displayed synchronously with the reproduction of the VOB, as often seen with camcorders, it is possible to obtain the recording date and time by adding an elapsed time in the VOB to the VOB\_REC\_TM.

VOB\_REC\_TM\_SUB (VOB Recording Date and Time Difference Information) is a field for absorbing the error of the VOB\_REC\_TM to be modified when the VOB head video frame is changed by the edit and the partial erasure on the VOB. The VOB\_REC\_TM has only information about year, month, day, hour, minute and second as shown in Fig. 9. Therefore, in the case where the edit or erasure is carried out in each frame or field, the VOB\_REC\_TM cannot provide a sufficient recording precision. By using this field, therefore, a fraction is recorded.

M\_VOB\_STI number corresponding to the VOB is recorded therein.

M\_VOB\#STI number shown herein is the recording order in the above-mentioned M\_VOB\_STI table.

The display start time of the VOB (VOB\_V\_S\_PTM (VOB Video Start PTM) is recorded therein with the same reference time as a time stamp in a stream. The display end time of the VOB VOB\_V\_E\_PTM (VOB Video End
PTM) is recorded therein with the same reference time as a time stamp in a stream. The time stamp in the stream indicates the display start time of the frame, while VOB_V_E_PTM stores the display end time, that is, a time obtained by adding the display period of the frame to the display start time.

SMLI (Seamless Information) stores the following information necessary for seamless reproduction with the last VOB. This field is provided when “1b” is recorded in the above-mentioned SML_FLG (Fig. 16).

VOB_FIRST_SCR (VOB Head SCR): SCR in the first pack of the VOB is recorded.

PREV_VOB_LAST_SCR (Previous VOB Last SCR): SCR of the last pack of the previous VOB is recorded therein.

AGAPI (Audio Gap Information) stores the information necessary for processing an audio reproducing gap in a decoder. This field is provided in the case where a value other than “00b” is recorded in either the above-mentioned AO_GAP_LOC or A1_GAP_LOC (Fig. 16).

The time of the audio reproducing gap (VOB_A_STP_PTM (VOB Audio Stop PTM)), that is, the time during which the decoder temporarily stops audio reproduction, is recorded therein with the same reference time as a time stamp in a stream.

VOB_A_GAP_LEN (VOB Audio Gap Length): The time length of an audio reproducing gap is recorded with a precision of 90 kHz.

CP_MNGI (Copy Management Information) comprises copy management information for the VOB, CPG_STATUS and CPGI (Fig. 16).

CPG_STATUS (Copy Protecting Status): As the copy protecting status of the VOB, values for identifying "copy free or "one generation copying" are recorded therein.
CPGI (Copy Protecting information): Copy protecting information applied to the VOB is recorded therein.

"TMAPI" (Fig. 18): TMPAI (Time Map Information) comprises TMAP_GI, TM_ENT and VOBU_ENT.

"TMAP_GI" (Fig. 18): TMAP_GI (TMAP General Information) comprises TM_ENT_Ns, VOBU_ENT_Ns, TM_OFS and ADR_OFS.

TM_ENT_Ns (Number of TM_ENT): Number of fields of TM_ENT which will be described below is recorded therein.

VOBU_ENT_Ns (Number of VOBU_ENT): Number of fields of VOBU_ENT which will be described below is recorded therein.

TM_OFS (Time Offset): The offset value of a time map is recorded therein with a video field precision.

ADR_OFS (Address Offset): An offset value in the AV file of the head of the VOB is recorded therein.

"TM_ENT" (Fig. 18): TM_ENT (Time Entry) comprises fields as access point information for each constant interval TMU. TMU for NTSC is 600 video fields (NTSC), while TMU for PAL is 500 video fields.

VOBU_ENTTN (VOBU_ENT Number): The entry number of VOBU including a time indicated by the TM_ENT (TMU x (N-1) + TM_OFS for Nth TM_ENT) is recorded therein.

TM_DIFF (Time Difference): A difference between a time indicated by the TM_ENT and the display start time of VOBU indicated by the above-mentioned VOBU_ENTTN is recorded therein.

VOBU_ADR (VOBU Address): A head address in the VOB of the VOBU indicated by the above-mentioned VOBU_ENTTN is recorded therein.
"VOB_USER" (Fig. 19): VOBU_ENT (VOBU Entry) stores structure information of the corresponding VOBU in a format shown in Fig. 19. By adding succeeding fields in order, it is possible to obtain a time and address information necessary for accessing desirable VOBU.

ISTREF_SZ: Number of packs from a VOBU head pack to a pack including last data of the head I picture in the VOBU is recorded therein.

VOBU_PB_TM: The reproducing time length of the VOBU is recorded therein.

VOBU_SZ: The data amount of the VOBU is recorded therein.

"S_AVFIT" (Fig. 20): S_AVFIT (Still picture AV File Information Table) has management information corresponding to the still picture AV file "RTR_STO.VRO" recorded therein, and comprises S_AVFITI, S_VOB_STI and S_AVFI.

"S_AVFITI" (Fig. 20): S_AVFITI (Still Picture AV File Information Table Information) stores the following information necessary for accessing SVOB_STI and S_AVFI.

S_AVFI_Ns (Number of Still Picture AV File Information): "0" or "1" is recorded therein as the S_AVFI number. This value also corresponds to the still picture AV file number (i.e., the presence of the RTR_STO.VRO file).

S_VOB_STI_Ns (Number of Still Picture VOB Stream Information): Number of S_VOB_STI which will be described below is recorded therein.

S_AVFI_EA (Still Picture AV File Information End Address): The end address of S_AVFI is recorded therein.

"S_VOB_STI" (Fig. 20): In S_VOB_STI (Still Picture VOB Stream Information) is recorded the following information as the stream information of the still picture VOB.
V_ATR (Video Attribute): Video compression mode, TV system, aspect ratio, and video resolution are recorded therein as video attribute information. Individual fields are the same as V_ATR in the above-mentioned M_VOB_STI.

OA_ATR (Audio Stream Attribute): Audio coding mode, Application Flag, Quantization/DRC, fs, and Number of Audio channels are recorded as audio stream attribute information. Individual fields are the same as A_ATR0 in the above-mentioned M_VOB_STI.

SP_ATR (Sub-picture Attribute): Application Flag is recorded therein as sub-picture attribute information. The field is the same as SP_ATR in the above-mentioned M_VOB_STI.

SP_PLT (Sub-picture Color Palette): Color palette information for a sub-picture is recorded therein. A recording format is the same as SP_PLT in the above-mentioned M_VOB_STI.

"S_AVFI" (Fig. 23): S_AVFI (Still Picture AV File Information) comprises information necessary for accessing a still picture VOG, S_AVFI_GI, S_VOGL_SRP and S_VOGL.

"S_AVFI_GI" (Fig. 23): S_AVFI_GI (Still Picture AV File Information General Information) stores S_VOGL_SRP_Ns.

S_VOGL_SRP_Ns (Number of Still Picture VOB Group Search Pointer): Number of fields of S_VOGL_SRP which will be below is recorded therein.

"S_VOGL_SRP" (Fig. 23): S_VOGL_SRP (Static VOB Group Information Search Pointer) stores S_VOGL_SA. "S_VOGL" (Fig: 23): The start address of S_VOGL is recorded in the S_VOGL_SA (Still Picture VOB Group Information Start Address). The S_VOGL (Still Picture VOB Group Information) comprises the management information of the still picture VOB, S_VOGL_GI S_VOBL_ENT and CP_MNGI. "S_VOGL_GI" (Fig. 23): The following information is recorded as the general information of a still picture VOB group in S_VOGL_GI (Still Picture VOB Group General Information).
S_VOBS Ns (Number of Still Picture VOBs): Number of still picture VOBs in the still picture VOB group is recorded therein. S_VOBS_TIN (S_VOBS_TI Number): Recorded therein is S_VOBS_TI number of S_VOBS_TI which stores the stream information of the still picture VOB. The S_VOBS_TI number is the recording order in the above-mentioned S_VOBS_TI table.

FIRST_VOBS_RECT_TM (First VOB Recording Data and Time): The recording date and time information of the first (head) still picture VOB in the still picture VOB group is recorded therein. LAST_VOBS_RECT_TM (Last VOB Recording Data and Time): The recording date and time information of the last still picture VOB in the still picture VOB group is recorded therein. S_VOBS_SA (Still Picture VOB Group Start Address): The start address of the still picture VOB group in the RTR_STO.VRO file is recorded therein.

"CP_MNGI": CP_MNGI (Copy Management Information) stores copy management information related to the still picture VOB group. Individual fields are the same as the CP_MNGI of the above-mentioned M_VOBI.

"S_VOBS_ENT" (Fig. 24): S_VOBS_ENT (Still Picture VOB Entry) corresponds to individual still picture VOBs in the still picture VOB group, and is divided into types A and B depending on the presence of audio data.

"S_VOBS_ENT (Type A)" (Fig. 24): The type A comprises S_VOBS_ENT_TY and V_PART_SZ.

S_VOBS_ENT_TY (Still Picture VOB Entry Type): The type information of the still picture VOB is recorded therein in a format shown in Fig. 25.

MAP_TY: Any one of the following values for identifying the type A or the type B is recorded therein: 00b: Type A; or 01b: Type B.

Any one of the following values for identifying the status (TE) of the still picture VOB is recorded therein: 0b: Normal status; or 1b: Temporary erasing status.
SPST_Ns: Number of sub-picture streams in the still picture VOB is recorded therein.

V_PART_SZ (Video Part Size): The data amount of the still picture VOB is recorded therein.

"S VOB_ENT (Type B)" (Fig. 24): The type B has A_PART_SZ and A_PB_TM in addition to S_VOB_ENT_TY and V_PART_SZ. S_VOB_ENT_TY (Still Picture VOB Entry Type): The type information of the still picture VOB is recorded therein. Individual fields are the same as the above-mentioned type A.

V_PART_SZ (Video Part Size): The data amount of a video part in the still picture VOB is recorded therein. A_PART_SZ (Audio Part Size): The data amount of an audio part in the still picture VOB is recorded therein.

A_PB_TM (Audio Reproducing Time): The reproducing time length of the audio part of the still picture VOB is recorded.

"UD_PGCIT" (Fig. 26): UD_PGCIT (User-Defined PGC Information Table) comprises UD_PGCITI, UD_PGCI_SRP and UD_PGCI. "UD_PGCITI" (Fig. 26): UD_PGCITI (User-Defined PGC Information Table Information) stores the following information constituting the user-defined PGC information table. UD_PGCI_SRP_Ns (Number of User-Defined PGC Information Search Pointers): Number of UD_PGCI_SRP is recorded therein. UD_PGCIT_EA (User-Defined PGC Information Table End Address): The end address of UD_PGCIT is recorded therein. "UD_PGCI_SRP" (Fig. 26): UD_PGCI_SA is recorded in UD_PGCI_SRP (User-Defined PGC Information Search Pointer). UD_PGCI_SA (User-Defined PGC Information Start Address): The start address of UD_PGCIT is recorded in UD_PGCI_SA. A seek is carried out up to a recorded address when the PGCI is accessed. "UD_PGCI" (Fig. 26): The details of the UD_PGCI (User-Defined PGC Information) will be described in the following PGCI.
“O_PGCI” (Fig. 5): The details of O_PGCI (Original PGC Information) will be described in the following PGCI.

“TXTDT_MG” (Fig. 27): TXTDT_MG (Text Data Management) comprises TXTDTI, IT_TXT_SRP and IT_TXT. “TXTDTI” (Fig. 27): TXTDTI (Text Data Information) comprises CHRS, IT_TXT_SRP_Ns and TXTDT_MG_EA.

CHRS (Character Set Code): A character set code to be used for the IT_TXT is recorded therein.

IT_TXT_SRP_Ns (Number of IT_TXT Search Pointers): Number of the IT_TXT_SRP is recorded therein. TXTDT_MG_EA (Text Data Management End Address): The end address of the TXTDT_MG is recorded therein.

“IT_TXT_SRP” (Fig. 27): IT_TXT_SRP (IT_TXT Search Pointer) stores the following as access information to corresponding IT_TXT. IT_TXT_SA (IT_TXT Start Address): The start address of the IT_TXT is recorded therein. When the IT_TXT is accessed, a seek is carried out up to this address. IT_TXT_SZ (IT_TXT Size): The data size of the IT_TXT is recorded therein. When the IT_TXT is to be read, data with only this size is read. "IT_TXT" (Fig. 27): The IT_TXT comprises a plurality of sets or one set, each set having IDCD (identification code), TXT (text) corresponding to the IDCD and TMCD (termination code). When there is no TXT corresponding to the IDCD, the IDCD and the TMCD may make a set without TXT. The IDCD are defined below.

Genre code: 30h: Movie; 31h: Music; 32h: Drama; 33h: Animation; 34h: Sports; 35h: Documentary; 36h: News; 37h: Weather; 38h: Education; 39h: Hobby; 3Ah: Entertainment; 3Bh: Art (play, opera); or 3Ch: Shopping.

Input Source Code: 60h: Broadcasting station; 61h: Cam coder; 62h: Photograph; 63h: Memo; or 64h: Others.

“PGCI” (Fig. 28): PGCI (PGC Information) has a data structure which is common to O_PGCI and UD_PGCI and comprises PGC_GI, PGI, CI_SRP and CI. "PGC_GI" (Fig. 28): PGC_GI (PGC General Information) comprises PG_Ns
and CL_SRP_Ns as the PGC general information. PG_Ns (Number of Programs): Number of programs in the PGC is recorded therein. For the user-defined PGC, "0" is recorded in this field because the user-defined PGC has no program.

5 Cl_SRP_Ns (Number of Cl_SRP): Number of Cl_SRP which will be described below is recorded.

"PGI" (Fig. 28): PGI (Program Information) comprises PG_TY, C_Ns, PRM_TXTI, IT_TXT_SRPN and THM_PTRI.

PG_TY (Program Type): The information indicative of the status of this program is recorded therein by using a format shown in Fig. 29.

Protect (protect): 0b: Normal status; or 1b: Protect status.

C_Ns (Number of Cells): Number of cells in this program is described.

PRM_TXTI (Primary Text Information): Text information indicative of the contents of this program is recorded therein. The details are the same as in the above-mentioned PL_SRPT.

IT_TXT_SRPN (IT_TXT_SRP Number): In the case where information indicative of the contents of this program is optionally recorded as the IT_TXT in addition to the above-mentioned primary text, the number of IT_TXT_SRP recorded in the TXTDT_MG is recorded in this field. THM_PTRI (Thumb Nail Pointer Information): Thumb nail information which is representative of this program is described therein. The details of THM_PTRI are the same as in the THM_PTRI of the above-mentioned PL_SRPT.

"CI_SRP" (Fig. 28): CI_SRP (Cell Information Search Pointer) stores address information for accessing the cell information. CI_SA (Cell Information Start Address): The start address of the cell information is recorded therein. In the case where the cell is accessed, a seek is carried out up to this address.
"Cl" (Fig. 30): Cl (Cell Information) is classified into MI_Cl for a motion picture and S_Cl for a still picture.

"M Cl" (Fig. 30): M_Cl (Motion picture Cell Information) comprises M_C_GI and M_C_EPI. "M_C_GI" (Fig. 30): M_C_G1 (Motion picture General Information) has the following basic information constituting a cell. C_TY (Cell Type): The following information for identifying a motion picture cell and a still picture cell are recorded in a format shown in Fig. 31. C_TY1: 000b: Motion Picture (Movie) Cell; or 001b: Still Picture Cell.

M_VOBI_SRPN (Movie VOB Information Search Pointer Number): The search pointer number of movie VOB information to which this cell corresponds is recorded therein. In the case where access is to be given to stream data to which this cell corresponds, access is first given to a movie VOB information search pointer number indicated by this field.

C_EPI_Ns (Number of Cell Entry Point Information): Number of entry point present in this cell is recorded therein. C_V_S_PTM (Cell Video Start Time): The reproducing start time of this cell is recorded in a format shown in Fig. 10. C_V_E_PTM (Cell Video End Time): The reproducing end time of this cell is recorded in the format shown in Fig. 10. The effective interval of this cell in the VOB to which this cell corresponds is specified by using the C_V_S_PTM and C_V_E_PTM.

"M_C_EPI" (Fig. 32): M_C_EPI (Motion Picture Cell Entry Point Information) is classified into a type A and a type B depending on the presence of a primary text. "M_C_EPI (Type A)" (Fig. 32): M_C_EPI (Type A) comprises the following information indicative of an entry point.

EP_TY (Entry Point Type): The following information for identifying the type of this entry point is recorded in accordance with a format shown in Fig. 33. EP_TY1: 00b: Type A; or 01b: Type B. EP_PTM (Entry Point Time): A time that the entry point is put is recorded in accordance with the format shown in Fig. 10.
"M_C_EPI (Type B)" (Fig. 32): M_C_EPI (Type B) has the following PRM_TXTI in addition to the EP_TY and EP_PTM included in the type A.

PRM_TXTI (Primary Text Information): Recorded therein is text information indicative of the contents of locations indicated by this entry point. The details are the same as in the above-mentioned PL_SRPT.

"S_CI" (Fig. 30): S_CI (Still Picture Cell Information) comprises S_C_GI and S_C_EPI. "S_C_GI" (Fig. 30): S_C_GI (Still Picture Cell General Information) has the following basic information constituting a cell.

C_TY (Cell type): Information for identifying a motion picture cell and a still picture cell are recorded. The details are the same as in the above-mentioned motion picture cell.

S_VOGL_SRPN (Still Picture VOB Group Information Search Pointer Number): Recorded therein is the search pointer number of still picture VOB group information to which this cell corresponds. In the case where access is to be given to stream data to which this cell corresponds, access is first given to a still picture VOB group information search pointer number indicated by this field.

C_EPI_Ns (Number of Cell Entry Point Information): Number of entry points present in this cell is recorded. S_S_VOBN (Start Still Picture VOB Number): The reproducing start still picture VOB number of this cell is recorded in the format shown in Fig. 11. The still picture VOB number is the order in the S_VOGL indicated by the above-mentioned S_VOGL_SRPN. E_S_VOBN (End Still Picture VOB Number): The reproducing end still picture VOB number of this cell is recorded in the format shown in Fig. 11. The still picture VOB number is the order in the S_VOGL indicated by the above-mentioned S_VOGL_SRPN. The effective interval of this cell in the S_VOGL to which the cell corresponds is specified by using the S_S_VOBN and E_S_VOBN.

"S_C_EPI" (Fig. 32): S_C_EPI (Still Picture Cell Entry Point Information) is classified into a type A and a type B depending on the presence of a primary text. "S_C_EPI (Type A)" (Fig. 32): S_C_EPI (Type A) comprises the following
information indicative of an entry point. EP_TY (Entry Point Type): The information for identifying the type of this entry point is recorded in accordance with a format shown in Fig. 33. EP_TY1: 00b: Type A or 01b: Type B.

S_VOB_ENTN (Still Picture VOB Entry Number): A number of still picture on which an entry point is put is recorded therein in accordance with the format shown in Fig. 11. "S_C_EPI (Type B)" (Fig. 32): S_C_EPI (Type B) has the following PRM_TXTI in addition to the EP_TY and S_VOB_ENTN included in S_C_EPI of type A.

PRM_TXTI (Primary Text Information): Recorded therein is text information indicative of the contents of locations indicated by this entry point. The details are the same as in the above-mentioned PL_SRPT.

**DVD Recorder**

The structure of the DVD recorder of the present embodiment will be described.

The DVD-recorder of this embodiment has a similar structure to the one of the first embodiment but differs in the following manner: the system controller 7802 includes an after-recording check section 78021 and an after-recording operation section 78022 for performing after-recording as shown in Fig.53.

Though the operation of the recorder of this embodiment is similar to the first embodiment, there is a difference in that the after-recording check section 78021 of the recorder of this embodiment checks in advance whether the recorder has an ability to perform after-recording for an audio stream which is intended to be after-recorded.

As described above, the optical disc of this embodiment has bit rate information ("Bitrate") as attribute information of a dummy audio stream provided for after-recording in addition to audio coding mode information and information on the number of audio channels.
With reference to the audio attribute information, the DVD recorder checks in advance whether or not the recorder can perform after-recording operation by using the dummy audio stream. In particular, it is determined whether an after-recording operation is possible or not by comparing audio coding mode, audio channel number and bit rate with encoding ability of the DVD recorder.

When the after-recording operation is determined to be possible, the after-recording operation is performed as in the first embodiment. When the after-recording operation is determined to be impossible, the user is notified that the after-recording operation is impossible via the user interface 7801 in a predetermined manner (for example, a display message). This operation is described below with reference to flow charts in Figs. 54, 55 and 56.

Referring to Fig. 54, on receiving user request for after-recording to a desired program (PG) via the user interface 7801 (S1), the system controller 7802 reads in movie VOB information (M_VOBI) and movie VOB stream information (M_VOB_STI) related to the designated program (PG) (S2). Then, the possibility of after-recording operation in the recorder is checked (S3) (i.e., it is determined whether or not the after-recording operation is possible with reference to M_VOBI and M_VOB_STI (S3)). With the result, when the after-recording operation is determined to be possible (S4), that the controller starts the after-recording operation (S5). When the after-recording operation is determined to be impossible (S4), the controller notifies the user that the after-recording operation is impossible (for example, displays message) (S6).

The check routine of possibility of after-recording operation (step S3) is performed in accordance with the flowchart of Fig. 55.

The controller checks the number of audio streams based on AST_Ns of M_VOB_STI (in Fig. 12) (S31). When there are two audio streams (S32), the attribute of each audio stream is checked or a determination of whether or not each audio stream is in a state where it is possible to perform after-recording
operation to the stream (referred to as "after-recordable state") (S33) is made. With the result of the check, when the audio stream is in after-recordable state (S34), the coding mode ("Audio Coding Mode") (see Fig. 13) in A_ATTR1 of M_VOB_ST1 is checked (S35). When an encoder of the DVD recorder is operable in the checked coding mode (S36), bit rate ("Bitrate") in A_ATTR1 of M_VOB_ST1 is checked (S37). When the encoder is operable in the checked bit rate (S38), it is decided that the after-recording operation is "possible" (S39). Otherwise, it is decided that after-recording operation is "impossible" (S40).

The check routine of attribute of audio stream (step S33) is performed in accordance with the flowchart in Fig. 56.

It is determined whether or not the A1_STATUS of audio stream for after-recording (audio stream 2) (see Fig. 17) is in "dummy state for after-recording" (S321). When the A1_STATUS is in "dummy state for after-recording", the audio stream is decided to be in "after-recordable state" (S322). It is noted that "dummy state for after-recording" indicates that the audio stream is prepared for after-recording but that after-recording data have not been recorded yet in the audio stream. When the A1_STATUS is not in "dummy state for after-recording", notice is served to the user that the audio stream has already been after-recorded, and the user's response is awaited (S323). When after-recording is ordered by user in the response (S324), the audio stream is decided to be in after-recordable state (S322). When after-recording is not ordered by user in the response (S324), the audio stream is decided not to be in after-recordable state (S325).

The DVD recorder according to the present embodiment creates the management information for each motion picture recording. The DVD recorder especially creates audio coding mode, number of audio channels and bit rate information as an audio stream attribute information, and records them onto the optical disc. While in this embodiment the recorder is provided for DVD-RAM disc, this invention is not limited to DVD-RAM but applicable to re-writable disc.
In the present embodiment details of data structure on the disc is described; the data structure is not limited to the structure described above. That is, the embodiments of the present invention can be implemented by the recorder that compares audio attribute information including bit rate with encoding ability in advance when the recorder performs after-recording. Further, the same advantage could be obtained when only one audio stream is recorded.

Although the present invention has been described in connection with specified embodiments thereof, many other modifications, corrections and applications are apparent to those skilled in the art. Therefore, the present invention is not limited by the disclosure provided herein but limited only by the scope of the appended claims.
CLAIMS:

1. An information recording medium storing at least one video object and management information wherein:

5  the at least one video object includes a video stream obtained by coding a video signal, a first audio stream obtained by coding an audio signal and a second audio stream obtained by coding an audio signal, the second audio stream is multiplexed with the video stream and the first audio stream to be included in the video object, wherein the management information includes:

10  status information indicating whether or not the second audio stream is provided for an after-recording operation and further indicating whether or not after-recording data is present in the second audio stream when the second audio stream is provided for the after-recording operation;

    a bit rate of the second audio stream;

15  a number of audio streams; and

    a coding mode of the second audio stream.

2. An information recording medium storing at least one video object and management information wherein:

20  the at least one video object includes a video stream obtained by coding a video signal, a first audio stream obtained by coding a first audio signal and a second audio stream obtained by coding a second audio signal, the second audio stream is multiplexed with the video stream and the first audio stream to be included in the video object, wherein the management information includes:
status information indicating whether or not the second audio stream is provided for an after-recording operation, and whether or not after-recording data is present in the second audio stream when the second audio stream is provided for the after-recording operation;

a bit rate of the first audio stream and a bit rate of the second audio stream; and

a coding mode of the first audio stream and a coding mode of the second audio stream,

wherein the first and second audio streams have the same bit rate and the same coding mode when the second audio stream is provided for the after-recording operation.

3. An information recording medium storing at least one video object and management information, wherein:

the at least one video object includes a video stream obtained by coding a video signal, a first audio stream obtained by coding a first audio signal and a second audio stream obtained by coding a second audio signal, the second audio stream is multiplexed with the video stream and the first audio stream to be included in the video object;

wherein the management information comprises first and second management information segments, the first management information segment including at least one stream information having a specified number, the at least one stream information including a bit rate of the first audio stream, a bit rate of the second audio stream, a number of audio streams included in the at least one video object, a coding mode of the first audio stream, and a coding mode of the second audio stream, wherein the second management information segment is for storing a video management information for the at least one video object, the video management information including a status information and the specified
number, the status information for indicating whether or not the second audio stream is provided for an after-recording operation and whether or not after-recording data is present in the second audio stream when the second audio stream is provided for the after-recording operation; and

wherein the specified number is for designating one of the at least one stream information.

4. An information recording medium storing at least one video object and management information, wherein:

the at least one video object includes a video stream obtained by coding a video signal, a first audio stream obtained by coding an audio signal and a second audio stream obtained by coding an audio signal, the second audio stream is multiplexed with the video stream and the first audio stream to be included in the video object, and wherein the management information comprises:

a status information for indicating whether or not the second audio stream is provided for an after-recording operation and for further indicating whether or not after-recording data is present in the second audio stream when the second audio stream is provided for the after-recording operation; and

a bit rate of the second audio stream;

wherein the first audio stream and the second audio stream are the same in each packet for the stream number.

5. An apparatus comprising the information recording medium of any one of claims 1 to 4 operating in conjunction with an information recording apparatus, the information recording apparatus for performing the after-recording operation on the second audio stream, the information recording apparatus comprising:
checking means for checking in advance whether or not the information recording apparatus can perform the after-recording operation on the second audio stream based on at least the status information and the bit rate of the second audio stream; and

starting means for starting the after-recording operation.

6. The apparatus of claim 5, wherein the checking means comprising:

first determining means for determining whether or not the second audio stream is in a status where the after-recording operation can be done with reference to the status information;

second determining means for determining whether or not the information recording apparatus is able to encode the second audio stream with reference to the bit rate of the second audio stream; and

third determining means for determining if the information recording apparatus is able to perform after-recording operation when it has been determined that the second audio stream is in a status where the after-recording operation can be done and that the recording apparatus is able to encode the second audio stream.

7. The apparatus of claim 6, wherein the checking means further comprising notifying means for notifying a user that the after-recording operation is impossible when the third determining means determines that the information recording apparatus is not able to perform the after-recording operation.

8. The apparatus according to claim 6, wherein when the management information comprises the number of audio streams included in the at least one video object, the first determining means makes the determination with reference to the number of audio streams in addition to the status information.

9. The apparatus according to claim 6, wherein when the management information comprises the coding mode of the second audio stream, the second determining means determines whether or not the information recording
apparatus can encode the second audio stream with reference to the coding mode of the second audio stream in addition to the bit rate of the second audio stream.

10. A method for performing an after-recording operation on the second audio stream recorded on the information recording medium according to any one of claims 1 to 4 by using an information recording apparatus, the method comprising the steps of:

    checking in advance of the after-recording operation whether or not the information recording apparatus can perform the after-recording operation on the second audio stream based on at least the status information and the bit rate included in the management information; and

    starting the after-recording operation.

11. The method of claim 10, wherein the checking step comprises the additional steps of:

15            (a) determining whether or not the second audio stream is in a status where the after-recording operation can be done with reference to the status information of the second audio stream;

15            (b) determining whether or not the information recording apparatus is able to encode the second audio stream with reference to the bit rate of the second audio stream; and

15            (c) determining if information recording apparatus is able to perform the after-recording operation when it is determined that the second audio stream is in the status where the after-recording operation can be done and that the information recording apparatus is able to encode the second audio stream.

12. The method of claim 11, wherein the checking further comprises notifying a user that after-recording operation is impossible when step (c) determines that the apparatus is not able to perform the after-recording operation.
13. The method of claim 11, wherein when the management information further comprises the number of audio streams included in the video object, step (a) makes the determination with reference to the number of audio streams in addition to the status information.

14. The method of claim 11, wherein when the management information further comprises the coding mode of the second audio stream, step (b) determines whether or not the apparatus can encode the second audio stream with reference to the coding mode of the second audio stream in addition to the bit rate of the second audio stream.

15. A reproducing apparatus for reproducing data from the recording medium of any one of claims 1 to 4.
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**Fig. 7**

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Book version

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**Fig. 8**
**Fig. 9**

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Fig. 13

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<th>Video resolution</th>
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*Fig. 14*
Fig. 15
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Fig. 18

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**Fig.22**
Fig. 23
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<td>V PART. TY</td>
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Fig. 24
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Fig 25
28 / 56

FIG. 28
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Fig.29
### PGCI
- PGC GI
- PGI #1
- : 
- PGI #m
- Cl SRP #1
- : 
- Cl SRP #n
- Cl #1
- : 
- Cl #n

### M CI
- M CI
- M C GI
- M C EPI #1
- : 
- M C EPI #n

### M C GI
- reserved
- 1byte
- C TY
- 1byte
- M VOB1 SRPN
- 2bytes
- C EPI Ns
- 2bytes
- C V S PTM
- 6bytes
- C V E PTM
- 6bytes

### S CI
- S CI
- S C GI
- S C EPI #1
- : 
- S C EPI #n

### S C GI
- reserved
- 1byte
- C TY
- 1byte
- S VOGI SRPN
- 2bytes
- C EPI Ns
- 2bytes
- S S VOB ENTN
- 1byte
- E S VOB ENTN
- 1byte
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Fig. 31
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**Fig. 32**
Fig. 3.4 Prior Art

10. Optical Pick Up
11. Track Buffer
12. ECC
13. Encoder
14. Decoder
15. Encoder Block = 16 Sectors
16. Decoder Block = 2KB
Fig. 36

Prior Art

display order

coding order
Fig. 37
Prior Art
Fig. 40  Prior Art

RECORDING/REPRODUCING HEAD

→ TAPE RUNNING DIRECTION

AUDIO 2
AUDIO 1
VIDEO
Fig. 43

SAME DATA

V A#1 A#2 V V V A#1 V A#2 V

PAYLOAD

AUDIO STREAM #1
PTS=aaa
original_or_copy=1

PAYLOAD

AUDIO STREAM #2
PTS=aaa
original_or_copy=0
Fig. 48

- DVD-ROM
- DRIVE
- TRACK BUFFER
- TRACK BUFFER 1
- TRACK BUFFER 2
- TRACK BUFFER 3
- TRACK BUFFER 4
- SYSTEM CONTROLLER
- ENCODER
- DECODER
- INPUT SECTION
- OUTPUT SECTION

Connections:
- 7801 → 7802 → 7803 → 7804 → 7805 → 7806 → 7807 → 7808
Fig. 49

AV STREAM

MULTIPLEXER

VIDEO ENCODER

Audio FRAME

2 STREAMS

AUDIO ENCODER

1 STREAM

VIDEO SIGNAL

AUDIO SIGNAL
Fig. 53

SYSTEM CONTROLLER

AFTER-RECORDING CHECK SECTION

AFTER-RECORDING OPERATION SECTION
**Fig. 54**

1. **PROCESS ON AFTER-RECORDING**
2. **S1** RECEIVE REQUEST FOR AFTER-RECORDING FROM USER
3. **S2** READ IN M_VOBI, M_VOB_SI
4. **S3** CHECK POSSIBILITY OF AFTER-RECORDING OPERATION
5. **S4** AFTER-RECORDING OPE. IS POSSIBLE?
   - **YES**
     - **S5** START AFTER-RECORDING
   - **NO**
     - **S6** NOTIFY IMPOSSIBILITY OF AFTER-RECORDING TO USER
6. **END**
Fig. 55

CHECK POSSIBILITY OF AFTER-RECORDING OPERATION

S31 CHECK NUMBER OF AUDIO STREAMS USING AST_NS OF M_VOBS_TI

S32 TWO AUDIO STREAMS?

S33 CHECK ATTRIBUTE OF AUDIO STREAM

S34 AUDIO STREAM IS IN AFTER-RECORDABLE STATE?

S35 CHECK CODING MODE IN A_ATRI OF M_VOBS_TI

S36 ENCODER CAN OPERATE IN THE CODING MODE?

S37 CHECK BITRATE IN A_ATRI OF M_VOBS_TI

S38 ENCODER CAN OPERATE WITH THE BITRATE?

S39 AFTER-RECORDING POSSIBLE

S40 AFTER-RECORDING IMPOSSIBLE

RETURN
Fig. 56

1. CHECK ATTRIBUTE OF AUDIO STREAM
   S321 A1 STATUS="10b" ?
   (IS AFTER-RECORDING DUMMY STATE ?)
   If NO, go to S325.
   If YES, go to S323.

2. S323 NOTIFY USER OF AFTER-RECORDING STATE AND WAIT FOR RESPONSE

3. S324 IS ORDERED BY USER ?
   If NO, go to S325.
   If YES, continue with S322.

4. S322 AUDIO STREAM IS IN AFTER-RECORDABLE STATE
   RETURN

5. S325 AUDIO STREAM IS NOT IN AFTER-RECORDABLE STATE
### V ATR

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### A ATR0/1

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