Recording and reproducing an MPEG information signal on/from a record carrier.

The invention relates to a recording arrangement for recording an information signal in tracks on a record carrier, the recording arrangement comprising
- an input terminal for receiving the information signal,
- channel encoding means for channel encoding the information signal so as to obtain a channel signal suitable for recording in a track on said record carrier,
- writing means for writing the channel signal in the track,
the channel signal comprising subsequent signal blocks, each signal block comprising a first block section which comprises a synchronisation signal and a second block section which comprises a number of channel bytes, to a record carrier obtained with the recording arrangement, and to a reproducing arrangement for reproducing the video signal from the record carrier.

A recording arrangement as given in the opening paragraph is known from EP-A 492,704, document (1) in the list of references that can be found at the end of this application.

The known arrangement is a recording arrangement of the helical scan type and records an information signal comprising a digital audio signal and a digital video signal in audio signal recording sectors and video signal recording sectors respectively in subsequent tracks, where, when recording a track, the video signal recording sector in a track comes first and is followed by the audio signal recording sector. The order in which the sectors occur in a track can however also be in the reverse order. Further, other sectors may be included in a track, such as a clock run-in area located at the beginning of a track, so as to enable a locking-in of the internal system clock on the signals read from the track, and preamble and postamble areas that are located between the various sectors and function as an edit gap. Reference is made in this respect to the earlier filed European patent applications no.93.202.950, reference (2) in the list of references and no. 93.201.263, reference (3) in the list of documents.

The prior art documents relate to proposals for the realisation of a new digital video cassette (DVC) recorder standard, which enables the recording and reproduction of

digital video and digital audio on/from a longitudinal magnetic record carrier. This new digital video recorder standard will lead to new digital videorecorders/reproducers of the so-called DVC type.

The invention aims at providing a recording arrangement which is capable of recording other type of information signals in the known tape format as defined in the preamble. The recording arrangement in accordance with the invention is characterized in that the information signal is an MPEG information signal in accordance with an MPEG format, the MPEG information signal comprising subsequent transport packets, that the channel encoding means are adapted to store each time information included in x transport packets of the MPEG information signal in the second block sections of a group of y signal blocks of the channel signal, that the second block section of at least the first signal block of the group of y signal blocks comprise a third block section for storing identification information identifying the signal block as being the first signal block of the group of y signal blocks, and that x and y are integers such that $x \geq 1$ and $y > 1$.
More specifically, the recording arrangement in accordance with the opening paragraph is characterized in that the information signal is an MPEG information signal in accordance with an MPEG format, the MPEG information signal comprising subsequent transport packets, that the channel encoding means are adapted to store each time information included in x transport packets of the MPEG information signal in the second block sections of a group of y signal blocks of the channel signal, that the second block sections of the signal blocks comprise a third block section for storing sequence number information relating to a sequence number of the signal blocks, and that x and y are integers such that $x \geq 1$ and $y > 1$.

The invention is based on the following recognition. The draft Grand Alliance HDTV System Specification dated February 22, 1994, document (4) in the list of references, more specifically the chapters V and VI of this specification, comprises a description of a transport system for transmitting an MPEG information signal, which includes a data compressed digital video signal and a corresponding data compressed digital audio signal, for broadcasting purposes or for transmission via a cable network. The MPEG information signal is in the form of transport packets having either an equal length or a variable length in time. In both cases however, a transport packet comprises 188 bytes of information, the first byte being a synchronization byte.

A transmission such an MPEG information signal in the form of a recording on and a reproduction from a record carrier, such as a magnetic record carrier, require special

measures to be taken in order to realize such kind of transmission via the known tape format. More specifically, the invention relates to storing the transport packets in the signal blocks of the known tape format.

Generally, it can be said that, when storing the information included in a number of x transport packets of the MPEG information signal in a number of y signal blocks, some unoccupied space remains available in the y signal blocks for the storage of additional information, which additional information relates to the specific application of recording and reproducing the MPEG information signal on/from the record carrier. In a specific example of the DVC format, the second block sections can comprise 77 bytes of information. In that situation, two transport packets, from each of which the sync byte has been deleted, can be stored in second block sections of five signal blocks. Now, 11 bytes (= 5 x 77 - 2 x 187) remain available in the five signal blocks. Those 11 bytes can be divided over the second block sections of the five signal blocks in various ways so as to obtain the third block sections. One such way is that the first two bytes of all second block sections are available as third block sections and that the last byte available can be considered as a third block section to indicate the boundary between the information of the two transport packets as stored in the five signal blocks.

In the above example, identification information identifying the signal block as being the first signal block of the group of y signal blocks can be stored in a third block section of the first signal block in a group of y signal blocks. Or, sequence number information (sequence numbers) relating to the sequence of the signal blocks can be stored in the third block sections. This sequence number can also be identified as a continuity counter. The measures proposed result in a number of advantages.

The advantage of using identification information identifying a signal block as being the first signal block in a group of y signal blocks, is that the beginning of a group can be detected, which simplifies the read out of the data during reproduction.

One advantage using sequence numbers is that, when reproducing the signal blocks, it can be decided upon retrieval of the sequence numbers, whether a signal block has been missed because of reproduction errors or not, so that an error correction or concealment can be carried out. Another advantage is that one may shuffle the information to be stored in the signal blocks upon recording. Upon retrieval of the sequence numbers it is possible to realize a corresponding deshuffling in response to the sequence numbers retrieved so as to obtain the original datastream.

Further, having sequence numbers included in the third block sections of the

signal blocks, makes it possible to repeat signal blocks in the case that a transport packet of the MPEG data stream stored in those signal blocks require a higher protection against errors that can occur during the recording and a subsequent reproduction process.

The recording arrangement as given in the opening paragraph may be also characterized in that the information signal is an MPEG information signal in accordance with an MPEG format, the MPEG information signal comprising subsequent transport packets, that the channel encoding means are adapted to store each time information included in x transport packets of the MPEG information signal in the second block sections of a first group of y first signal blocks of said signal blocks of the channel signal so as to enable a normal play mode using video information stored in said first group of y first signal blocks during a normal play reproduction mode, the channel encoding means further being adapted to retrieve a trick mode video signal from the MPEG information signal and being adapted to store said trick mode video signal in second block sections of a second group of z second signal blocks of said signal blocks of the channel signal so as to enable a trick play mode using the video information stored in said second signal blocks, that the second block sections of at least one signal block in each first and second group of first and second signal blocks respectively comprise a third block section for storing identification information indicating whether the group comprises first signal blocks or second signal blocks, and that x, y and z are integers such that $x \geq 1$, $y > 1$ and $z > 1$.

More specifically, the information signal is an MPEG information signal in accordance with an MPEG format, the MPEG information signal comprising subsequent transport packets, that the channel encoding means are adapted to store each time information included in x transport packets of the MPEG information signal in the second block sections of a group of y signal blocks of the channel signal, that the second block sections of at least those signal blocks in a group of y signal blocks that comprises the start portion of a transport packet comprise a third block section for storing sequence number information relating to a transport packet sequence number corresponding to the transport packet having its start portion stored in the second block section of the signal block, and that x and y are integers such that $x \geq 1$ and $y > 1$.

This enables a reproduction in the reproducing arrangement in a normal play mode using the first signal blocks and a reproduction in a trick play mode using the second signal blocks, in response to the detection of the information indicating the groups comprising first signal blocks or second signal blocks respectively.

The recording arrangement as given in the opening paragraph may also be

characterized in that the second block sections of all signal blocks in each first and second group of first and second signal blocks respectively comprise a third block section for storing identification information indicating whether the group comprises first signal blocks or second signal blocks.

More specifically, the second block sections of a group of y signal blocks each comprise a third block section for storing sequence number information relating to a transport packet sequence number corresponding to the transport packet of which information is stored in said signal block.

Storing a packet sequence number has its advantages if an MPEG datastream is received having a constant bitrate, and comprising a number of different video programs interleaved in the MPEG datastream. Generally, such datastream has a too high bitrate for recording the total datastream on the record carrier. The recording arrangement now comprises a program selector for retrieving one video program and corresponding audio signal from the MPEG datastream so as to obtain the MPEG information signal for recording. As information corresponding to only one video program is included in a MPEG transport packet, such program selector selects only those transport packets from the MPEG datastream that comprise information corresponding to said only one video program. That means that some packets of the original MPEG datastream received are deleted. Upon reproduction however, an MPEG video signal in accordance with the MPEG standard, however now comprising only the one video program, should be regenerated. Such regenerated datastream should have the transport packets that were selected upon recording at the same location, that is in one or other way, dummy packets corresponding to the packets deleted upon recording must be inserted in the regenerated datastream. Upon recording a sequence number is added to each transport packet received, that is: also for the packets that will be deleted. The sequence numbers of the packets that are selected and stored is stored in the third block section of the signal blocks in which a transport packet is stored. Upon reproduction, a sequence of numbers is retrieved, where subsequent numbers will not necessarily be next higher numbers. In that situation one or more dummy packets must be inserted so as to regenerate the replica of the original MPEG datastream.

The recording arrangement as given in the opening paragraph can further be characterized in that the information signal is an MPEG information signal in accordance with an MPEG format, the MPEG information signal comprising subsequent transport packets, the recording arrangement comprising detection means for detecting the moment of receipt of the transport packets and for generating timing information for each transport

packet received, the timing information for a transport packet corresponding to said moment of receipt of said transport packet, that the channel encoding means are adapted to each time store information included in x transport packets of the MPEG information signal in the second block sections of a group of y signal blocks of the channel signal, that the second block sections of at least those signal blocks in a group of y signal blocks that comprises the start portion of a transport packet comprise a third block section for storing the timing information for said transport packet having its start portion stored in the second block section of the signal block,

and that x and y are integers such that $x \geq 1$ and $y > 1$.

More specifically, the second block sections of a group of y signal blocks each comprise a third block section for storing the timing information corresponding to the transport packet which has information stored in the second block section of said signal block.

Storing timing information corresponding to transport packet requires that the recording arrangement is provided with detection means for detecting the time of receipt of a transport packet. This measure has its advantages if an MPEG datastream is received having a variable bitrate, and comprising a number of different video programs interleaved in the MPEG datastream. As has been said above, generally, such datastream has a too high bitrate for recording the total datastream on the record carrier. The recording arrangement now comprises a program selector for retrieving one video program with its corresponding audio signal from the MPEG datastream so as to obtain the MPEG information signal for recording. As information corresponding to only one video program is included in a MPEG transport packet, such program selector selects only those transport packets from the MPEG datastream that comprise information corresponding to said only one video program. By detecting and storing the timing information corresponding to a transport packet, the reproducing arrangement will be capable of retrieving the timing information and recreate the MPEG information signal using said timing information.

It should be noted that the measures discussed above can be applied solely or in combination with one another in the recording arrangement. As a result, record carriers will be obtained having signal blocks stored in tracks on the record carrier, the signal blocks having a first block section which comprises a synchronisation signal and a second block section which comprises a number of channel bytes, x transport packets of the MPEG information signal being stored in the second block sections of a group of y signal blocks of the channel signal. Further in accordance with the invention,

- the second block section of at least the first signal block of the group of y signal blocks

comprise a third block section for storing identification information identifying the signal block as being the first signal block of the group of y signal blocks, or

- said identification information is sequence number information and the second block sections of a group of y signal blocks all comprise a third block section for storing sequence number information relating to the sequence numbers of the signal blocks, or

- the second block sections of the signal blocks each comprise a third block section for storing identification information indicating whether the signal block comprise 'normal play' data or 'trick mode' data, or

- the second block sections of at least those signal blocks in a group of y signal blocks that comprises the start portion of a transport packet comprise a third block section for storing identification information relating to a transport packet sequence number corresponding to the transport packet having its start portion stored in the second block section of the signal block, or

- the second block sections of at least those signal blocks in a group of y signal blocks that comprises the start portion of a transport packet comprise a third block section for storing the timing information for said transport packet having its start portion stored in the second block section of the signal block, or

- third block sections comprise information resulting from a combination of one or more of the measures listed above.

It will be apparent that a reproducing arrangement will be needed which is adapted to each specific embodiment of the recording arrangement, so as to enable a reproduction of the MPEG information signal recorded on the record carrier. Such reproducing arrangement is the subject of the claims directed to the reproduction arrangement.

These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereafter. In the figure description shows

figure 1 the track format of a record carrier of the DVC-type,

figure 2 schematically the contents of the video signal recording sector in the track of figure 1,

figure 3 schematically the serial MPEG datastream and the format of the transport packets included in the serial MPEG datastream,

figure 4 an example of the storage of two transport packets in five signal blocks,

figure 5 the contents of the track when having MPEG information recorded in it,

figure 6 an embodiment of the recording arrangement,

figure 7 an embodiment of the reproducing arrangement,

figure 8a an example of an original serial MPEG datastream having a constant bitrate and packet rate, figure 8b the MPEG datastream that is recorded and figure 8c the regenerated replica of the original serial MPEG datastream,

figure 9 an embodiment of the 'normal play' processing unit in the recording arrangement of figure 6,

figure 10 an example of a sequence of three groups of five signal blocks each,

figure 11 another example of a sequence of three groups of five signal blocks each,

figure 12 an example of the 'normal play' processing unit in the reproducing arrangement of figure 7,

figure 13a an example of an original serial MPEG datastream having a variable bitrate and packet rate, figure 13b the MPEG datastream that is recorded and figure 13c the regenerated replica of the original serial MPEG datastream,

figure 14 another embodiment of the 'normal play' processing unit in the recording arrangement of figure 6,

figure 15 another embodiment of the 'normal play' processing unit in the reproducing arrangement of figure 7,

figure 16 the record carrier and the read head scanning the record carrier during a trick play mode,

figure 17 the sequence of signal blocks in a track forming the trick play area.

Figure 1 shows the format of the signals as they are recorded in a track on a magnetic record carrier by means of a helical scan videorecorder of the DVC type. The left end of the track 1 in figure 1 is the start of the track and the right end of the track is the terminal part of the track. The track comprises a number of track parts. The track part denoted by G1 is the pre-amble track part. An example of the preamble track part G1 has been described extensively in reference (1).

The track part G1 is followed by tracking tone recording part TP1, which is denoted by ITI (insert timing information) track part and which contains a tracking tone, synchronisation information and identification (or timing) information. Further explanation of

the contents of the ITI track can be found in reference (3).

The track part TP1 is followed by an edit gap G2. The edit gap G2 is followed by the track part TP2, which is the audio signal recording sector and comprises digital audio information. The edit gap G3 is followed by a track part TP3 which is the video signal recording sector and comprises digital video information. The edit gap G4 is followed by a track part TP4, denoted by INDEX and which comprises amongst others subcode information, such as absolute and/or relative time information and a table of contents (TOC). The track is terminated by the track part G5. It can be said that the sequence order in which the parts TP1, TP2 and TP3 occur in the tracks may be different.

The contents of the video signal recording sector TP3 is given in figure 2. Figure 2 in fact shows schematically a number of 149 horizontal lines, denoted by $j=1$ to $j=149$, having bytes of information stored in it. The 149 lines are in fact 149 signal blocks (or sync blocks) that are stored sequentially in the video signal recording sector TP3. 90 bytes of information, denoted by $i=1$ to $i=90$, are stored in each signal block.

The first two bytes ($i=1$ and $i=2$) of each signal block form a synchronisation pattern of 2 bytes long. The following three bytes in each signal block form an ID code, comprising amongst others information which indicates the sequence number of the signal block in the video signal recording part TP3. The last eight bytes in the signal blocks form horizontal parity information. Vertical parity information is stored in the storage locations $i=6$ to $i=82$ inclusive of the last 11 signal blocks.

Bytes of video signal information are stored in the storage locations $i=6$ to $i=82$ inclusive of the signal blocks having the sequence numbers $j=3$ to $j=137$ inclusive. Bytes of auxiliary data are stored in the storage locations $i=6$ to $i=82$ inclusive of the signal blocks having the sequence numbers $j = 1, 2$ and 138. The signal blocks are stored sequentially in the video signal part TP3, starting with the signal block denoted $y=1$, followed by the signal block denoted $j=2$, and so on until the signal block denoted $j=149$.

The auxiliary data for storage in the signal blocks denoted $j = 1, 2$ and 138 can be teletext data or control data.

It should be noted here that it can be specified that the auxiliary data will be stored in a different location in the memory. Reference is made in this respect to document (1), figure 13, where the auxiliary data is stored in the memory part denoted by III.

Figure 3 shows schematically the MPEG datastream applied to a recording arrangement in accordance with the invention. The MPEG datastream comprises subsequent transport packets, denoted by ..., P_{k-1}, P_k, P_{k+1}, ... The packets each comprise a packet

header portion PH of 4 bytes long and a body portion of 184 bytes long. The transport packets can be transmitted in a datastream having a constant bitrate. This means that the packets are equally long, viewed in time, and are received at a fixed packet rate. The transport packets may also be transmitted in a datastream having a variable bitrate. In this situation, the packets need not be of the same length, viewed in time, and may be received with a variable packet rate. The first byte in the packet header PH is a sync byte. The sync byte is identical for all the transport packets. The other three bytes in the header comprise ID information, such as a packet identifier. For a further explanation of the contents of the ID information, reference is made to document (4) in the list of references, more specifically chapter V, paragraph 5.1 on page 27.

The body portion of the transport packets comprise each 184 bytes for storing the video and audio information that should be transmitted in accordance with the MPEG format. The body portion of one transport packet can store either audio information corresponding to a certain video signal, or the video signal. Further, in the case that a number of video programs are transmitted via the MPEG datastream, the body portion stores a video signal corresponding to one of such video programs transmitted.

The invention now aims at recording the video signal, and the corresponding audio signal as may be appreciated, corresponding to one of those video programs transmitted via the MPEG data stream on the record carrier having the track format disclosed in figure 1 and 2. Information stored in the transport packets should be stored in the signal blocks, more specifically, in the 135 signal blocks denoted j=3 to j=137 in the video signal recording part TP3 of a track. The two sync bytes, denoted i=1 and 2, the ID information in the form of the three ID bytes denoted i=3, 4 and 5, as well as the 8 horizontal parity bytes, denoted by i=83 to 90, in those signal blocks are required for a correct recording and reproduction. As a consequence, only the 77 bytes, denoted by i=6 to 82, in the signal blocks denoted by j=3 to 137, are available for the storage of the transport packets of the MPEG information. The part of the signal blocks formed by the 77 bytes i=6 to 82 is defined as being the second block sections of the signal blocks.

As synchronization during recording and reproduction is assured by means of the sync words in each of the signal blocks, there is no need for transmitting the sync bytes of the transport packets via the record carrier. So, before storing the information comprised in the transport packets in the second block sections of the signal blocks denoted by j=3 to 135, the sync byte of all the transport packets is thrown away. As a result only 187 bytes of information should be stored in the signal blocks for each transport packet.

A simple calculation makes clear that two transport packets can be stored in five signal blocks, and that 11 bytes remain available for the storage of other information. Figure 4 gives an example of how the two transport packets can be stored in the second block sections of the group of five signal blocks, denoted SB1 to SB5 in figure 4. Figure 4 only shows the contents of the second block sections of length of 77 bytes included in the signal blocks. As can be seen in figure 4, the 11 bytes are divided over the group of five signal blocks such that each second block section comprises a third block section TB3.1 to TB3.5, of two bytes long at the beginning of the second block sections of the five signal blocks SB1 to SB5 respectively, and a third block section in the form of one byte, denoted by FB, is available in the third signal block SB3. The 187 bytes of the first transport packet are stored in the signal blocks SB1, SB2 and SB3, where the three ID bytes of the packet header of the first transport packet, indicated by TH1, are stored first in the signal block SB1, directly after the third block section TB3.1, and next the first 72 first bytes in the body of the first transport packet are stored thereafter in the second block section of the signal block SB1. The next 75 bytes in the body of the first transport packet are stored in the second block section of the signal block SB2, after the third block section TB3.2, and the last 37 bytes in the body of the first transport packet are stored in the second block section of the signal block SB3, after the third block section TB3.3.

Next comes the byte FB, which indicates the boundary between the information of the first and second transport packets stored in the group of five signal blocks. The 187 bytes of the second transport packet are stored in the signal blocks SB3, SB4 and SB5, where the three ID bytes of the packet header of the second transport packet, indicated by TH2, are stored first in the signal block SB3, directly after the byte FB. Next the first 34 first bytes in the body of the second transport packet are stored thereafter in the second block section of the signal block SB3. The next 75 bytes in the body of the second transport packet are stored in the second block section of the signal block SB4, after the third block section TB3.4, and the last 75 bytes in the body of the second transport packet are stored in the second block section of the signal block SB5, after the third block section TB3.5.

It should be noted that also another spreading of the 11 available bytes over the five signal blocks is possible. As an example, the 11 bytes could have been split into two third block sections, the one third block section having as an example 6 bytes and being located at the beginning of the first signal block SB1, and the other third block section of 5 bytes long being located in the third signal block and indicating the boundary between the two transport packets stored in the five signal blocks. Another example could have been to

have a third block section located at the beginning of the signal blocks SB1 and SB3 and another third block section in the third signal block SB3, indicating the boundary between the two transport packets stored in the five signal blocks, where the third block section in the signal block SB1 can have eg. 4 bytes, the first third block section in the signal block SB3 eg. 3 bytes and the third block section in signal block SB3 indicating the said boundary being eg. 4 bytes long.

The third block sections TB3.1 to TB3.5 can be used for the storage of additional information. As a first example, the third block section TB3.1 can include an indication identifying the signal block SB1 as being the first signal block in a group of five signal blocks. This can be realized by storing in one specific bit location in the third block section TB3.1 a bit value of a certain polarity, such as '0' or '1'. In the same bit locations in the third block sections TB3.2 to TB3.5 a bit value of the opposite polarity should be stored. In another example, sequence number information, eg. sequence numbers running from 1 to 5 can be stored in the third block sections TB3.1 to TB5 respectively, of the group of five signal blocks, where the third block section TB3.1 has the sequence number '1' and the third block section TB3.5 has the sequence number '5' stored in them. Three specific bit locations in the third block sections TB3.1 to TB3.5 are required to stored the sequence numbers. The sequence numbers can however also run across the group boundaries so as to identify a larger sequence of signal blocks, eg within one track, or even in more than one track.

In another example, one specific bit location in the third block sections TB3.1 to TB3.5 of a group of five signal blocks can be used to store either a bit value of one polarity, such as '0' or '1', so as to indicate that the video data included in the signal block is so-called 'normal play' data, or a bit value of the opposite polarity, so as to indicate that the video data included in the signal block is so-called 'trick play' video data. The use of the 'normal play' video data and 'trick play' video data will be explained later.

In again another example, sequence numbers are generated in response to transport packets in the MPEG datastream that is received. As has been explained earlier, such MPEG datastream can include more than one video programs. As the bitrate of the MPEG datastream is normally higher than the bitrate of the signal that can be recorded, only one video program may be selected from the serial MPEG datastream for recording. Selection of one video program means selection of transport packets out of the datastream of the MPEG datastream that comprise the information relating to said video program, and deleting the other packets. Consequently the serial array of transport packets that will be recorded have sequence numbers that not necessarily are next higher numbers, as those

sequence numbers of the transport packets deleted are not present. When storing the sequence numbers in the third block sections, those sequence numbers can be retrieved upon reproduction. By checking the subsequent sequence numbers retrieved, it can be established whether the original MPEG datastream applied to the recording arrangement, originally included deleted transport packets between two transport packets reproduced. If so, a replica of the original MPEG datastream can be regenerated by inserting one or more dummy packets between the two transport packets reproduced.

In a related example, timing information is stored in the third block sections, for the same reason as given above, namely for regenerating a replica of the original MPEG datastream, in the case that such datastream is a datastream having a variable bitrate.

It will be clear that also a combination of the additional information described above can be included in the 11 bytes available for the storage of such information in a group of five signal blocks.

As an example, it has been made clear above that a 3-bit word is needed in the third block sections to indicate the sequence numbers of the signal blocks in the group of five signal blocks. More specifically, the 3-bit words '000', '001', '010', '011' and '100' could have been used to identify the sequence. That means that the 3-bit words '101', '110' and '111' remain available for a further identification. As an example, the 3-bit words '101' and '110' could be used to identify either 'normal play' data or 'trick mode' data.

Figure 5 shows the track format of the track if the MPEG information has been stored in the second block portions of the signal blocks of the track portion TP3 of figure 1, now denoted by track portion TP3'. Figure 5 shows the first two signal blocks (j=1,2) in the track portion TP3' that still includes the auxiliary data, followed by 135 signal blocks (j=3 to j=137) now comprising the MPEG information and the additional information described above. Next one signal block (j=138) also comprising the auxiliary data, followed by 11 signal blocks comprising the parity information. The storage of the MPEG information and the additional information in the 135 signal blocks may require an additional error encoding step to be carried out on the said information, resulting in additional parity information that should also be stored in a track. As the MPEG information, which includes video information and corresponding audio information, is stored in the signal 135 blocks in the track portion TP3', there is no need for storing audio information in the track portion TP2 of figure 1. This portion, now denoted by TP2' in figure 5, can be used to store the parity information resulting from the additional error encoding step.

Figure 6 shows schematically an embodiment of the recording arrangement. The

recording arrangement comprises an input terminal 11 for receiving the MPEG serial datastream for recording transport packets included in the datastream in the signal blocks of the track portions TP3' of the tracks. The input terminal 11 is coupled to an input 12 of a 'normal play' processing unit 14. Optionally, a 'trick play' processing unit 16 is provided having an input 17 also coupled to the input terminal 11. Outputs 19 and 20 of the 'normal play' processing unit 14 and the 'trick play' processing unit 16 (if present) are coupled to corresponding inputs of a multiplexer 22. It will be clear that in the absence of the 'trick play' processing unit 16, also the multiplexer 22 will be absent.

An auxiliary signal generator 24 is present for supplying the auxiliary signal information for storage in the signal blocks denoted by j=1,2 and 138, see figure 2. Outputs of the multiplexer 22 and the generator 24 are coupled to corresponding inputs of an error correction encoder unit 26. The error correction encoder unit 26 is capable of carrying out a first error correction encoding step, denoted ECC3 and a second error correction encoding step, denoted ECC2. Next a third error correction encoding step, denoted ECC1, is carried out in an error correction encoder unit 28.

The recording arrangement further comprises a generator 30 for adding the ID information in the bytes i=3, 4 and 5 of the signal blocks, see figure 2, for adding the index information for storage in the track portion TP4, see figure 5, and the gap information for realizing the gaps G1 to G5, see figure 5. After combination of the signals in the combining unit 32, the combined signal is applied to a unit 34, in which an encoding is carried out where each time 24-bit words of the incoming bitstream are converted into 25-bit words, where a sync word is added so as to obtain the first two bytes (i=1,2) in the signal blocks and where the ITI information is added for storage in the track portion TP1.

The 24-to-25 encoding carried out in the encoding unit 34 is well known in the art. Reference is made in this respect to US patent spec. no. 5,142,421, document (5) in the list of references. This document also a way of adding the sync word to the datastream.

An output of the encoding unit 34 is coupled to an input of a writing unit 36, in which the datastream obtained with the encoding unit 34 is recorded in the slant tracks on the record carrier, by means of at least one write head 42.

The first error correction encoding step, denoted ECC3, is required so as to realize the additional error protection of the MPEG information to be recorded on the record carrier, and results in parity information that will be stored in the track portion TP2', as has been explained previously. The second error correction encoding step, denoted ECC2, results in the vertical parity information that will be stored in the 11 signal blocks (j=139 to 149) of

the track portion TP3', see the figures 2 and 5. The third error correction encoding step, denoted ECC1, results in the horizontal parity information that will be stored in the last 8 bytes of the signal blocks in the track portion TP3', see the figure 2 and 5.

Before a further description of the 'normal play' processing unit 14 and the 'trick play' processing unit 16 of the recording arrangement of figure 6 will be given, first a schematic description of the reproducing arrangement will be given. This has the advantage that, when further describing certain measures applied in the processing units 14 and 16, a direct relation can be given to the advantages and consequences of those measures during reproduction.

Figure 7 shows schematically an embodiment of a reproduction arrangement for reproducing information from the record carrier 40 obtained with the recording arrangement of figure 6. The reproduction arrangement comprises a reading unit 50, having at least one reading head 52 for reading information from the slant tracks on the record carrier 40. An output of the reading unit 50 is coupled to an input of a decoding unit 54, which carries out a 25-to-24 decoding on the signal read out, so as to convert 25-bit words in the incoming datastream into 24-bit words. Next, after having selected out in the selector unit 56 all those information that is not required for recreating a replica of the original MPEG datastream, an error correction is carried out in the error correction unit 58. It will be clear that the error correction carried out has three steps. One error correction step based on the ECC1, using the horizontal parities, see figure 2, a second error correction step based on ECC2, using the vertical parities, and a third error correction step based on ECC3, using the parity information stored in the track portion TP2', see figure 5.

The output terminal of the error correction unit 58 is coupled to an input of a 'normal play' processing unit 60. Optionally, a 'trick play' processing unit 62 is provided having an input also coupled to the output of the error correction unit 58. Outputs 64 and 65 of the 'normal play' processing unit 60 and the 'trick play' processing unit 62 (if present) are coupled to corresponding terminals a and b respectively of a switch 66, a c-terminal of which is coupled to an output terminal 68. It will be clear that in the absence of the 'trick play' processing unit 62, also the switch 66 will be absent. If the reproducing arrangement is switched into a 'normal play' reproduction mode, this means that the record carrier is transported at a nominal speed, that the 'normal play' processing unit 60 is enabled and the switch 66 is switched into the position a-c. If the reproducing arrangement is switched into a 'trick play' reproduction mode, also called 'feature mode', this means that the record carrier is transported at a speed other than the nominal speed, that the 'trick play' processing unit 62

is enabled and the switch 66 is switched into the position b-c.

Now a further discussion will be given of the processing units 14 and 16 of figure 6, in combination with the processing units 60 and 62 of figure 7.

It is assumed that the recording arrangement is capable of selecting one video program and its corresponding audio signal from the serial MPEG datastream that is applied to the input terminal 11, in response to a selection signal supplied to the arrangement by a user. As has been said earlier, only those transport packets in the serial MPEG stream should be selected that include information relating to the video program selected. Figure 8a shows the serial MPEG datastream as a function of time comprising the transport packets denoted P_k. It should be noted that the transport packets of the MPEG datastream do not comprise a packet number. The packet number k, given to the packets in figure 8a are therefore the numbers that will be generated by the packet number generator 86 of figure 9 that will be discussed later.

Selecting only those packets of the packets P_k of figure 8a that include information relating to the video program selected means, as an example, that the packets P_{k-4}, P_{k-1}, P_k, P_{k+2}, P_{k+4}, P_{k+8} will be selected and that the intermediate packets will be thrown away. As a result, a datastream has been obtained in the recording arrangement for recording on the record carrier, as shown in figure 8b, which shows the datastream as a function of time. No conclusion should be drawn from the timing in the time scales of figure 8a and 8b, nor from the relative location between the time scales in figure 8a and 8b. This for the reason that, as has been said previously, the bitrate of the original MPEG datastream (figure 8a) is different from (higher than) the bitrate with which the selected transport packets will be recorded on the record carrier.

An embodiment of the 'normal play' processing unit 14 for recording a datastream as shown in figure 8b is shown schematically in figure 9. The embodiment denoted 14' in figure 9, comprise a selector unit 76 having an input coupled to the input 11 of the unit 14'. The selector unit 76 has another input 78 for receiving the selection signal supplied by the user. An output 79 of the selector unit 78 is coupled to the input of a sync stripper 80, whose output is coupled to a signal combining unit 82. Further, an output 81 of the selector 76 is coupled to a control input 83 of the combining unit 82, for supplying a control signal to the combining unit 82.

The input 11 is further coupled to an input of a packet detector 84, which has an output coupled to an input of a packet number generator 86. An output of the generator 86 is coupled to a second input of the combining unit 82.

The selector 76 selects the transport packets P_{k-4}, P_{k-1}, P_k, P_{k+2}, P_{k+4}, P_{k+8} from the serial MPEG datastream applied to the input 11 in response to the selection signal received via the input 78. The packets selected are applied to the sync stripper 80, in which the first sync byte in the packet header PH, see figure 3, is deleted from the packets, in accordance with a description given previously. The packet detector 84 detects the receipt of each packet in the original serial MPEG data stream applied to the input 11 and generates a clock impulse for each packet detected. The generator 86 includes a counter that counts up under the influence of the clock impulses applied to the generator 86. As a consequence a next higher count number is applied to the output for each clock impulse received. At the output 87 of the generator 86 thus appear count numbers .... k-4, k-3, k-2, k-1, k, k+1, k+2, k+3, k+8, ... Under the influence of the control signal applied to the control input 83 of the combining unit 82, the control unit combines the packets P_{k-4}, P_{k-1}, P_k, P_{k+2}, P_{k+4}, P_{k+8} selected by the selector 76 as well as the count numbers k-4, k-1, k, k+2, k+4, k+8 out of the count number stream supplied by the packet number generator 86 for storage into the signal blocks.

Figure 10 shows an example how the transport packets and the corresponding packet numbers can be stored in the groups of five signal blocks. Figure 10 shows three subsequent groups of five signal blocks, denoted G1, G2 and G3 in which the information is stored. In the third block section TB3.1 of the first signal block SB1 of the group G1, the packet number k-4 is stored and the information comprised in the packet P_{k-4} is stored thereafter in the signal blocks SB1, SB2 and SB3 of the group G1. In the third block section denoted FB of the third signal block SB3 of the group G1, the packet number k-1 is stored and the information comprised in the packet P_{k-1} is stored thereafter in the signal blocks SB3, SB4 and SB5 of the group G1. In the third block section TB3.1 of the first signal block SB1 of the group G2, the packet number k is stored and the information comprised in the packet P_k is stored thereafter in the signal blocks SB1, SB2 and SB3 of the group G2. In the third block section denoted FB of the third signal block SB3 of the group G2, the packet number k+2 is stored and the information comprised in the packet P_{k+2} is stored thereafter in the signal blocks SB3, SB4 and SB5 of the group G2. In the third block section TB3.1 of the first signal block SB1 of the group G3, the packet number k+4 is stored and the information comprised in the packet P_{k+4} is stored thereafter in the signal blocks SB1, SB2 and SB3 of the group G3. In the third block section denoted FB of the third signal block SB3 of the group G3, the packet number k+8 is stored and the information comprised in the packet P_{k+8} is stored thereafter in the signal blocks SB3, SB4 and SB5 of the group G3. As

long as the number of bits of the packet number is smaller than or equal to 8, the packet number will fit in the third block section FB, which is 1 byte long.

Another example of storing the packet numbers in the third block sections is given in figure 11. In the third block sections TB3.1, TB3.2 and TB3.3 of the signal blocks SB1, SB2 and SB3 respectively of the group G1, the packet number k-4 is stored and the information comprised in the packet P_{k-4} is stored in the signal blocks SB1, SB2 and SB3 of the group G1, as explained previously with reference to figure 4. In the third block section denoted FB of the third signal block SB3 of the group G1, as well as in the third block sections TB3.4 and TB3.5 of the signal blocks SB4 and SB5 of the group G1, the packet number k-1 is stored and the information comprised in the packet P_{k-1} is stored in the signal blocks SB3, SB4 and SB5 of the group G1, as explained previously with reference to figure 4. In the third block sections TB3.1, TB3.2 and TB3.3 of the signal blocks SB1, SB2 and SB3 respectively of the group G2, the packet number k is stored and the information comprised in the packet P_k is stored in the signal blocks SB1, SB2 and SB3 of the group G2. In the third block section denoted FB of the third signal block SB3 of the group G2, as well as in the third block sections TB3.4 and TB3.5 of the signal blocks SB4 and SB5 respectively of the group G2, the packet number k+2 is stored and the information comprised in the packet P_{k+2} is stored in the signal blocks SB3, SB4 and SB5 of the group G2. In the third block sections TB3.1, TB3.2 and TB3.3 of the signal blocks SB1, SB2 and SB3 of the group G3, the packet number k+4 is stored and the information comprised in the packet P_{k+4} is stored in the signal blocks SB1, SB2 and SB3 of the group G3. In the third block section denoted FB of the third signal block SB3 of the group G3, as well as in the third block sections TB3.4 and TB3.5 of the signal blocks SB4 and SB5 of the group G3, the packet number k+8 is stored and the information comprised in the packet P_{k+8} is stored in the signal blocks SB3, SB4 and SB5 of the group G3.

Instead of storing the packet number k-4 in the third block section TB3.3 of the signal block SB3 in group G1, one could have stored the packet number k-1 in said third block section. Instead of storing the packet number k in the third block section TB3.3 of the signal block SB3 in group G2, one could have stored the packet number k+2 in said third block section. Instead of storing the packet number k+4 in the third block section TB3.3 of the signal block SB3 in group G3, one could have stored the packet number k+8 in said third block section.

Figure 12 schematically shows an embodiment of the 'normal play' processing unit 60 of the reproducing arrangement of figure 7, for regenerating a replica of the original

MPEG datastream of figure 8a from the datastream as shown in figure 8b, using the packet number information also stored in the signal blocks, in the way described above. The regenerated replica of the MPEG datastream is shown in figure 8c. The embodiment of the 'normal play' processing unit of figure 12, denoted by 60', comprises a demultiplexer 90 having its input coupled to the input 59 of the processing unit 60' for receiving the subsequent groups of signal blocks, such as the groups G1, G2 and G3 of figure 10 or 11, and for retrieving therefrom the packets that are supplied to an output 91 and for retrieving the array of packet numbers ... k-4, k-1, k, k+2, k+4, k+8 .... from the third block sections in the signal blocks, and for supplying the said array of packet numbers to an output 92. The packets retrieved are supplied to a sync adder circuit 94 in which the one byte long packet sync signal is reinserted as first byte in all the packets. The packets thus obtained are supplied to an input 95 of a combining unit 96. The output 92 of the demultiplexer 90 is coupled to inputs 97 and 98 of the combining unit 96 and a dummy packet generator 100 respectively. An output 102 of the dummy packet generator 100 is coupled to an input 103 of the combining unit 103. An output 105 of the combining unit 96 is coupled to the output 64 of the 'normal play' processing unit 60'.

Let us now assume that the packet P_{k-4} and the packet number k-4 are retrieved from the first group G1 of five signal blocks, and are applied to the combining unit 96 and the dummy packet generator 100. This results in the packet P_{k-4} being supplied to the output 105 by the combining unit 96. Next, the packet P_{k-1} and the packet number k-1 are retrieved from the group G1 and are applied to the combining unit 96 and the dummy packet generator 100. It is established, by means of a comparator and/or a subtractor (not shown), that the packet number k-1 is not the next higher packet number of the packet number k-4, received previously and that two packet numbers are missing. As a result, the dummy packet generator 100 generates twice a dummy packet of the same length as the other packets in the datastream, and the combining unit 96 inserts those two dummy packets in the serial datastream, directly after the packet P_{k-4}, see figure 8c. Next, the combining unit 96 inserts the packet P_{k-1} into the serial datastream.

It should be noted here, that there is no specific need for the generator 100 to be explicitly a dummy packet generator. It is also possible that the generator 100 is a dummy info generator that generates dummy info of a certain length in time, this length of time being equal to the length of time of a packet or equal to a multiple of the length of time of a packet.

The packet P_k is the next packet that is retrieved by the demultiplexer 90, and

the packet is supplied, after the addition of the sync byte, to the input 95 of the combining unit 96. The packet number k is supplied to the inputs 97 and 98 of the combining unit 96 and the dummy packet generator 100. As the packet number k is the next higher packet number to packet number k-1, no dummy packet is generated, and the packet P_k is supplied to the output 105.

Next the packet P_{k+2} is retrieved. After comparison of the packet number k+2 with the previous packet number k retrieved, it appears that one dummy packet must be inserted in the serial datastream. Next, the packet P_{k+2} is added to the datastream, see figure 8c. This process is continued for the other packets, so as to obtain the regenerated replica of the MPEG datastream of figure 8c. When comparing figure 8a and 8c, it will be clear that figure 8c shows an MPEG serial datastream having the same bitrate and packet rate as the MPEG datastream of figure 8a. This datastream can now be applied to a standard MPEG decoder which is capable of decoding the one video program selected by the recording arrangement during recording, from the MPEG datastream of figure 8c.

Figure 13a shows an MPEG serial datastream as a function of time, the datastream comprising packets P_k having a variable length, and the bitrate in the datastream also being variable. It should be noted that the transport packets of the MPEG datastream do not comprise a packet number. The packet number k, given to the packets in figure 13a are therefore only added in this description for identification purposes. Figure 14 shows schematically an embodiment of the 'normal play' processing unit 14 for recording one video program that is included in the serial datastream as shown in figure 13a. The embodiment denoted 14'' in figure 14 shows large resemblances with the embodiment of figure 9. The embodiment 14'' differs from the embodiment of figure 9, in that, instead of the packet number generator 86, now a timing detector 110 is present, having its input coupled to the output of the detector 84, and having its output 111 coupled to the input 112 of the combining unit 82.

Selecting only those packets of the packets P_k in the serial datastream of figure 13a that include information relating to one video program that will be selected again means, as an example, that the packets P_{k-4}, P_{k-1}, P_k, P_{k+2}, P_{k+4}, P_{k+8} will be selected and that the intermediate packets will be thrown away. Figure 13b shows the datastream of the selected packets that will be stored in the groups of signal blocks, as already has been explained with reference to the figures 10 and 11. It should be noted also here, that there is no time relationship between the time axes in the figures 13a and 13b. Further, it should be noted that, although the packets in the datastream of figure 13a have unequal length, they all

include 188 bytes of information. Therefore, the packets selected and displayed in figure 13b have been shown as packets having an equal length.

The embodiment of figure 14 receives the datastream of figure 13a and selects therefrom the packets P_{k-4}, P_{k-1}, P_k, P_{k+2}, P_{k+4}, P_{k+8}. The packet detector 84 detects the receipt of each packet in the original serial MPEG data stream applied to the input 11 and generates a clock impulse for each packet detected. In response to each clock impulse received, the timing detector 110 detects the time instants t_k, see figure 13a, of occurrence of the packets P_k. Thus at the output 111 of the detector 110 appear the time instants ... t_{k-4}, t_{k-3}, t_{k-2},t_{k-1}, t_k, ... etc. Moreover the time detector 110 detects the lengths of the time intervals dt_k between two subsequent time instants, where dt_k equals the time interval t_{k+1}-t_k. Those time interval values dt_k are also applied to the output 111. Under the influence of the control signal applied to the control input 83 of the combining unit 82', the control unit combines the packets P_{k-4}, P_{k-1}, P_k, P_{k+2}, P_{k+4}, P_{k+8} selected by the selector 76 as well as the time instants and corresponding time intervals t_{k-4}, dt_{k-4}, t_{k-1}, dt_{k-1}, t_k, dt_k, t_{k+2}, dt_{k+2}, t_{k+4}, dt_{k+4}, t_{k+8}, dt_{k+8} out of the information stream supplied by the timing detector 110 for storage into the signal blocks.

The storage of the transport packets in the signal blocks will be carried out in the same way as discussed above with reference to the figures 10 and 11. The storage of the timing information in the third block sections can be as follows.

In the third block section TB3.1 of the first signal block SB1 of the group G1 of figure 10, the timing information t_{k-4} and dt_{k-4} is stored. In the third block section denoted FB of the third signal block SB3 of the group G1, the timing information t_{k-1} and dt_{k-1} is stored. In the third block section TB3.1 of the first signal block SB1 of the group G2, the timing information t_k and dt_k is stored. In the third block section denoted FB of the third signal block SB3 of the group G2, the timing information t_{k+2} and dt_{k+2} is stored. In the third block section TB3.1 of the first signal block SB1 of the group G3, the timing information t_{k+4} and $dt_{k+4}$is stored. In the third block section denoted FB of the third signal block SB3 of the group G3, the timing information t_{k+8} and dt_{k+8} is stored.

It may be so that the third block section TB3.1 in the first signal block SB1 in the groups and/or the third block section FB in the third signal block SB3 in the groups is/are too small for storing the timing information. In that case, the timing information can be stored somewhere else, or can be stored partly in the third block section TB3.1 and FB and partly somewhere else, see below.

In accordance with the example of figure 11, the timing information t_{k-4} and

dt_{k-4} is stored in the third block sections TB3.1, TB3.2 and TB3.3 of the signal blocks SB1, SB2 and SB3 respectively of the group G1. The storage of the timing information can be carried out once in the total storage capacity of the third block sections TB3.1, TB3.2 and TB3.3 or can be repeated at least once. As an example, the timing information t_{k-4} and dt_{k-4} is stored in each of the third block sections TB3.1, TB3.2 and TB3.3. The timing information t_{k-1} and dt_{k-1} can be stored in the third block sections FB, TB3.4, and TB3.5 of the signal blocks SB3, SB4 and SB5 respectively of the group G1. The storage of the timing information can be carried out once in the total storage capacity of the third block sections FB, TB3.4 and TB3.5 or can be repeated at least once. As an example, the timing information t_{k-4} and dt_{k-4} is stored in each of the third block sections TB3.4 and TB3.5. It may be possible to store the timing information for the packet P_{k-1} in the third block section TB3.3. It is further possible to store the timing information in the third block sections TB3.4 and TB3.5, and not in the block section FB.

The timing information for the packet P_k can be stored in the third block sections of the group G2 in the same way as the timing information for the packet P_{k-4} has been stored in the third block sections of the group G1. The timing information for the packet P_{k+2} can be stored in the third block sections of the group G2 in the same way as the timing information for the packet P_{k-1} has been stored in the third block sections of the group G1.

The timing information for the packet P_{+4k} can be stored in the third block sections of the group G3 in the same way as the timing information for the packet P_{k-4} has been stored in the third block sections of the group G1. The timing information for the packet P_{k+8} can be stored in the third block sections of the group G3 in the same way as the timing information for the packet P_{k-1} has been stored in the third block sections of the group G1.

Figure 15 schematically shows an embodiment of the 'normal play' processing unit 60 of the reproducing arrangement of figure 7, denoted 60'', for regenerating a replica of the original MPEG datastream of figure 13a from the datastream as shown in figure 13b, using the timing information also stored in the signal blocks, in the way described above. The regenerated replica of the MPEG datastream is shown in figure 13c. The embodiment 60''of figure 12 shows a large resemblance with the processing unit of figure 12. The demultiplexer 90' is again adapted to retrieve the packets from the subsequent groups of signal blocks, and to supply the packets to the output 91. The demultiplexer 90' is further adapted to retrieving the timing information t_k and dt_k from the third block sections in the

signal blocks, and for supplying the said timing information to the output 92. A sync byte is added to each packet in the sync adder 94. The packets thus obtained are supplied to the input 95 of the combining unit 96'. The output 92 of the demultiplexer 90 is coupled to inputs 97 and 98 of the combining unit 96' and a dummy info generator 100' respectively for supplying the timing information to the combining unit 96' and the generator 100'.

Let us now assume that the packet P_{k-4} and the corresponding timing information are retrieved from the first group G1 of five signal blocks, and are applied to the combining unit 96' and the dummy packet generator 100'. This results in the packet P_{k-4} being supplied to the output 105 by the combining unit 96', in response to the timing information. The length of the packet P_{k-4} will be equal to dt_{k-4}, and the packet will be applied to the output 105 at a time instant corresponding to t_{k-4}. Next, the packet P_{k-1} and the timing information corresponding to the packet P_{k-1} are retrieved from the group G1 and are applied to the combining unit 96' and the dummy packet generator 100'. It is established, by means of a comparator and/or a subtractor (not shown), that the time instant t_{k-1} is not equal to $t_{k-4}+dt_{k-4}$. Consequently at least one packet following the packet P_{k-4} has been thrown away during recording. As a result, the dummy info generator 100' generates a block of dummy information so as to fill the gap between the end of the packet P_{k-4}, at the time instant $t_{k-4}+dt_{k-4}$, and the time instant t_{k-1}, see figure 13c.

Next, the combining unit 96' inserts the packet P_{k-1} having the length dt_{k-1} into the serial datastream.

The packet P_k is the next packet that is retrieved by the demultiplexer 90, and the packet is supplied, after the addition of the sync byte, to the input 95 of the combining unit 96'. The timing information corresponding to the packet P_k is supplied to the inputs 97 and 98 of the combining unit 96 and the dummy info generator 100'. As t_k equals $t_{k-1}+dt_{k-1}$, no dummy information need to be is generated, and the packet P_k is supplied to the output 105.

Next the packet P_{k+2} is retrieved. After comparison of t_{k+2} with t_k+dt_k, it is established that a gap is present that need to be filled with dummy information generated by the generator 100'. Next, the packet P_{k+2} having a length dt_{k+2} is added to the datastream, see figure 13c. This process is continued for the other packets, so as to obtain the regenerated replica of the MPEG datastream of figure 13c. When comparing figure 13a and 13c, it will be clear that figure 13c shows an MPEG serial datastream having the same (variable) bitrate and packet rate as the MPEG datastream of figure 13a. This datastream can now be applied to a standard MPEG decoder which is capable of decoding the one video program

selected by the recording arrangement during recording, from the MPEG datastream of figure 13c having the variable bitrate and packet rate.

Now, other information will be described that can be inserted in the free space in the groups of signal blocks alone or together with the packet number information and or the timing information described above.

One example of such other information is the information identifying a signal block in a group of y(=5) signal blocks to be the first signal block in the group of signal blocks. Such information can be stored in the third block sections TB3.1 of the signal blocks SB1 in the groups G1, G2 and G3, in the figures 10 and 11.

Another example of such other information is the inclusion of a signal block number in the third block sections of the signal blocks, such as in the situation of figure 11. Signal block numbering can be carried out within a group, so that in the example of figure 11, the numbers 1 to 5 are stored in the third block sections TB3.1 to TB3.5 respectively of the signal blocks SB1 to SB5 in each group. Signal block numbering can also be realized for a larger number of signal blocks, belonging to more than one group of signal blocks. One could imagine that all the signal blocks in one track have a unique signal block number stored in the third block sections of the signal blocks. Now, all the signal blocks in a track can be identified by their unique signal block number.

Signal block numbering the signal blocks as described above has a number of advantages. Numbering the signal blocks open the possibility to shuffle signal blocks in an order different from their original order, as long as the shuffling is done within a group of signal blocks identified by unique signal block numbers. By detecting the signal block numbers upon reproduction, a deshuffling can be carried out on the shuffled signal blocks so as to obtain the original sequence order of the signal blocks.

Another measure that can be carried out is repeating a signal block, for the reason that the recording and subsequent reproduction of the information included in the signal block require a higher protection against transmission errors. Repeated signal blocks will have the same signal block numbers so that they are identifiable upon reproduction.

Further, upon detection of the signal block numbers, it can be detected whether a signal block has been lost because of transmission errors occurring during the subsequent recording and reproduction step. When missing a signal block number in a sequence of signal block numbers, it can be decided that the signal block having the signal block number that has been missed is lost. Upon such detection, an error correction or concealment can be carried out so as to correct or conceal the missing signal block.

Next, an explanation will be given of the functioning of the 'trick play' processing units 16 and 62 in the recording arrangement of figure 6 and the reproducing arrangement of figure 7 respectively. For carrying out a trick mode (or feature mode) reproduction with the reproduction arrangement, the record carrier 40 is transported with a speed other than the nominal transport speed. Figure 16 shows the record carrier 40 having a number of slant tracks recorded on it. Figure 16 also shows a path, denoted by the reference numeral 120, via which path the reading head 52 scans the record carrier in said trick mode. Generally, the information in the tracks is recorded by at least two heads having gaps of different azimuth angles, so that even numbered tracks have the one azimuth and odd numbered tracks have the other azimuth. That means that, when scanning the record carrier along the path 120, the head 52, which head has one of the two azimuth angles, will be able to read information from only the even numbered or only the odd numbered tracks.

In order to enable a reproduction of video information during a trick play mode, especially in the case of video information being recorded in a data reduced form, it is required to add special trick play information in special locations in the tracks such that those locations are scanned by the head 52 for the various transport speeds for the record carrier that are possible in a trick play mode. This trick play information is special video information recorded in addition to the normal play video information that has been recorded in the tracks in the way described above. As a consequence some of the signal blocks in a track comprise this trick play information, which should be scanned and read by the head 52 in the trick play mode.

It should be noted here that the MPEG data, as far as the video data in the MPEG datastream is concerned, comprises data reduced video information. To realize such data reduced video information the information corresponding to one picture is intra encoded so as to obtain so called I-frames. A higher data reduction can be obtained by carrying out an interframe encoding on at least two subsequent pictures, resulting in an I-frame for the first picture and a P-frame for the second picture. For recreating the two pictures an intraframe decoding, inverse to the intraframe encoding, must be carried out on the I-frame information, so as to regenerate the first picture, and an interframe decoding, inverse to the interframe encoding, must be carried out using both the I-frame information and the P-frame information, so as to regenerate the second picture.

In a trick mode, only I-frame information can be used to regenerate a video signal, as retrieving not only the I-frame information but also the corresponding P-frame information so as to realize an interframe decoding, is not possible. Therefore, in order to

obtain the 'trick play' information, only the information stored in I-frames included in the serial MPEG datastream is extracted and used as 'trick play' data.

It can be said that in a special location in a track, such as in the location indicated by the hatched area 122 in the track 124 in figure 16, a number of signal blocks are inserted that comprise the 'trick play' information. Figure 17 shows the sequence of signal blocks in the track 124. The hatched area 122 in figure 16 is formed by the sequence of signal blocks SB_i to SB_j inclusive in the sequence given in figure 17. The third block sections TB in the signal blocks comprised in the trick play area 122 of the track now comprise an indication that the signal blocks comprise trick mode information. This indication information is denoted by 'T' in the third block sections TB3 of the signal blocks SB_i to SB_j inclusive. The signal blocks stored in the track prior to the trick play area 122, as well as the signal blocks stored in the track after the trick play area 122 comprise information indicating that the information stored in the signal blocks is normal play information. This indication information is denoted by 'N' in the third block sections TB3 in the signal blocks SB_{i-2}, SB_{i-1}, SB_{j+1}.

The 'trick play' processing unit 16 of figure 6 is thus capable of deriving the trick play information from the MPEG datastream applied to its input 17, storing the trick play information in those signal blocks that are specifically meant for storing the trick play information in a specific location in a track and for inserting the indication information indicating that the signal block is a signal block in which trick mode information is stored in the third block sections of those signal blocks. The 'normal play' processing unit 14 will further be capable of storing the indication information indicating that the signal blocks generated by the unit 14 comprise normal play information, in the third block sections of those signal blocks.

When the reproducing arrangement is switched into its trick mode, the trick play' processing unit 62 will be capable of detecting those signal blocks that have the 'T' identification stored in their third block sections and to retrieve the information from those signal blocks for further processing so as to realize a reviewing option during the trick mode.

It should be noted that, although the invention has been described in the foregoing using embodiments of recording arrangements of the helical scan type, this should not be interpreted restrictively. The invention is equally well applicable to recording arrangements of the linear recording type, or to recording arrangements for recording information on disk like record carriers.

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(5) US patent specification no. 5,142,421 (PHN 13.537)

Claims



1. Recording arrangement for recording an information signal in tracks on a record carrier, the recording arrangement comprising

- an input terminal for receiving the information signal,
- channel encoding means for channel encoding the information signal so as to obtain a channel signal suitable for recording in a track on said record carrier,
- writing means for writing the channel signal in the track,

the channel signal comprising subsequent signal blocks, each signal block comprising a first block section which comprises a synchronisation signal and a second block section which comprises a number of channel bytes, characterized in that the information signal is an MPEG information signal in accordance with an MPEG format, the MPEG information signal comprising subsequent transport packets, that the channel encoding means are adapted to store each time information included in x transport packets of the MPEG information signal in the second block sections of a group of y signal blocks of the channel signal, that the second block section of at least the first signal block of the group of y signal blocks comprise a third block section for storing identification information identifying the signal block as being the first signal block of the group of y signal blocks, and that x and y are integers such that $x \geq 1$ and $y > 1$.

2. Recording arrangement for recording an information signal in tracks on a record carrier, the recording arrangement comprising

- an input terminal for receiving the information signal,
- channel encoding means for channel encoding the information signal so as to obtain a channel signal suitable for recording in a track on said record carrier,
- writing means for writing the channel signal in the track,

the channel signal comprising subsequent signal blocks, each signal block comprising a first block section which comprises a synchronisation signal and a second block section which comprises a number of channel bytes, characterized in that the information signal is an MPEG information signal in accordance with an MPEG format, the MPEG information signal comprising subsequent transport packets, that the channel encoding means are adapted to store each time information included in x transport packets of the MPEG information

signal in the second block sections of a group of y signal blocks of the channel signal, that the second block sections of the signal blocks comprise a third block section for storing sequence number information relating to a sequence number of the signal blocks, and that x and y are integers such that $x \geq 1$ and $y > 1$.

3. Recording arrangement for recording an information signal in tracks on a record carrier, the recording arrangement comprising

- an input terminal for receiving the information signal,
- channel encoding means for channel encoding the information signal so as to obtain a channel signal suitable for recording in a track on said record carrier,
- writing means for writing the channel signal in the track,

the channel signal comprising subsequent signal blocks, each signal block comprising a first block section which comprises a synchronisation signal and a second block section which comprises a number of channel bytes, characterized in that the information signal is an MPEG information signal in accordance with an MPEG format, the MPEG information signal comprising subsequent transport packets, that the channel encoding means are adapted to store each time information included in x transport packets of the MPEG information signal in the second block sections of a first group of y first signal blocks of said signal blocks of the channel signal so as to enable a normal play mode using video information stored in said first group of y first signal blocks during a normal play reproduction mode, the channel encoding means further being adapted to retrieve a trick mode video signal from the MPEG information signal and being adapted to store said trick mode video signal in second block sections of a second group of z second signal blocks of said signal blocks of the channel signal so as to enable a trick play mode using the video information stored in said second signal blocks, that the second block sections of at least one signal block in each first and second group of first and second signal blocks respectively comprise a third block section for storing identification information indicating whether the group comprises first signal blocks or second signal blocks,

and that x, y and z are integers such that $x \geq 1$, $y > 1$ and $z > 1$.

4. Recording arrangement for recording an information signal in tracks on a record carrier, the recording arrangement comprising

- an input terminal for receiving the information signal,
- channel encoding means for channel encoding the information signal so as to obtain a channel signal suitable for recording in a track on said record carrier,
- writing means for writing the channel signal in the track,

the channel signal comprising subsequent signal blocks, each signal block comprising a first block section which comprises a synchronisation signal and a second block section which comprises a number of channel bytes, characterized in that the information signal is an MPEG information signal in accordance with an MPEG format, the MPEG information signal comprising subsequent transport packets, that the channel encoding means are adapted to store each time information included in x transport packets of the MPEG information signal in the second block sections of a group of y signal blocks of the channel signal, that the second block sections of at least those signal blocks in a group of y signal blocks that comprises the start portion of a transport packet comprise a third block section for storing sequence number information relating to a transport packet sequence number corresponding to the transport packet having its start portion stored in the second block section of the sign block,

and that x and y are integers such that $x \geq 1$ and $y > 1$.

5. Recording arrangement as claimed in claim 3, characterized in that the second block sections of all signal blocks in each first and second group of first and second signal blocks respectively comprise a third block section for storing identification information indicating whether the group comprises first signal blocks or second signal blocks.

6. Recording arrangement as claimed in claim 5, characterized in that the second block sections of a group of y signal blocks each comprise a third block section for storing sequence number information relating to a transport packet sequence number corresponding to the transport packet of which information is stored in said signal block.

7. Recording arrangement for recording an information signal in tracks on a record carrier, the recording arrangement comprising

- an input terminal for receiving the information signal,
- channel encoding means for channel encoding the information signal so as to obtain a channel signal suitable for recording in a track on said record carrier,
- writing means for writing the channel signal in the track,

the channel signal comprising subsequent signal blocks, each signal block comprising a first block section which comprises a synchronisation signal and a second block section which comprises a number of channel bytes, characterized in that the information signal is an MPEG information signal in accordance with an MPEG format, the MPEG information signal comprising subsequent transport packets, the recording arrangement comprising detection means for detecting the moment of receipt of the transport packets and for generating timing information for each transport packet received, the timing information for a

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transport packet corresponding to said moment of receipt of said transport packet, that the channel encoding means are adapted to each time store information included in x transport packets of the MPEG information signal in the second block sections of a group of y signal blocks of the channel signal, that the second block sections of at least those signal blocks in a group of y signal blocks that comprises the start portion of a transport packet comprise a third block section for storing the timing information for said transport packet having its start portion stored in the second block section of the signal block,
and that x and y are integers such that $x \geq 1$ and $y > 1$.

8. Recording arrangement as claimed in claim 7, characterized in that the second block sections of a group of y signal blocks each comprise a third block section for storing the timing information corresponding to the transport packet which has information stored in the second block section of said signal block.

9. Recording arrangement as claimed in anyone of the preceding claims, characterized in that $y > x$.

10. Record carrier obtained with the recording arrangement as claimed in anyone of the claims 1 to 9.

11. Record carrier as claimed in claim 10, obtained with the recording arrangement as claimed in anyone of the claims 2 to 8, characterized in that identification information identifying the signal block as being the first signal block of the group of y signal blocks is stored in a third block section of the first signal block of a group of y signal blocks.

12. Record carrier as claimed in claim 10, obtained with the recording arrangement as claimed in anyone of the claims 1 and 3 to 8, characterized in that, sequence number information relating to the sequence number of the signal blocks is stored in the third block sections of the signal blocks.

13. Record carrier as claimed in claim 10, obtained with the recording arrangement as claimed in anyone of the claims 1, 2 and 5 to 8, characterized in that the channel signal recorded in a track comprises a first group of y first signal blocks so as to enable a normal play mode using the video information stored in said first group of y first signal blocks during a normal play reproduction mode, and comprises a second group of z second signal blocks in which a trick mode video signal is stored so as to enable a trick play mode using the video information stored a said second group of z second signal blocks, that indication information indicating whether a group comprises first signal blocks or second signal blocks is stored in the third block sections of at least one signal block of the first and

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second group.

14. Record carrier as claimed in claim 8, obtained with the recording arrangement as claimed in anyone of the claims 1 to 4, 7 and 8, characterized in that, the third block section of the second block sections of at least those signal blocks in a group of y signal blocks that comprises the start portion of a transport packet comprise information relating to a transport packet sequence number corresponding to the transport packet having its start portion stored in the second block section of the signal block.

15. Record carrier as claimed in claim 10, obtained with the recording arrangement as claimed in anyone of the claims 1 to 6, characterized in that the third block section of the second block sections of at least those signal blocks in a group of y signal blocks that comprises the start portion of a transport packet comprise timing information for said transport packet having its start portion stored in the second block section of the signal block.

16. Reproducing arrangement for reproducing an information signal that has been recorded in the form of a channel signal in tracks on a record carrier, the reproducing arrangement comprising

- reading means for reading the channel signal from a track,

the channel signal comprising subsequent signal blocks, each signal block comprising a first block section which comprises a synchronisation signal and a second block section which comprises a number of channel bytes,

- channel decoding means for channel decoding the channel signal so as to obtain the information signal,

- an output terminal for applying the information signal,

characterized in that the information signal recorded in the tracks is an MPEG information signal in accordance with an MPEG format, the MPEG information signal comprising subsequent transport packets, information comprised in x transport packets of the MPEG information signal being stored in the second block sections of a group of y signal blocks of the channel signal, that x and y are integers such that $x \geq 1$ and $y > 1$,

that the second block section of at least the first signal block of the groups of y signal blocks comprise a third block section for storing identification information identifying the signal block as being the first signal block of a group of y signal blocks,

the reproducing arrangement further comprising

- first retrieving means for retrieving the information comprised in the x transport packets of the MPEG information signal from the group of y signal blocks,

- second retrieving means for retrieving said indication information from the third block sections of the first signal blocks in the group of y signal blocks.

17. Reproducing arrangement for reproducing an information signal that has been recorded in the form of a channel signal in tracks on a record carrier, the reproducing arrangement comprising

- reading means for reading the channel signal from a track,

the channel signal comprising subsequent signal blocks, each signal block comprising a first block section which comprises a synchronisation signal and a second block section which comprises a number of channel bytes,

- channel decoding means for channel decoding the channel signal so as to obtain the information signal,

- an output terminal for applying the information signal,

characterized in that the information signal recorded in the tracks is an MPEG information signal in accordance with an MPEG format, the MPEG information signal comprising subsequent transport packets, information comprised in x transport packets of the MPEG information signal being stored in the second block sections of a group of y signal blocks of the channel signal, that x and y are integers such that $x \geq 1$ and $y > 1$,

that the second block sections of the signal blocks comprise a third block section for storing sequence number information relating to the sequence number of the signal blocks,

the reproducing arrangement further comprising

- first retrieving means for retrieving the information comprised in the x transport packets of the MPEG information signal from the group of y signal blocks,

- second retrieving means for retrieving the sequence numbers information from the third block sections of the signal blocks in said track.

18. Reproducing arrangement for reproducing an information signal that has been recorded in the form of a channel signal in tracks on a record carrier, the reproducing arrangement comprising

- reading means for reading the channel signal from a track,

the channel signal comprising subsequent signal blocks, each signal block comprising a first block section which comprises a synchronisation signal and a second block section which comprises a number of channel bytes,

- channel decoding means for channel decoding the channel signal so as to obtain the information signal,

- an output terminal for applying the information signal,

characterized in that the information signal recorded in the tracks is an MPEG information signal in accordance with an MPEG format, the MPEG information signal comprising subsequent transport packets, information comprised in x transport packets of the MPEG information signal being stored in the second block sections of a first group of y first signal blocks of the channel signal so as to enable a normal play mode using the video information stored in said first group of y first signal blocks during a normal play reproduction mode, that x and y are integers such that $x \geq 1$ and $y > 1$,

a trick mode video signal being stored in a second group of z second block sections of second signal blocks of said signal blocks of the channel signal so as to enable a trick play mode using the video information stored in said second group of second signal blocks, that the second block sections of at least one first and second signal block in the first and second group each comprise a third block section for storing indication information indicating whether the group comprise first signal blocks or second signal blocks,

the reproducing arrangement further comprising

- first retrieving means for retrieving in said normal play mode the video information of the x transport packets of the MPEG information signal from the first group of y first signal blocks, and for retrieving in said trick play mode the trick mode video signal from the second group of z second signal blocks, in response to a first or a second control signal respectively supplied by
- second retrieving means for retrieving the indication information indicating whether the group comprise first signal blocks or second signal blocks from the third block sections of the at least one signal block in the first and second groups respectively, the second retrieving means being further adapted to generate said first and second control signal in response thereto.

19. Reproducing arrangement for reproducing an information signal that has been recorded in the form of a channel signal in tracks on a record carrier, the reproducing arrangement comprising

- reading means for reading the channel signal from a track,

the channel signal comprising subsequent signal blocks, each signal block comprising a first block section which comprises a synchronisation signal and a second block section which comprises a number of channel bytes,

- channel decoding means for channel decoding the channel signal so as to obtain the information signal,
- an output terminal for applying the information signal,

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characterized in that the information signal recorded in the tracks is an MPEG information signal in accordance with an MPEG format, the MPEG information signal comprising subsequent transport packets, information comprised in x transport packets of the MPEG information signal being stored in the second block sections of a group of y signal blocks of the channel signal, that x and y are integers such that $x \geq 1$ and $y > 1$, that the second block sections of at least those signal blocks in a group of y signal blocks that comprises the start portion of a transport packet comprise a third block section for storing sequence number information relating to a transport packet sequence number corresponding to the transport packet having its start portion stored in the second block section of the signal block,

the reproducing arrangement further comprising

- first retrieving means for retrieving the information comprised in the x transport packets of the MPEG information signal from the group of y signal blocks,
- second retrieving means for retrieving the sequence number information relating to the transport packet sequence number from a third block section of a signal block in the group of y signal blocks.

20. Reproducing arrangement for reproducing an information signal that has been recorded in the form of a channel signal in tracks on a record carrier, the reproducing arrangement comprising

- reading means for reading the channel signal from a track,

the channel signal comprising subsequent signal blocks, each signal block comprising a first block section which comprises a synchronisation signal and a second block section which comprises a number of channel bytes,

- channel decoding means for channel decoding the channel signal so as to obtain the information signal,
- an output terminal for applying the information signal.

characterized in that the information signal recorded in the tracks is an MPEG information signal in accordance with an MPEG format, the MPEG information signal comprising subsequent transport packets, information comprised in x transport packets of the MPEG information signal being stored in the second block sections of a group of y signal blocks of the channel signal, that x and y are integers such that $x \geq 1$ and $y > 1$, that the second block sections of at least those signal blocks in a group of y signal blocks that comprises the start portion of a transport packet comprise a third block section for storing timing information for said transport packet having its start portion stored in the second block section of the signal block,

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the reproducing arrangement further comprising

- first retrieving means for retrieving the information comprised in the x transport packets of the MPEG information signal from the group of y signal blocks,
- second retrieving means for retrieving the timing information from a third block section of a signal block in the group of y signal blocks.

21. Reproducing arrangement as claimed in anyone of the claims 16 to 20, characterized in that $y > x$.

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