

Recording and reproducing a digital information signal in a first or a second recording/reproducing mode on/from a record carrier.

The invention relates to an apparatus for recording a digital information signal in a track on a record carrier, to a method of recording, to an apparatus for reproducing said digital information signal and to a record carrier having the digital information signal recorded on it. A recording apparatus as defined in the opening paragraph is known from WO 98-34226 (PHN 16614), document D1 in the list of related documents.

The known apparatus is adapted to record the digital information signal on the record carrier by means of at least one write head, with a specific transport velocity of the record carrier so as to enable a reproduction of the digital information signal in a reproduction apparatus, having at least one read head and with the same transport velocity. This recording/reproduction mode is called 'standard', or 'standard definition' (STD) mode. Further, the known recording apparatus is adapted to generate a trick play signal, e.g. by deriving said trick play signal from said digital information signal, to merge the trick play signal with said digital information signal so as to obtain a composite digital information signal and to record the composite signal on said record carrier. The trick play signal is meant to enable a trick play reproduction mode in said reproduction apparatus, with a second transport velocity of said record carrier so as to reproduce said trick play signal. The second transport velocity is a multiplicity of said first mentioned transport velocity. This reproduction mode is called: a trick play reproduction for said STD mode.

The invention aims at providing a recording apparatus which is capable of carrying out at least a second recording mode, and which is adapted to generate such composite digital information signal that the corresponding reproduction apparatus is capable of carrying out a corresponding second reproduction mode, as well as capable of carrying out trick play reproduction for said second mode.

The recording apparatus in accordance with the invention comprises



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- input means for receiving the digital information signal,
  - writing means for writing the digital information signal in a track on the record carrier, the writing means comprising at least one write head,
  - transport means for moving the record carrier with a first or a second velocity in said first and second recording mode, respectively, the second velocity being equal to  $1/k$  times the first velocity, where  $k$  is a constant larger than 1,
  - trick play signal generating means for generating a first trick play signal when the apparatus is in said first recording mode and for generating a second trick play signal when the apparatus is in said second recording mode,
  - merging means for merging said digital information signal and said first or second trick play signal, when the apparatus is in said first or second recording mode, respectively, so as to obtain a composite digital information signal, said writing means being adapted to write the composite digital information signal in the track on the record carrier,
  - the composite digital information signal being recorded such on said record carrier so as to enable in an apparatus for reproducing said digital information signal
    - (a) a first reproduction mode for reproducing said digital information signal, when being recorded on said record carrier by the recording apparatus in said first recording mode,
    - (b) a second reproduction mode for reproducing said digital information signal, when being recorded on said record carrier by the recording apparatus in said second recording mode,
    - (c) a third reproduction mode for reproducing said first trick play signal, when being recorded on said record carrier by the recording apparatus in said first recording mode,
    - (d) a fourth reproduction mode for reproducing said second trick play signal, when being recorded on said record carrier by the recording apparatus in said second recording mode,
  - said reproducing apparatus being provided with
    - reading means for reading information from said record carrier, the reading means comprising at least one read head,
    - transport means for moving the record carrier with said first velocity in said first reproduction mode, with said second velocity in said second reproduction mode, with a third velocity in said third reproduction mode and a fourth velocity in said fourth reproduction mode, where the third velocity is  $n$  times the first velocity and the fourth velocity is  $m$  times the second velocity,  $n$  and  $m$  being constants larger than 1,
- wherein:

. the trick play signal generating means are adapted to generate the first and the second trick play signal, and

. the merging means are adapted to merge the digital information signal with said first or second trick play signal, and

- 5 . the writing means are adapted to write the composite signal in a track on the record carrier, such that reproduction in said reproducing apparatus of said first trick play signal in said third reproduction mode is enabled and reproduction in said reproducing apparatus of said second trick play signal in said fourth reproduction mode is enabled with a velocity of the record carrier which is substantially equal for both third and fourth reproduction modes.

10 The invention is based on the following recognition. The known recording apparatus describes a recording/reproduction apparatus that functions in a so-called STD mode. In this STD mode, a so-called 'normal' recording mode and a corresponding 'normal play' reproduction mode is possible with the velocity of the record carrier in both modes being equal to the first velocity ( $v_1$ ). The recording apparatus is adapted to generate trick play signals for  
15 various trick play reproduction modes in said STD mode. That is: the corresponding reproduction apparatus is, apart from the 'normal play reproduction mode', capable of carrying out one or more trick play reproduction modes, with different record carrier transport speeds, such as the third velocity ( $v_3$ ) defined above, in said trick play reproduction mode, defined above as the third reproduction mode. As defined above,  $v_3 / v_1 = n$ .

20 An essential feature of all the trick play signals generated for said trick play reproduction modes, was that such trick play signals were generated upon recording, and the trick play signals were recorded in the tracks on the record carrier in such a format, that, for each of the trick play speeds, 102 sync blocks of trick play data were read by the heads, during one revolution of the head drum, on which the read heads are positioned. In other words, in all  
25 trick play reproduction modes, a constant bitrate for the reproduced trick play signal is realised. This is necessary in order to realise trick play signals of a substantially equal visual quality.

A long play (LP) recording/reproduction mode has a lower record carrier transport velocity, the second velocity ( $v_2$ ) defined above, than the record carrier velocity in the  
30 'normal' recording/reproduction mode for STD ( $v_1$ ), whilst the rotational velocity of the head drum is the same. As a consequence, the bitrate in the long play recording/reproduction mode is lower. More specifically, the bitrate is the factor  $k$ , introduced above, lower, compared to the bitrate in the 'normal' recording/reproducing mode for STD, where  $k$  equals the ratio

between the first and the second velocity ( $v_1$  and  $v_2$ , respectively), or  $k = v_1 / v_2$ . The long play recording is defined above as the second recording mode

Trick play in a long play mode is an aspect that has not been the subject of much attention. In a trick play reproduction mode of a long play signal, a trick play signal, e.g. derived from said long play signal, is reproduced with the above defined fourth velocity ( $v_4$ ), which has the above defined relationship with the second velocity:  $m = v_4 / v_2$ .

In accordance with the invention, the one or more velocities for the one or more trick play reproduction modes for LP are chosen such that they are equal to the velocities for the trick play reproduction modes in STD.

An example: in the above WO 98-34226, a recording/reproducing apparatus for carrying out a standard (STD) recording/reproduction is disclosed. This apparatus is further adapted to generate trick play signals for three trick play speeds, which trick play signals are subsequently merged with the standard mode video signal into a composite signal and recorded on the record carrier. Those three trick play speeds are: a trick play velocity ( $v_3$ ) of ( $n=$ ) 4 times the normal play velocity ( $v_1$ ), a trick play velocity of 12 times  $v_1$  and a trick play velocity of 24 times  $v_1$ .

Suppose, such an apparatus is further capable of carrying out a LP mode where  $k=3$  (a so-called LP3 mode). That means: a digital video signal is recorded with a record carrier transport velocity equal to  $v_1/3$ . Further, with a head drum and two heads located at  $180^\circ$  around the circumference of the head drum, the video signal is recorded burstwise, each third scan of a head on the record carrier. Trick play modes for LP3 will, in accordance with the invention, have a trick play reproduction velocities ( $v_4$ ) of 12 times the record carrier velocity ( $v_2$ ) of the 'normal' recording/reproducing mode in LP3, of 36 times  $v_2$  and of 72 times  $v_2$ . This means that the absolute record carrier transport velocity for the two corresponding trick play reproduction modes (one for STD and the other for LP3) is the same. That is: for the lowest trick play mode in STD and LP3, the velocity is  $4v_1$ , for the highest trick play mode in STD and LP, the velocity is  $24v_1$  and for the intermediate trick play modes in STD and LP3, the velocity is  $12v_1$ .

Another example: the apparatus described above is also capable of realising a second long play mode where  $k=5$  (the so-called LP5 mode). The corresponding trick play reproduction modes will have record carrier transport velocities equal to 20, 60 and 120 times the record carrier velocity of the 'normal' recording/reproduction mode in LP5, which is  $v_1/5$ . Thus, again the trick play modes in the LP5 mode have velocities equal to  $4v_1$ ,  $12v_1$  and  $24v_1$ .

Again another example: the apparatus described above is capable of carrying out a HD mode. In this mode, the record carrier is transported with a velocity  $2v_1$ , or  $k=1/2$ . The HD video signal is recorded by means of two head pairs located at  $180^\circ$  around the circumference of the head drum.

- 5 The corresponding trick play reproduction modes now are 2 ( $4 \times k$ ), 6 ( $12 \times k$ ) and 12 ( $24 \times k$ ) times the 'normal' recording/reproduction mode in HD, which is  $2v_1$ . Thus, again the trick play modes in the HD mode have velocities equal to  $4v_1$ ,  $12v_1$  and  $24v_1$ .

It will be understood that the following relationship exists between recording data rate (averaged over time, of course) and replay data rate:

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$$\text{Recording rate} = \text{replay rate} / n, \quad (1)$$

where  $n$  equals the relative velocity ratio between the velocity during replay (reproduction) and the velocity during recording. As an example, for trick play speeds  $4x$ ,  $12x$  and  $24x$  the nominal record carrier speed in the STD mode,  $n$  equals 4, 12 and 24 respectively. For the corresponding trick play modes in the LP3 mode,  $n$  equals 12, 36, and 72, respectively.

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The replay rate should be kept constant for the various modes in order to maintain a sufficient picture quality, even in the higher LP modes.

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Further, the following relationship exists between the recording rate in STD and the recording rate for an LPk mode:

$$\text{Recording rate for LPk} \approx \text{recording rate in STD}/k. \quad (2)$$

The recording rate is defined as the rate with which the normal play data as well as the trick play data are recorded on the record carrier. So, also the recording rate of the trick play data would decrease with a factor of  $k$  for the LP  $k$  mode. This would, in accordance with eq (1), directly affect the replay rate. In order to avoid the replay rate to decrease in eq. (1),  $n$  should be increased by a factor of  $k$  as well. This therefore results in the same absolute trick play velocities in the various LP modes.

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The invention has the following characteristics:

- (a) the overhead is the same for all the trick play modes.
- (b) the track patterns for corresponding trick play modes in STD, LP3, LP5 are substantially the same, which means that
- (c) the generation of the trick play signals in the various modes can be the same.

- (d) in case of mixed recordings (STD, followed by eg. LP3) provided with trick play signals for corresponding speeds, it is possible to reproduce both trick play signals in the trick play reproduction mode with the same absolute velocity.
- (e) the scan path of the heads for corresponding trick play modes is thus the same.

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These and other aspects of the invention will be further described with reference to examples given in the following figure description, in which

figure 1 shows the track pattern for a standard STD mode, further provided with trick play segments for two trick play modes at speeds +12 times and -12 times the normal reproduction record carrier velocity  $v_1$ ,

figure 2 shows the track pattern for an LP3 mode, further provided with trick play segments for two trick play modes at speeds +36 times and -36 times the normal reproduction record carrier velocity in the LP3 mode, which is equal to  $v_1/3$ ,

figure 3 shows the track pattern for an LP5 mode, further provided with trick play segments for two trick play modes at speeds +60 times and -60 times the normal reproduction record carrier velocity in the LP5 mode, which is equal to  $v_1/5$ ,

figure 4 shows the track pattern for an HD mode, further provided with trick play segments for two trick play modes at speeds +6 times and -6 times the normal reproduction record carrier velocity in the HD mode, which is equal to  $2v_1$ ,

figure 5 shows the track pattern for a standard STD mode, further provided with trick play segments for two trick play modes at speeds +24 times and -24 times the normal reproduction record carrier velocity  $v_1$ ,

figure 6 shows the track pattern for an LP3 mode, further provided with trick play segments for two trick play modes at speeds +72 times and -72 times the normal reproduction record carrier velocity in the LP3 mode, which is equal to  $v_1/3$ ,

figure 7 shows the track pattern for an LP5 mode, further provided with trick play segments for two trick play modes at speeds +120 times and -120 times the normal reproduction record carrier velocity in the LP5 mode, which is equal to  $v_1/5$ ,

figure 8 shows the track pattern for an HD mode, further provided with trick play segments for two trick play modes at speeds +12 times and -12 times the normal reproduction record carrier velocity in the HD mode, which is equal to  $2v_1$ ,

figure 9 shows a recording apparatus for recording a digital information signal in a STD mode and at least one other mode, such as an LP mode or an HD mode, and

figure 10 shows a reproducing apparatus for reproducing the information signal recorded by the apparatus of figure 9 in said STD mode and said at least one other mode, the said apparatus further being capable of carrying out a trick play reproduction mode for said STD mode and said at least one other mode.

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Figure 1 shows the track pattern for a standard STD reproduction mode at a record carrier speed of  $v_1$ , further provided with trick play segments for two trick play reproduction modes at speeds +12 times and -12 times the normal reproduction record carrier velocity  $v_1$ .

10 Figure 1 shows a group of 48 tracks in this specific example, which is repeated each time. It will be understood that, in other examples, the groups of tracks may include a different number of tracks than 48. The tracks comprise sync blocks of information of an information signal, such as a video information signal, as an example encoded in the form of an MPEG encoded information signal. This information signal is meant for a reproduction in said  
15 standard reproduction mode at said record carrier speed of  $v_1$ .

Each track in figure 1 comprises 306 sync blocks of information, resulting in 14688 in total in a group of 48 tracks. 13344 sync blocks comprise normal play data and 1344 sync blocks comprise trick play data, to be described hereafter. The normal play data rate is 12.54 Mb/s.

20 Some of the tracks in a group, such as the tracks numbered 2, 4, 6, 8, 15, 17, 19, 21, 26, 28, 30, 32, 39, 41, 43 and 45 comprise segments, numbered 10.1 to 10.16, inclusive, in which a trick play information signal is accommodated. In the present example, this trick play signal is the trick play signal for enabling a trick play reproduction mode at a record carrier speed of +12 times  $v_1$ . In addition, some of the tracks in a group, such as the tracks numbered  
25 44, 42, 40, 38, 33, 31, 29, 27, 20, 18, 16, 14, 9, 7, 5 and 3 comprise segments, numbered 12.1 to 12.16, inclusive, in which a trick play information signal is accommodated. In the present example, this trick play signal is the trick play signal for enabling a trick play reproduction mode at a record carrier speed of -12 times  $v_1$ .

30 Upon recording the information in the groups of 48 tracks, eg. by means of a first recording head with a first azimuth angle and a second head with a second azimuth angle, see the slant lines in the circle in figure 1 with the reference numeral 14, the even numbered tracks have been created by writing the composite signal with the head of the first azimuth angle and the odd numbered tracks have been created by writing the composite signal with the head of the second azimuth angle, such that the tracks are recorded on the record carrier, one after

another, numbered 0, 1, 2, 3, .. etc. The record carrier velocity is  $v_1$  in this standard recording mode.

Upon reproducing in the standard, normal play, reproduction mode, the information from the groups of 48 tracks, eg. by means of a first reproducing head with a first azimuth angle and a second reproducing head with a second azimuth angle, see again the slant lines in the circle in figure 1 with the reference numeral 14, the tracks numbered 0, 1, 2, 3, .. etc. are read one after another by the two heads, the even numbered tracks by the first reproducing head and the odd numbered tracks by the second reproducing head. The record carrier velocity is  $v_1$  in this standard reproduction mode. Only the normal play information, that is the information in the tracks outside the trick play segments 10.1 to 10.16, inclusive, and 12.1 to 12.16, inclusive, is used for reproduction.

Upon trick play reproduction with the record carrier speed being equal to  $+12v_1$ , the two reproduction heads scan the record carrier such that, during a first scan (which corresponds to half a revolution of the head drum on which the heads are located), the scanning line of the first reproduction head with the first azimuth angle across the record carrier at least substantially coincides with the segments 10.1 to 10.4, inclusive, that, during a second scan (which corresponds to the next half revolution of the head drum on which the heads are located), the scanning line of the second reproduction head with the second azimuth angle across the record carrier at least substantially coincides with the segments 10.5 to 10.8, inclusive, that, during the third scan (which corresponds to again the next half revolution of the head drum on which the heads are located), the scanning line of the first reproduction head with the first azimuth angle across the record carrier at least substantially coincides with the segments 10.9 to 10.12, inclusive, and that, during the fourth scan (which corresponds to again the next half revolution of the head drum on which the heads are located), the scanning line of the second reproduction head with the second azimuth angle across the record carrier at least substantially coincides with the segments 10.13 to 10.16, inclusive.

The trick play segments for the  $+12v_1$  trick play reproduction mode each comprise a number of 14 trick play sync blocks, including parity sync blocks, and three times a repetition of those 14 trick play sync blocks. As a result, during each revolution of the head drum, 112 trick play sync blocks are read from the record carrier by the two read heads. More specifically, of those 112 trick play sync blocks are 10 sync blocks that comprise parity information. This is in conformity with the examples shown in document D1. The repetitions are present so as to enable a correct retrieval of the 112 trick play sync blocks per revolution

of the head drum, even in the case where a tracking error is present, so that the scanning lines introduced above do not cross the trick play segments exactly in the centre of the segments.

Upon trick play reproduction with the record carrier speed being equal to  $-12v_1$ , the two reproduction heads scan the record carrier such that, during a first scan (which corresponds to half a revolution of the head drum on which the heads are located), the scanning line of the first reproduction head with the first azimuth angle across the record carrier at least substantially coincides with the segments 12.1 to 12.4, inclusive, that, during a second scan (which corresponds to the next half revolution of the head drum on which the heads are located), the scanning line of the second reproduction head with the second azimuth angle across the record carrier at least substantially coincides with the segments 12.5 to 12.8, inclusive, that, during the third scan (which corresponds to again the next half revolution of the head drum on which the heads are located), the scanning line of the first reproduction head with the first azimuth angle across the record carrier at least substantially coincides with the segments 12.9 to 12.12, inclusive, and that, during the fourth scan (which corresponds to again the next half revolution of the head drum on which the heads are located), the scanning line of the second reproduction head with the second azimuth angle across the record carrier at least substantially coincides with the segments 12.13 to 12.16, inclusive.

The trick play segments for the  $-12v_1$  trick play reproduction mode each comprise a number of 14 trick play sync blocks, including parity sync blocks, and three times a repetition of those 14 trick play sync blocks. As a result, during each revolution of the head drum, 112 trick play sync blocks are read from the record carrier by the two read heads. More specifically, of those 112 trick play sync blocks are 10 trick play sync blocks comprising parity information. This is in conformity with the examples shown in document D1. The repetitions are, again, present so as to enable a correct retrieval of the 112 trick play sync blocks per revolution of the head drum, even in the case where a tracking error is present, so that the scanning lines introduced above do not cross the trick play segments exactly in the centre of the segments.

Figure 2 shows the track pattern for an LP3 reproduction mode at a record carrier speed of  $v_1/3$ , further provided with trick play segments for two trick play reproduction modes at speeds  $+36$  times and  $-36$  times the LP3 reproduction speed of  $v_1/3$ , so that this means a reproduction speed of  $+12x$  and  $-12x$  the normal reproduction record carrier velocity  $v_1$ . Figure 2 shows again a group of 48 tracks in this specific example, which is repeated each time.

Again, each track in figure 2 comprises 306 sync blocks of information, resulting in 14688 in total in a group of 48 tracks. 13344 sync blocks comprise normal play data and 1344 sync blocks comprise trick play data, to be described hereafter. The normal play data rate is 4.18 Mb/s, which is, as expected, a factor of 3 lower than the data rate given above for figure 1.

The tracks comprise sync blocks of information of an information signal, such as a video information signal, as an example encoded in the form of an MPEG encoded information signal. This information signal is meant for the reproduction in said LP3 reproduction mode at said record carrier speed of  $v_1/3$ . Further, some of the tracks in a group, such as the tracks numbered 2, 4, 6, 8, 15, 17, 19, 21, 26, 28, 30, 32, 39, 41, 43 and 45 comprise segments, numbered 16.1 to 16.16, inclusive, in which a trick play information signal is accommodated. In the present example, this trick play signal is the trick play signal for enabling a trick play reproduction mode at the record carrier speed of +36 times  $v_1/3$ , which equals  $+12v_1$ . In addition, some of the tracks in a group, such as the tracks numbered 44, 42, 40, 38, 33, 31, 29, 27, 20, 18, 16, 14, 9, 7, 5 and 3 comprise segments, numbered 18.1 to 18.16, inclusive, in which a trick play information signal is accommodated. In the present example, this trick play signal is the trick play signal for enabling a trick play reproduction mode at a record carrier speed of -36 times  $v_1/3$ , which equals the record carrier speed of  $-12v_1$ .

Upon recording the information in the groups of 48 tracks, eg. by means of the first and second recording heads, the even numbered tracks have been created by writing the composite signal with the head of the first azimuth angle and the odd numbered tracks have been created by writing the composite signal with the head of the second azimuth angle, such that the tracks are recorded on the record carrier, one after another, numbered 0, 1, 2, 3, .. etc. The record carrier velocity is  $v_1/3$  in this standard recording mode. In order to realise this track pattern, during a first rotation of the head drum, the first head writes the first track, numbered 0, during the second rotation of the head drum, the second head writes the track numbered 1, during the third rotation of the head drum, no information is written by both heads. During the fourth rotation, the first head writes the track numbered 2, during the fifth rotation of the head drum, the second head writes the track numbered 3 and during the sixth rotation of the head drum, no information is written by both heads. This recording sequence is carried out during each subsequent cycle of three rotations of the head drum.

Upon reproducing in the LP3, normal play, reproduction mode, the information from the groups of 48 tracks, is read by means of the first and second read heads with said first and second azimuth angles, respectively, in the following way.

During a first rotation of the head drum, the first read head reads the first track, numbered 0, during the second rotation of the head drum, the second read head reads the track numbered 1, during the third rotation of the head drum, no information is read by both heads. During the fourth rotation, the first head reads the track numbered 2, during the fifth rotation of the head drum, the second head reads the track numbered 3 and during the sixth rotation of the head drum, no information is written by both heads. This reproduction sequence is carried out during each subsequent cycle of three rotations of the head drum. The record carrier velocity is  $v_1/3$  in this LP3 reproduction mode. Only the normal play information, that is the information in the tracks outside the trick play segments 16.1 to 16.16, inclusive, and 18.1 to 18.16, inclusive, is used for reproduction.

Upon trick play reproduction with the record carrier speed being equal to 36 times the 'normal' LP3 speed (which is  $v_1/3$ ), and thus equal to  $+12v_1$ , the two read heads scan the record carrier such that, during a first scan (which corresponds to half a revolution of the head drum on which the heads are located), the scanning line of the first read head with the first azimuth angle across the record carrier at least substantially coincides with the segments 16.1 to 16.4, inclusive, that, during a second scan (which corresponds to the next half revolution of the head drum on which the heads are located), the scanning line of the second reproduction head with the second azimuth angle across the record carrier at least substantially coincides with the segments 16.5 to 16.8, inclusive, that, during the third scan (which corresponds to again the next half revolution of the head drum on which the heads are located), the scanning line of the first reproduction head with the first azimuth angle across the record carrier at least substantially coincides with the segments 16.9 to 16.12, inclusive, and that, during the fourth scan (which corresponds to again the next half revolution of the head drum on which the heads are located), the scanning line of the second reproduction head with the second azimuth angle across the record carrier at least substantially coincides with the segments 16.13 to 16.16, inclusive.

The trick play segments for this LP3 trick play reproduction mode each comprise a number of 14 trick play sync blocks, including parity sync blocks, and three times a repetition of those 14 trick play sync blocks. As a result, during each revolution of the head drum, 112 trick play sync blocks are read from the record carrier by the two read heads. More specifically, of those 112 trick play sync blocks are 10 trick play sync blocks comprising

parity information. This is in conformity with the number given above for the trick play reproduction mode for STD. The repetitions are present so as to enable a correct retrieval of the 112 trick play sync blocks per revolution of the head drum, even in the case where a tracking error is present, so that the scanning lines introduced above do not cross the trick play segments exactly in the centre of the segments.

Upon trick play reproduction with the record carrier speed being equal to  $-36$  times the 'normal' record carrier speed for the LP3 mode (which is  $v_1/3$ ) and thus equal to  $-12v_1$ , the two read heads scan the record carrier such that, during a first scan (which corresponds to half a revolution of the head drum on which the heads are located), the scanning line of the first reproduction head with the first azimuth angle across the record carrier at least substantially coincides with the segments 18.1 to 18.4, inclusive, that, during a second scan (which corresponds to the next half revolution of the head drum on which the heads are located), the scanning line of the second read head with the second azimuth angle across the record carrier at least substantially coincides with the segments 18.5 to 18.8, inclusive, that, during the third scan (which corresponds to again the next half revolution of the head drum on which the heads are located), the scanning line of the first read head with the first azimuth angle across the record carrier at least substantially coincides with the segments 18.9 to 18.12, inclusive, and that, during the fourth scan (which corresponds to again the next half revolution of the head drum on which the heads are located), the scanning line of the second read head with the second azimuth angle across the record carrier at least substantially coincides with the segments 18.13 to 18.16, inclusive.

The trick play segments for this trick play reproduction mode each comprise a number of 14 trick play sync blocks, including parity sync blocks, and three times a repetition of those .. trick play sync blocks. As a result, during each revolution of the head drum, 112 trick play sync blocks are read from the record carrier by the two read heads. Of those 112 trick play sync blocks are 10 sync blocks comprising parity information. This is the same as for the other trick play modes described up to now. The repetitions are, again, present so as to enable a correct retrieval of the 112 trick play sync blocks per revolution of the head drum, even in the case where a tracking error is present, so that the scanning lines introduced above do not cross the trick play segments exactly in the centre of the segments.

Figure 3 shows the track pattern for an LP5 reproduction mode at a record carrier speed of  $v_1/5$ , further provided with trick play segments for two trick play reproduction modes at speeds  $+60$  times and  $-60$  times the LP5 reproduction speed of  $v_1/5$ , so that this means a reproduction speed of  $+12x$  and  $-12x$  the normal reproduction record carrier velocity  $v_1$ .

Figure 3 shows again a group of 48 tracks in this specific example, which is repeated each time.

Again, each track in figure 3 comprises 306 sync blocks of information, resulting in 14688 in total in a group of 48 tracks. 13344 sync blocks comprise normal play data and 1344 sync blocks comprise trick play data, to be described hereafter. The normal play data rate is 2.51 Mb/s, which is, as expected, a factor of 5 lower than the data rate given above for figure 1.

The tracks comprise sync blocks of information of an information signal, such as a video information signal, as an example encoded in the form of an MPEG encoded information signal. This information signal is meant for the reproduction in said LP5 reproduction mode at said record carrier speed of  $v_1/5$ . Further, some of the tracks in a group, such as the tracks numbered 2, 4, 6, 8, 15, 17, 19, 21, 26, 28, 30, 32, 39, 41, 43 and 45 comprise segments, numbered 20.1 to 20.16, inclusive, in which a trick play information signal is accommodated. In the present example, this trick play signal is the trick play signal for enabling a trick play reproduction mode at the record carrier speed of +60 times  $v_1/5$ , which equals  $+12v_1$ . In addition, some of the tracks in a group, such as the tracks numbered 44, 42, 40, 38, 33, 31, 29, 27, 20, 18, 16, 14, 9, 7, 5 and 3 comprise segments, numbered 22.1 to 22.16, inclusive, in which a trick play information signal is accommodated. In the present example, this trick play signal is the trick play signal for enabling a trick play reproduction mode at a record carrier speed of -60 times  $v_1/5$ , which equals the record carrier speed of  $-12v_1$ .

Upon recording the information in the groups of 48 tracks, eg. by means of the first and second recording heads, the even numbered tracks have been created by writing the composite signal with the head of the first azimuth angle and the odd numbered tracks have been created by writing the composite signal with the head of the second azimuth angle, such that the tracks are recorded on the record carrier, one after another, numbered 0, 1, 2, 3, .. etc. The record carrier velocity is  $v_1/5$  in this standard recording mode. In order to realise this track pattern, during a first rotation of the head drum, the first head writes the first track, numbered 0. During the second rotation of the head drum, no information is written by any one of the heads. During the third rotation of the head drum, the second head writes the track numbered 1. During the fourth and fifth rotation of the head drum neither one head writes information on the record carrier. During the sixth rotation of the head drum, the first head writes the track numbered 2. During the seventh rotation, neither one of the heads write information in the record carrier. During the eighth rotation of the head drum, the second head writes the track

numbered 3. This recording sequence is carried out during each subsequent cycle of five rotations of the head drum.

Upon reproducing in the LP5, normal play, reproduction mode, the information from the groups of 48 tracks, is read by means of the first and second read heads with said first and second azimuth angles, respectively, in the following way.

During a first rotation of the head drum, the first read head reads the first track, numbered 0, during the third rotation of the head drum, the second read head reads the track numbered 1, during the sixth rotation of the head drum, the first head reads the track numbered 2, during the eighth rotation of the head drum, the second head reads the track numbered 3. This reproduction sequence is carried out during each subsequent cycle of five rotations of the head drum. The record carrier velocity is  $v_1/5$  in this LP5 reproduction mode. Only the normal play information, that is the information in the tracks outside the trick play segments 20.1 to 20.16, inclusive, and 22.1 to 22.16, inclusive, is used for reproduction.

Upon trick play reproduction with the record carrier speed being equal to 60 times the 'normal' LP5 speed (which is  $v_1/5$ ), and thus equal to  $+12v_1$ , the two read heads scan the record carrier such that, during a first scan (which corresponds to half a revolution of the head drum on which the heads are located), the scanning line of the first read head with the first azimuth angle across the record carrier at least substantially coincides with the segments 20.1 to 20.4, inclusive, and that, during a second scan (which corresponds to the next half revolution of the head drum on which the heads are located), the scanning line of the second reproduction head with the second azimuth angle across the record carrier at least substantially coincides with the segments 20.5 to 20.8, inclusive, that, during the third scan (which corresponds to again the next half revolution of the head drum on which the heads are located), the scanning line of the first reproduction head with the first azimuth angle across the record carrier at least substantially coincides with the segments 20.9 to 20.12, inclusive, and that, during the fourth scan (which corresponds to again the next half revolution of the head drum on which the heads are located), the scanning line of the second reproduction head with the second azimuth angle across the record carrier at least substantially coincides with the segments 20.13 to 20.16, inclusive.

The trick play segments read in this LP5 trick play reproduction mode each comprise a number of 14 trick play sync blocks, including parity sync blocks, and three times a repetition of those 14 trick play sync blocks. As a result, during each revolution of the head drum, 112 trick play sync blocks are read from the record carrier by the two read heads, more specifically, of those 112 trick play sync blocks are 10 sync blocks comprising parity

information. This is in conformity with the number given above for the trick play reproduction mode for STD. The repetitions are present so as to enable a correct retrieval of the 112 trick play sync blocks per revolution of the head drum, even in the case where a tracking error is present, so that the scanning lines introduced above do not cross the trick play segments

5 exactly in the centre of the segments.

Upon trick play reproduction with the record carrier speed being equal to  $-60$  times the 'normal' record carrier speed for the LP5 mode (which is  $v_1/5$ ) and thus equal to  $-12v_1$ , the two read heads scan the record carrier such that, during a first scan (which corresponds to half a revolution of the head drum on which the heads are located), the scanning line of the first reproduction head with the first azimuth angle across the record carrier at least substantially coincides with the segments 22.1 to 22.4, inclusive, that, during a second scan (which corresponds to the next half revolution of the head drum on which the heads are located), the scanning line of the second read head with the second azimuth angle across the record carrier at least substantially coincides with the segments 22.5 to 22.8, inclusive, that, during the third scan (which corresponds to again the next half revolution of the head drum on which the heads are located), the scanning line of the first read head with the first azimuth angle across the record carrier at least substantially coincides with the segments 22.9 to 22.12, inclusive, and that, during the fourth scan (which corresponds to again the next half revolution of the head drum on which the heads are located), the scanning line of the second read head with the second azimuth angle across the record carrier at least substantially coincides with the segments 22.13 to 22.16, inclusive.

The trick play segments for this trick play reproduction mode each comprise a number of 14 trick play sync blocks, including parity sync blocks, and three times a repetition of those 14 trick play sync blocks. As a result, during each revolution of the head drum, 112 trick play sync blocks are read from the record carrier by the two read heads. More specifically, 10 of them comprise parity information. This is the same as for the other trick play modes described up to now. The repetitions are, again, present so as to enable a correct retrieval of the 112 trick play sync blocks per revolution of the head drum, even in the case where a tracking error is present, so that the scanning lines introduced above do not cross the trick play segments exactly in the centre of the segments.

Figure 4 shows the track pattern for an HD reproduction mode at a record carrier speed of  $2v_1$ , further provided with trick play segments for two trick play reproduction modes at speeds  $+6$  times and  $-6$  times the HD reproduction speed of  $2v_1$ , so that this means a reproduction speed of  $+12x$  and  $-12x$  the normal reproduction record carrier velocity  $v_1$ .

Figure 4 shows again a group of 48 tracks in this specific example, which is repeated each time.

Again, each track in figure 4 comprises 306 sync blocks of information, resulting in 14688 in total in a group of 48 tracks. 13344 sync blocks comprise normal play data and 1344 sync blocks comprise trick play data, to be described hereafter. The normal play data rate is 25.09 Mb/s, which is, as expected, a factor of 2 higher than the data rate given above for figure 1.

The tracks comprise sync blocks of information of an information signal, such as a video information signal, as an example encoded in the form of an MPEG encoded information signal. This information signal is meant for the reproduction in said HD reproduction mode at said record carrier speed of  $2v_1$ . Further, some of the tracks in a group, such as the tracks numbered 2, 4, 6, 8, 14, 16, 18, 20, 26, 28, 30, 32, 38, 40, 42 and 44 comprise segments, numbered 24.1 to 24.16, inclusive, in which a trick play information signal is accommodated. In the present example, this trick play signal is the trick play signal for enabling a trick play reproduction mode at the record carrier speed of +6 times  $2v_1$ , which equals  $+12v_1$ .

In this mode, only the (two) heads of the first azimuth angle, located at  $180^\circ$  on the head drum, are used to retrieve the trick play information from the record carrier

In addition, some of the tracks in a group, such as the tracks numbered 45, 43, 41, 39, 33, 31, 29, 27, 21, 19, 17, 13, 9, 7, 5 and 3 comprise segments, numbered 26.1 to 26.16, inclusive, in which a trick play information signal is accommodated. In the present example, this trick play signal is the trick play signal for enabling a trick play reproduction mode at a record carrier speed of -6 times  $2v_1$ , which equals the record carrier speed of  $-12v_1$ .

In this mode, only the (two) heads of the second azimuth angle, located at  $180^\circ$  on the head drum, are used to retrieve the trick play information from the record carrier. By recording the trick play signals for the forward and reverse direction, in the way described above, this results in an equal distribution of the trick play data to be recorded over the tracks. Further, this does not lead to problems in locating the trick play information for the two directions in the tracks of the record carrier.

For recording the information in the groups of 48 tracks, the recording apparatus should be provided with two pairs of a first and a second recording head, the pairs being located at  $180^\circ$  around the circumference of the head drum. The first and second head of each pair are located side by side to each other. The first pair of heads write a pair of tracks, such as the tracks numbered 0 and 1, during half a rotation of the head drum. The second pair of

heads write the next pair of tracks, numbered 2 and 3, during the next half rotation of the head drum. This is repeated each time for subsequent rotations of the head drum. The record carrier velocity is  $2v_1$  in this standard recording mode.

5 Upon reproducing in the HD, normal play, reproduction mode, the information from the groups of 48 tracks, is read by means of two pairs of read head in the same way as the tracks have been written by the two pairs of write heads.

During the first half of a first rotation of the head drum, the first pair of read heads reads the first and second tracks, numbered 0 and 1, followed by a reading of the tracks numbered 2 and 3 during the second half of the first rotation by the second pair of heads. This  
10 is repeated each time for subsequent rotations of the head drum. The record carrier velocity is  $2v_1$  in this HD reproduction mode. Only the normal play information, that is the information in the tracks outside the trick play segments 24.1 to 24.16, inclusive, and 26.1 to 26.16, inclusive, is used for reproduction.

Upon trick play reproduction with the record carrier speed being equal to 6 times the  
15 'normal' HD speed (which is  $2v_1$ ), and thus equal to  $+12v_1$ , only the first read heads of both the first and second pairs of read heads, with the first azimuth, are used for reproduction.

The first read heads scan the record carrier such that, during a first scan (which corresponds to the first half revolution of the head drum on which the heads are located), the scanning line of the first read head of the first pair cross the record carrier along a line that at  
20 least substantially coincides with the segments 24.1 to 24.4, inclusive, and that, during a second scan (which corresponds to next half revolution of the head drum on which the heads are located), the scanning line of the first read head of the second pair cross the record carrier such that the line at least substantially coincides with the segments 24.5 to 24.8, inclusive. During the next half revolution of the head drum, the first read head of the first pair scans the  
25 record carrier such that the scanning line across the record carrier at least substantially coincides with the segments 24.9 to 24.12, inclusive. During again the next half revolution of the head drum, the first read head of the second pair scans the record carrier such that the scanning line across the record carrier at least substantially coincides with the segments 24.13 to 24.16, inclusive.

30 The trick play segments read in this HD trick play reproduction mode each comprise a number of 14 trick play sync blocks, and three times a repetition of those 14 trick play sync blocks. As a result, during each revolution of the head drum, 112 trick play sync blocks are read from the record carrier by the two first read heads, more specifically, of those 112 trick play sync blocks are 10 sync blocks comprising parity information. This is in conformity with

the number given above for the trick play reproduction mode for STD. The repetitions are present so as to enable a correct retrieval of the 112 trick play sync blocks per revolution of the head drum, even in the case where a tracking error is present, so that the scanning lines introduced above do not cross the trick play segments exactly in the centre of the segments.

5           Upon trick play reproduction with the record carrier speed being equal to  $-6$  times the 'normal' record carrier speed for the HD mode (which is  $2v_1$ ) and thus equal to  $-12v_1$ , the two second read heads of both pairs of heads scan the record carrier such that, during a first scan (which corresponds to the first half of a first revolution of the head drum on which the heads are located), the scanning line of the second read head of the first pair across the record carrier  
10           at least substantially coincides with the segments 26.1 to 26.4, inclusive. During a second scan (which corresponds to the second half of the first revolution of the head drum on which the heads are located), the scanning line of the second read head of the second pair across the record carrier at least substantially coincides with the segments 26.5 to 26.8, inclusive. During the third scan (which corresponds to the next half revolution of the head drum on which the  
15           heads are located), the scanning line of the second read head of the first pair across the record carrier at least substantially coincides with the segments 26.9 to 26.12, inclusive. And, during the fourth scan (which corresponds to again the next half revolution of the head drum on which the heads are located), the scanning line of the second read head of the second pair across the record carrier at least substantially coincides with the segments 26.13 to 26.16,  
20           inclusive.

          The trick play segments for this trick play reproduction mode each comprise a number of 14 trick play sync blocks, and three times a repetition of those 14 trick play sync blocks. As a result, during each revolution of the head drum, 112 trick play sync blocks are read from the record carrier by the two second read heads. More specifically, 10 of them comprise parity  
25           information. This is the same as for the other trick play modes described up to now. The repetitions are, again, present so as to enable a correct retrieval of the 112 trick play sync blocks per revolution of the head drum, even in the case where a tracking error is present, so that the scanning lines introduced above do not cross the trick play segments exactly in the centre of the segments.

30           The figures 5, 6, 7 and 8, show again track patterns for an STD, an LP3, LP5 and HD mode. The difference with the track patterns shown in the figures 1, 2, 3 and 4 is that in the track formats of the figures 5, 6, 7 and 8, in addition a trick play signal for a '(24.k) times' trick play mode is included, where  $k$  equals 1, 3, 5 and  $\frac{1}{2}$ , for the STD, the LP3, the LP5 and HD mode, respectively. The track patterns shown in figure 5, 6, 7 and 8, could thus be track

patterns obtained by another embodiment of a recording apparatus in accordance with the invention, or could be track patterns obtained with the apparatus already described with reference to the figures 1, 2, 3 and 4. In that case, it is to be understood that such a recording apparatus is capable of generating a track pattern that comprises the trick play segments for both the '12.k times' and the '24.k times' trick play modes. For clarity reasons, however, only the trick play segments for the '24.k times' trick play mode will be shown in the figures 5, 6, 7 and 8.

Figure 5 shows, as in figure 1, the track pattern for the standard STD reproduction mode at a record carrier speed of  $v_1$ , further provided with trick play segments for two trick play reproduction modes at speeds +24 times and -24 times the normal reproduction record carrier velocity  $v_1$ . Figure 5 shows again the group of 48 tracks, which is repeated each time.

Each track in figure 5 comprises 306 sync blocks of information, resulting in 14688 in total in a group of 48 tracks. 14016 sync blocks comprise normal play data and 672 sync blocks comprise trick play data, to be described hereafter. The normal play data rate is 13.18 Mb/s, which is, as expected, a little bit higher than the data rate given above for figure 1.

Some of the tracks in a group, such as the tracks numbered 6, 8, 10, 12, 14, 16, 18, 27, 29, 31, 33, 35, 37 and 39 comprise segments, numbered 28.1 to 28.14, inclusive, in which a trick play information signal is accommodated. In the present example, this trick play signal is the trick play signal for enabling a trick play reproduction mode at a record carrier speed of +24 times  $v_1$ . In addition, some of the tracks in a group, such as the tracks numbered 42, 40, 38, 36, 34, 32, 30, 19, 17, 15, 13, 11, 9 and 7 comprise segments, numbered 30.1 to 30.14, inclusive, in which a trick play information signal is accommodated. In the present example, this trick play signal is the trick play signal for enabling a trick play reproduction mode at a record carrier speed of -24 times  $v_1$ .

The way in which the composite signal is recorded on the record carrier, so as to obtain the track format shown in figure 5, is the same as the way described above with reference to figure 1.

The way in which reproducing in the standard, normal play, reproduction mode, takes place, has also been described above with reference to figure 1.

Upon trick play reproduction with the record carrier speed being equal to +24 $v_1$ , the two reproduction heads scan the record carrier such that, during a first scan (which corresponds to half a revolution of the head drum on which the heads are located), the scanning line of the first reproduction head with the first azimuth angle across the record carrier at least substantially coincides with the segments 28.1 to 28.7, inclusive, and that,

during a second scan (which corresponds to the next half revolution of the head drum on which the heads are located), the scanning line of the second reproduction head with the second azimuth angle across the record carrier at least substantially coincides with the segments 28.8 to 28.14, inclusive.

- 5           The trick play segments for the  $+24v_1$  trick play reproduction mode each comprise a number of 8 trick play sync blocks, and three times a repetition of those 8 trick play sync blocks. As a result, during each revolution of the head drum, 112 trick play sync blocks are read from the record carrier by the two read heads. More specifically, of those 112 trick play sync blocks are 10 sync blocks that comprise parity information. This is in conformity with the examples shown in document D1. The repetitions are present so as to enable a correct retrieval of the 112 trick play sync blocks per revolution of the head drum, even in the case where a tracking error is present, so that the scanning lines introduced above do not cross the trick play segments exactly in the centre of the segments.

- 15           Upon trick play reproduction with the record carrier speed being equal to  $-24v_1$ , the two reproduction heads scan the record carrier such that, during a first scan (which corresponds to half a revolution of the head drum on which the heads are located), the scanning line of the first reproduction head with the first azimuth angle across the record carrier at least substantially coincides with the segments 30.1 to 30.7, inclusive, and that, during a second scan (which corresponds to the next half revolution of the head drum on which the heads are located), the scanning line of the second reproduction head with the second azimuth angle across the record carrier at least substantially coincides with the segments 30.8 to 30.14, inclusive.

- 25           The trick play segments for the  $-24v_1$  trick play reproduction mode each comprise a number of 8 trick play sync blocks, and three times a repetition of those 8 trick play sync blocks. As a result, during each revolution of the head drum, 112 trick play sync blocks are read from the record carrier by the two read heads. More specifically, of those 112 trick play sync blocks are 10 trick play sync blocks comprising parity information. This is in conformity with the examples shown in document D1. The repetitions are, again, present so as to enable a correct retrieval of the 112 trick play sync blocks per revolution of the head drum, even in the case where a tracking error is present, so that the scanning lines introduced above do not cross the trick play segments exactly in the centre of the segments.

Figure 6 shows the track pattern for an LP3 reproduction mode at a record carrier speed of  $v_1/3$ , further provided with trick play segments for two trick play reproduction modes at speeds  $+72$  times and  $-72$  times the LP3 reproduction speed of  $v_1/3$ , so that this means a

reproduction speed of  $+24x$  and  $-24x$  the normal reproduction record carrier velocity  $v_1$ .

Figure 6 shows again a group of 48 tracks in this specific example, which is repeated each time. Again, each track in figure 6 comprises 306 sync blocks of information, resulting in 14688 in total in a group of 48 tracks. 14016 sync blocks comprise normal play data and 672 sync blocks comprise trick play data, to be described hereafter. The normal play data rate is 4.39 Mb/s, which is, as expected, a factor of 3 lower than the data rate given above for figure 5.

The tracks comprise sync blocks of information of an information signal, such as a video information signal, as an example encoded in the form of an MPEG encoded information signal. This information signal is meant for the reproduction in said LP3 reproduction mode at said record carrier speed of  $v_1/3$ , in the same way as described above with reference to figure 2. Further, some of the tracks in a group, such as the tracks numbered 6, 8, 10, 12, 14, 16, 18, 29, 31, 33, 35, 37, 39 and 41 comprise segments, numbered 32.1 to 32.14, inclusive, in which a trick play information signal is accommodated. In the present example, this trick play signal is the trick play signal for enabling a trick play reproduction mode at the record carrier speed of  $+72$  times  $v_1/3$ , which equals  $+24v_1$ . In addition, some of the tracks in a group, such as the tracks numbered 42, 40, 38, 36, 34, 32, 30, 19, 17, 15, 13, 11, 9 and 7 comprise segments, numbered 34.1 to 34.14, inclusive, in which a trick play information signal is accommodated. In the present example, this trick play signal is the trick play signal for enabling a trick play reproduction mode at a record carrier speed of  $-72$  times  $v_1/3$ , which equals the record carrier speed of  $-24v_1$ .

The way of recording the information in the groups of 48 tracks shown in figure 6 is the same as the way in which the tracks shown in figure 2 have been recorded. Therefore, no further description thereof will be given.

The way of reproducing the information in the LP3, normal play, reproduction mode, is the same as the way in which the information shown in figure 2 is reproduced. Reference is therefore made to the description of the reproduction in this mode, as given to figure 2.

Upon trick play reproduction with the record carrier speed being equal to 72 times the 'normal' LP3 speed (which is  $v_1/3$ ), and thus equal to  $+24v_1$ , the two read heads scan the record carrier such that, during a first scan (which corresponds to half a revolution of the head drum on which the heads are located), the scanning line of the first read head with the first azimuth angle across the record carrier at least substantially coincides with the segments 32.1 to 32.7, inclusive and that, during a second scan (which corresponds to the next half revolution of the head drum on which the heads are located), the scanning line of the second reproduction

head with the second azimuth angle across the record carrier at least substantially coincides with the segments 32.8 to 32.14, inclusive.

The trick play segments for this LP3 trick play reproduction mode each comprise a number of 8 trick play sync blocks, and three times a repetition of those 8 trick play sync blocks. As a result, during each revolution of the head drum, 112 trick play sync blocks are read from the record carrier by the two read heads. More specifically, of those 112 trick play sync blocks are 10 trick play sync blocks comprising parity information. This is in conformity with the number given above for the trick play reproduction mode for STD. The repetitions are present so as to enable a correct retrieval of the 112 trick play sync blocks per revolution of the head drum, even in the case where a tracking error is present, so that the scanning lines introduced above do not cross the trick play segments exactly in the centre of the segments.

Upon trick play reproduction with the record carrier speed being equal to  $-72$  times the 'normal' record carrier speed for the LP3 mode (which is  $v_1/3$ ) and thus equal to  $-24v_1$ , the two read heads scan the record carrier such that, during a first scan (which corresponds to half a revolution of the head drum on which the heads are located), the scanning line of the first reproduction head with the first azimuth angle across the record carrier at least substantially coincides with the segments 34.1 to 34.7, inclusive, and that, during a second scan (which corresponds to the next half revolution of the head drum on which the heads are located), the scanning line of the second read head with the second azimuth angle across the record carrier at least substantially coincides with the segments 34.8 to 34.14, inclusive.

The trick play segments for this trick play reproduction mode each comprise a number of 8 trick play sync blocks, and three times a repetition of those 8 trick play sync blocks. As a result, during each revolution of the head drum, 112 trick play sync blocks are read from the record carrier by the two read heads. Of those 112 trick play sync blocks are 10 sync blocks comprising parity information. This is the same as for the other trick play modes described up to now. The repetitions are, again, present so as to enable a correct retrieval of the 112 trick play sync blocks per revolution of the head drum, even in the case where a tracking error is present, so that the scanning lines introduced above do not cross the trick play segments exactly in the centre of the segments.

Figure 7 shows the track pattern for an LP5 reproduction mode at a record carrier speed of  $v_1/5$ , further provided with trick play segments for two trick play reproduction modes at speeds  $+120$  times and  $-120$  times the LP5 reproduction speed of  $v_1/5$ , so that this means a reproduction speed of  $+24x$  and  $-24x$  the normal reproduction record carrier velocity  $v_1$ . Figure 7 shows again a group of 48 tracks in this specific example, which is repeated each

time. Again, each track in figure 7 comprises 306 sync blocks of information, resulting in 14688 in total in a group of 48 tracks. 14016 sync blocks comprise normal play data and 672 sync blocks comprise trick play data, to be described hereafter. The normal play data rate is 2.64 Mb/s, which is, as expected, a factor of 5 lower than the data rate given above for figure

5 5.

The tracks comprise sync blocks of information of an information signal, such as a video information signal, as an example encoded in the form of an MPEG encoded information signal. This information signal is meant for the reproduction in said LP5 reproduction mode at said record carrier speed of  $v_1/5$ , as explained above with reference to figure 3. Further, some of the tracks in a group, such as the tracks numbered 6, 8, 10, 12, 14, 16, 18, 29, 31, 33, 35, 37, 39 and 41 comprise segments, numbered 36.1 to 36.14, inclusive, in which a trick play information signal is accommodated. In the present example, this trick play signal is the trick play signal for enabling a trick play reproduction mode at the record carrier speed of +120 times  $v_1/5$ , which equals  $+24v_1$ . In addition, some of the tracks in a group, such as the tracks numbered 42, 40, 38, 36, 34, 32, 30, 19, 17, 15, 13, 11, 9 and 7 comprise segments, numbered 38.1 to 38.14, inclusive, in which a trick play information signal is accommodated. In the present example, this trick play signal is the trick play signal for enabling a trick play reproduction mode at a record carrier speed of -120 times  $v_1/5$ , which equals the record carrier speed of  $-24v_1$ .

The way of recording the information in the groups of 48 tracks is the same as the way in which the information shown in figure 3 has been recorded on the record carrier. Therefore, no further description of this recording will be given and reference is made to the description thereof to figure 3.

The way of reproducing in the LP5, normal play, reproduction mode, has also been extensively described with reference to figure 3, so that no further description will now be given.

Upon trick play reproduction with the record carrier speed being equal to 120 times the 'normal' LP5 speed (which is  $v_1/5$ ), and thus equal to  $+24v_1$ , the two read heads scan the record carrier such that, during a first scan (which corresponds to half a revolution of the head drum on which the heads are located), the scanning line of the first read head with the first azimuth angle across the record carrier at least substantially coincides with the segments 36.1 to 36.7, inclusive, and that, during a second scan (which corresponds to the next half revolution of the head drum on which the heads are located), the scanning line of the second

reproduction head with the second azimuth angle across the record carrier at least substantially coincides with the segments 36.8 to 36.14.

The trick play segments read in this LP5 trick play reproduction mode each comprise a number of 8 trick play sync blocks, and three times a repetition of those 8 trick play sync blocks. As a result, during each revolution of the head drum, 112 trick play sync blocks are read from the record carrier by the two read heads, more specifically, of those 112 trick play sync blocks are 10 sync blocks comprising parity information. This is in conformity with the number given above for the trick play reproduction mode for STD. The repetitions are present so as to enable a correct retrieval of the 112 trick play sync blocks per revolution of the head drum, even in the case where a tracking error is present, so that the scanning lines introduced above do not cross the trick play segments exactly in the centre of the segments.

Upon trick play reproduction with the record carrier speed being equal to  $-120$  times the 'normal' record carrier speed for the LP5 mode (which is  $v_1/5$ ) and thus equal to  $-24v_1$ , the two read heads scan the record carrier such that, during a first scan (which corresponds to half a revolution of the head drum on which the heads are located), the scanning line of the first reproduction head with the first azimuth angle across the record carrier at least substantially coincides with the segments 38.1 to 38.7, inclusive, and that, during a second scan (which corresponds to the next half revolution of the head drum on which the heads are located), the scanning line of the second read head with the second azimuth angle across the record carrier at least substantially coincides with the segments 38.8 to 38.14, inclusive.

The trick play segments for this trick play reproduction mode each comprise a number of 8 trick play sync blocks, and three times a repetition of those 8 trick play sync blocks. As a result, during each revolution of the head drum, 112 trick play sync blocks are read from the record carrier by the two read heads. More specifically, 10 of them comprise parity information. This is the same as for the other trick play modes described up to now. The repetitions are, again, present so as to enable a correct retrieval of the 112 trick play sync blocks per revolution of the head drum, even in the case where a tracking error is present, so that the scanning lines introduced above do not cross the trick play segments exactly in the centre of the segments.

Figure 8 shows the track pattern for an HD reproduction mode at a record carrier speed of  $2v_1$ , further provided with trick play segments for two trick play reproduction modes at speeds  $+12$  times and  $-12$  times the HD reproduction speed of  $2v_1$ , so that this means a reproduction speed of  $+24x$  and  $-24x$  the normal reproduction record carrier velocity  $v_1$ . Figure 8 shows again a group of 48 tracks in this specific example, which is repeated each

time. Again, each track in figure 8 comprises 306 sync blocks of information, resulting in 14688 in total in a group of 48 tracks. 14016 sync blocks comprise normal play data and 672 sync blocks comprise trick play data, to be described hereafter. The normal play data rate is 26.35 Mb/s, which is, as expected, a factor of 2 higher than the data rate given above for figure

5 5.

The tracks comprise sync blocks of information of an information signal, such as a video information signal, as an example encoded in the form of an MPEG encoded information signal. This information signal is meant for the reproduction in said HD reproduction mode at said record carrier speed of  $2v_1$ , just as given in figure 4. Further, some of the tracks in a group, such as the tracks numbered 2, 4, 6, 8, 10, 12, 14, 16, 28, 30, 32, 34, 36, 38 and 40 comprise segments, numbered 40.1 to 40.14, inclusive, in which a trick play information signal is accommodated. In the present example, this trick play signal is the trick play signal for enabling a trick play reproduction mode at the record carrier speed of +12 times  $2v_1$ , which equals  $+24v_1$ .

15 Again, the trick play information included in the segments identified above is retrieved therefrom by the two heads having the first azimuth, see the description with reference to figure 4.

In addition, some of the tracks in a group, such as the tracks numbered 43, 41, 39, 37, 35, 33, 31, 19, 17, 15, 13, 11, 9 and 7 comprise segments, numbered 42.1 to 42.14, inclusive, in which a trick play information signal is accommodated. In the present example, this trick play signal is the trick play signal for enabling a trick play reproduction mode at a record carrier speed of -12 times  $2v_1$ , which equals the record carrier speed of  $-24v_1$ .

25 Again, the trick play information included in the segments identified above is retrieved therefrom by the two heads having the second azimuth, see the description with reference to figure 4.

The way of recording the information in the groups of 48 tracks is the same as described above with reference to figure 4.

The way of reproducing in the HD, normal play, reproduction mode is the same as the way described above with reference to figure 4.

30 Upon trick play reproduction with the record carrier speed being equal to 12 times the 'normal' HD speed (which is  $2v_1$ ), and thus equal to  $+24v_1$ , only the first read heads of both the first and second pairs of read heads, with the first azimuth, are used for reproduction.

The first read head of the first pair scans the record carrier such that, during a first scan (which corresponds to a first revolution of the head drum on which the heads are located), the

scanning line of the first read head of the first pair crosses the record carrier along a line that at least substantially coincides with the segments 40.1 to 40.7, inclusive. During a second scan (which corresponds to next half revolution of the head drum), the first head of the second pair crosses the record carrier such that its scanning line at least substantially coincides with the segments 40.8 to 40.14, inclusive.

The trick play segments read in this HD trick play reproduction mode each comprise a number of 8 trick play sync blocks, and three times a repetition of those 8 trick play sync blocks. As a result, during each revolution of the head drum, 112 trick play sync blocks are read from the record carrier by the two read heads, more specifically, of those 112 trick play sync blocks are 10 sync blocks comprising parity information. This is in conformity with the number given above for the trick play reproduction mode for STD. The repetitions are present so as to enable a correct retrieval of the 112 trick play sync blocks per revolution of the head drum, even in the case where a tracking error is present, so that the scanning lines introduced above do not cross the trick play segments exactly in the centre of the segments.

Upon trick play reproduction with the record carrier speed being equal to  $-12$  times the 'normal' record carrier speed for the HD mode (which is  $2v_1$ ) and thus equal to  $-24v_1$ , the two second read heads of both pairs of heads scan the record carrier such that, during a first scan (which corresponds to the first half revolution of the head drum on which the heads are located), the scanning line of the second read head of the first pair across the record carrier at least substantially coincides with the segments 42.1 to 42.7, inclusive. During a second scan (which corresponds to the second half revolution of the head drum on which the heads are located), the scanning line of the second read head of the second pair across the record carrier at least substantially coincides with the segments 42.8 to 42.14, inclusive.

The trick play segments for this trick play reproduction mode each comprise a number of 8 trick play sync blocks, and three times a repetition of those 8 trick play sync blocks. As a result, during each revolution of the head drum, 112 trick play sync blocks are read from the record carrier by the two read heads. More specifically, 10 of them comprise parity information. This is the same as for the other trick play modes described up to now. The repetitions are, again, present so as to enable a correct retrieval of the 112 trick play sync blocks per revolution of the head drum, even in the case where a tracking error is present, so that the scanning lines introduced above do not cross the trick play segments exactly in the centre of the segments.

Next, an apparatus of the helical scan type, for recording the digital video information signal and the one or more trick play signals as recorded in accordance with one of the formats

shown in the figures 1 to 8 on the longitudinal record carrier, is described. Figure 9 shows the recording apparatus which comprises an input terminal 111 for receiving a video signal and a corresponding audio signal. The video signal and the corresponding audio signal may have been encoded into transport packets included in an MPEG serial datastream, well known in the art. The input terminal 111 is coupled to an input 112 of a 'normal play' processing unit 114. Further, a 'trick play' processing unit 116 is provided having an input 117 also coupled to the input terminal 111. Outputs 119 and 120 of the 'normal play' processing unit 114 and the 'trick play' processing unit 116 are coupled to corresponding inputs of a multiplexer 122. The 'normal play' information as well as the 'trick play' information will be recorded in the tracks on the record carrier 140.

For a further description of the 'normal play' processing unit 114 and the 'trick play' processing unit 116, reference is made to US-A 5,579,183, document D2 in the list of references.

A subcode signal generator 124 is present for supplying the subcode signal information for storage in a subcode signal recording portion in the tracks on the record carrier. Outputs of the multiplexer 122 and the generator 124 are coupled to corresponding inputs of an error correction encoder unit 126. The error correction encoder unit 126 is capable of carrying out a error correction encoding step on the 'normal play' (video and audio) information and the trick play information, so as to obtain the parity information.

The recording apparatus further comprises a generator 130 for adding sync and ID information. After combination of the signals in the combining unit 132, the combined signal is applied to a unit 134, in which a channel encoding is carried out on the composite signal. The channel encoding carried out in the encoding unit 134 is well known in the art. For an example of such channel coding, reference is made in this respect to US-A 5,142,421, document D4 in the list of references.

An output of the channel encoding unit 134 is coupled to an input of a writing unit 136, in which the datastream obtained with the encoding unit 134 is recorded in the slant tracks on a record carrier 140, by means of at least two write heads 142 and 144 positioned on a rotating head drum 146. The write heads 142 and 144 have head gaps with a mutually different azimuth angle. Further, a time stamp generator 147 is available for generating the time stamps for the normal play processing unit 114 and the trick play processing unit 116. Via an input 176, a control signal can be applied to a microprocessor unit 148, indicating which recording mode should be carried out by the recording apparatus, such as an STD mode, one or more LP modes or an HD mode.

The microprocessor unit 148 is present for controlling the functioning of the various blocks, such as:

- the control of the normal play signal processing block 114 in each of the possible modes, such as the STD mode, one or more LP modes and an HD mode, via the control connection 5 150,
- the control of the trick play signal processing block 116 in each of said modes, via the control connection 152,
- the control of the subcode signal generator block 124 via the control connection 154,
- the control of the error correction encoding block 126 via the control connection 156,
- 10 - the control of the sync signal and ID signal generator block 130 via the control connection 158,
- the control of the channel encoding block 134 via the control connection 160,
- the control of the transport velocity of the record carrier 140 and the rotation of the head drum 146 in each of said modes, via the control connection 162, and
- 15 - the control of the time stamp generator 147 via the control connection 164.

The trick play processing 116 is adapted to retrieve I-frame information from the video information signal, supplied to the input terminal 111, in a way as eg. described in earlier filed European patent application no. 98201959.8, document D3 in the list of related documents. The trick play signal obtained for a specific trick play speed is accommodated in trick play 20 sync blocks, for recording on the record carrier.

Further, for each trick play information signal, trick play sync blocks are generated, in the sense that for each trick play sync block, a trick play speed identifier and a direction identifier are generated and stored in the trick play sync block and a time stamp is added to each packet in the various trick play information signals, as eg. described in WO 98-34224 25 (PHN 16.261), document D6 in the list of related documents.

Next, the trick play sync blocks and the 'normal play' sync blocks, generated by the normal play signal processing unit 114, are combined in the multiplexer unit 122. Subcode data is added and an error correction encoding is carried out on the combined normal play data and trick play data so as to obtain the parity information. Further, sync words and 30 identification information is added. Next, a channel encoding step is carried out on the information prior to recording the information in the tracks.

Figure 9 shows a head drum configuration provided with the first and second writing heads 142 and 144 having mutually different azimuth angles. With such a head drum configuration it is possible to realise the following modes: STD and the LP modes. For an HD

mode, a different head drum configuration is needed, shown in figure 9a. This head drum configuration is provided with two head pairs, 142a,142b and 144a,144b, located at  $180^0$  at the circumference of the head drum 146'. The heads 142a and 144a have the same azimuth angles and the heads 142b and 144b have the same azimuth angles, where the azimuth angle of the heads 142a and 144a is the above mentioned first azimuth angle, and is different from the azimuth angle of the heads 142b and 144b, which is the second azimuth angle, mentioned above.

When, under the influence of a control signal applied to the terminal 176, the apparatus is switched into an STD recording mode, the apparatus generates a composite signal for recording on the record carrier, resulting in the track format shown in figure 1 or 5, or a combination thereof, namely in the case when the trick play signal unit 116 is capable of generating trick play signals for both the +12 times and - 12 times the nominal reproduction speed ( $v_1$ ), and/or the trick play signals for the +24 times and -24 times  $v_1$  speeds.

When, under the influence of a control signal applied to the terminal 176, the apparatus is switched into an LP3 recording mode, the apparatus generates a composite signal for recording on the record carrier, resulting in the track format shown in figure 2 or 6, or a combination thereof, namely in the case when the trick play signal unit 116 is capable of generating trick play signals for both the +36 times and - 36 times the nominal reproduction speed ( $v_1/3$ ), which is the record carrier speed during recording in the LP3 mode, and/or the trick play signals for the +72 times and -72 times  $v_1$  speeds.

When, under the influence of a control signal applied to the terminal 176, the apparatus is switched into an LP5 recording mode, the apparatus generates a composite signal for recording on the record carrier, resulting in the track format shown in figure 3 or 7, or a combination thereof, namely in the case when the trick play signal unit 116 is capable of generating trick play signals for both the +60 times and - 60 times the nominal reproduction speed ( $v_1/5$ ), which is the record carrier speed during recording in the LP5 mode, and/or the trick play signals for the +120 times and -120 times  $v_1$  speeds.

When, under the influence of a control signal applied to the terminal 176, the apparatus is switched into an HD recording mode, the apparatus generates a composite signal for recording on the record carrier, resulting in the track format shown in figure 4 or 8, or a combination thereof, namely in the case when the trick play signal unit 116 is capable of generating trick play signals for both the +6 times and - 6 times the nominal reproduction speed ( $2v_1$ ), which is the record carrier speed during recording in the HD mode, and/or the +12 times and -12 times  $v_1$  speeds.

Figure 10 shows an apparatus for reproducing the digital video information signal and the one or more trick play signals as recorded in accordance with the formats shown in the figures 1 to 8. The reproduction apparatus comprises a reading unit 250, having at least two reading heads 252 and 254, for reading information from the slant tracks on the record carrier 140. The one read head has a gap with an azimuth angle which equals the first azimuth angle, see the azimuth angle from bottom left to top right in the circle 14 of figure 1, and the other read head has a gap with an azimuth angle which equals the second azimuth angle, see the azimuth angle from bottom right to top left in the circle 14 of figure 1. An output of the reading unit 250 is coupled to an input of a channel decoding unit 254. The channel decoding unit may be adapted to carry 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, such as disclosed in document D4. Next, an error correction is carried out in the error correction unit 258.

The error correction unit 258 is used for carrying out an (inner) error correction step on the information read from the record carrier in the 'normal play' as well as in a 'trick play' reproduction.

The output of the error correction unit 258 is coupled to an input 259 of a 'normal play' processing unit 260. Further, a 'trick play' processing unit 262 is provided having an input 261 also coupled to the output of the error correction unit 258. Outputs 264 and 265 of the 'normal play' processing unit 260 and the 'trick play' processing unit 262 respectively, are coupled to corresponding terminals a and b respectively of a switch 266, a c-terminal of which is coupled to an output terminal 268. Further a microprocessor unit 294 is present for controlling the function of the reproducing apparatus in response to an instruction control signal supplied to the microprocessor unit 294 via an input 296. Therefore, control lines 280, 282, 284, 286, 290 and 292 are present for supplying a control signal via those lines to the various units in the apparatus. The instruction control signal is a control signal inputted by a user of the apparatus and indicates in which mode the reproducing apparatus should function, such as a normal play reproduction mode or a trick play reproduction mode in one of the possible trick play speeds.

The processing unit 260 comprises a circuit part capable of carrying out an error correction step on the information supplied by the error correction unit 258 in the normal play reproduction mode. The processing unit 262 comprises a circuit part capable of carrying out an error correction step on the information supplied by the error correction unit 258 in the trick play reproduction.

If the reproducing apparatus is switched into a 'normal play' reproduction mode, the apparatus will recognize from the data read from the record carrier whether the data on the

record carrier have been written in the STD recording mode, the LP3 recording mode, the LP5 recording mode, or the HD recording mode. This means that the record carrier 140 will be transported at the required record carrier speed  $v_1$ . In this reproduction mode, the 'normal play' processing unit 260 is enabled and the switch 266 is switched into the position a-c.

- 5           It is to be understood in this respect that, in order to enable an HD reproduction mode, the head drum 251 should be provided with two head pairs, in the same way as explained above with reference to the recording apparatus.

          If the reproducing apparatus is switched into a 'trick play' reproduction mode, also called 'feature mode', this means that the record carrier 140 is transported at a speed other than  
10   the nominal speed, that the 'trick play' processing unit 262 is enabled and the switch 266 is switched into the position b-c.

          For enabling a 'trick play' reproduction mode with the lowest trick play speed, the absolute record carrier velocity will be made equal to  $12v_1$ . For enabling a trick play reproduction mode with the higher trick play speed, the absolute record carrier velocity will be  
15   made equal to  $24v_1$ , assuming a trick play reproduction mode in the forward direction has been chosen.

          In such trick play reproduction mode, the reproducing apparatus is further provided with a tape tracking servo control means 270 which generates a control signal for controlling the speed of the record carrier 140 accordingly. More specifically, the control means 270  
20   generates a control signal during the 'trick play' reproduction mode for transporting the record carrier 140 such that, in the lowest trick play mode with the record carrier speed being +12 times  $v_1$ , the (two) scanning lines of the head 252 across the record carrier in figure 1, during two complete revolutions of the head drum cross the track segments 10.1 to 10.4 and 10.9 to 10.12 and, the (two) scanning lines of the head 254 across the record carrier in figure 1, during  
25   two complete revolutions of the head drum cross the track segments 10.5 to 10.8 and 10.13 to 10.16.

          Suppose the reproducing apparatus was reproducing information from a record carrier shown in figure 2, the control means 270 generates a control signal during the 'trick play' reproduction mode for transporting the record carrier 140 such that, in the lowest trick play  
30   mode with the record carrier speed being +12 times  $v_1$ , the (two) scanning lines of the head 252 across the record carrier in figure 2, during two complete revolutions of the head drum cross the track segments 16.1 to 16.4 and 16.9 to 16.12 and, the (two) scanning lines of the head 254 across the record carrier in figure 2, during two complete revolutions of the head drum cross the track segments 16.5 to 16.8 and 16.13 to 16.16.

It will be understood that the same scanning lines will be realised when reproducing information from the record carriers shown in the figures 3 and 4, for a trick play reproduction mode with a record carrier velocity equal to  $+12v_1$ .

Suppose the reproducing apparatus was reproducing information from a record carrier shown in figure 1, in the lowest trick play reproduction mode in the backwards direction. The control means 270 now generates a control signal during the 'trick play' reproduction mode for transporting the record carrier 140 such that, in the lowest trick play mode with the record carrier speed being  $-12$  times  $v_1$ , the (two) scanning lines of the head 252 across the record carrier in figure 1, during two complete revolutions of the head drum cross the track segments 12.1 to 12.4 and 12.9 to 12.12 and, the (two) scanning lines of the head 254 across the record carrier in figure 1, during two complete revolutions of the head drum cross the track segments 12.5 to 12.8 and 12.13 to 12.16.

Suppose the reproducing apparatus was reproducing information from a record carrier shown in figure 2, the control means 270 generates a control signal during the 'trick play' reproduction mode for transporting the record carrier 140 such that, in the lowest trick play mode with the record carrier speed being  $-12$  times  $v_1$ , the (two) scanning lines of the head 252 across the record carrier in figure 2, during two complete revolutions of the head drum cross the track segments 18.1 to 18.4 and 18.9 to 18.12 and, the (two) scanning lines of the head 254 across the record carrier in figure 2, during two complete revolutions of the head drum cross the track segments 18.5 to 18.8 and 18.13 to 18.16.

It will be understood that the same scanning lines will be realised when reproducing information from the record carriers shown in the figures 3 and 4, for a trick play reproduction mode with a record carrier velocity equal to  $-12v_1$ .

Suppose the reproducing apparatus is switched into the higher trick play reproduction mode by means of the control signal applied to the terminal 296. Suppose, the reproducing apparatus was reproducing information from a record carrier shown in figure 5, the control means 270 generates a control signal during the 'trick play' reproduction mode for transporting the record carrier 140 such that, in the higher trick play mode with the record carrier speed being  $+24$  times  $v_1$ , the scanning line of the head 252 across the record carrier in figure 5, during one complete revolution of the head drum cross the track segments 28.1 to 28.7, and the scanning line of the head 254 across the record carrier in figure 5, during one complete revolution of the head drum cross the track segments 28.8 to 28.14.

Suppose now that the reproducing apparatus was reproducing information from a record carrier shown in figure 6, the control means 270 generates a control signal during the

'trick play' reproduction mode for transporting the record carrier 140 such that, in the higher trick play mode with the record carrier speed being  $+24$  times  $v_1$ , the scanning line of the head 252 across the record carrier in figure 6, during one complete revolution of the head drum cross the track segments 32.1 to 32.7, and the scanning line of the head 254 across the record carrier in figure 6, during one complete revolution of the head drum cross the track segments 32.8 to 32.14.

It will be understood that the same scanning lines will be realised when reproducing information from the record carriers shown in the figures 7 and 8, for a trick play reproduction mode with a record carrier velocity equal to  $+24v_1$ .

10 Suppose the reproducing apparatus was reproducing information from a record carrier shown in figure 5, in the higher trick play reproduction mode in the backwards direction. The control means 270 now generates a control signal during the 'trick play' reproduction mode for transporting the record carrier 140 such that, in the lowest trick play mode with the record carrier speed being  $-24$  times  $v_1$ , the scanning line of the head 252 across the record carrier in figure 5, during one complete revolution of the head drum cross the track segments 30.1 to 30.7 and the scanning line of the head 254 across the record carrier in figure 5, during one complete revolution of the head drum cross the track segments 30.8 to 30.14.

Suppose the reproducing apparatus was reproducing information from a record carrier shown in figure 6, the control means 270 generates a control signal during the 'trick play' reproduction mode for transporting the record carrier 140 such that, in the lowest trick play mode with the record carrier speed being  $-24$  times  $v_1$ , the scanning line of the head 252 across the record carrier in figure 6, during one complete revolution of the head drum cross the track segments 34.1 to 34.7 and the scanning line of the head 254 across the record carrier in figure 6, during one complete revolution of the head drum cross the track segments 34.8 to 34.

25 It will be understood that the same scanning lines will be realised when reproducing information from the record carriers shown in the figures 7 and 8, for a trick play reproduction mode with a record carrier velocity equal to  $-24v_1$ .

The record carrier transport control realised in the way explained above is named: track select transport control, in the sense that specific paths across the record carrier are selected for reproduction in a trick play reproduction mode, said paths beginning at specific tracks on the record carrier. That is track numbered 0 for the head 252.

For a further description of the tracking control, reference is made to earlier filed European patent application no. 98200422.8, document D5 in the list of related documents.

Whilst the invention has been described with reference to preferred embodiments thereof, it is to be understood that these are not limitative examples. Thus, various modifications may become apparent to those skilled in the art, without departing from the scope of the invention, as defined by the claims.

5        Further, the invention lies in each and every novel feature or combination of features.

## List of related documents

- (D1) WO 98-34226 (PHN 16614)
- (D2) US-A 5,579,183 (PHN 14818)
- 5 (D3) European patent application no. 98201959.8 (PHN 16959)
- (D4) US-A 5,142,421 (PHN 13.537)
- (D5) European patent application no. 98200422.8 (PHN 16771)
- (D6) WO 98-34224 (PHN 16261)

## CLAIMS:

1. A recording apparatus for recording a digital information signal on a record carrier, wherein:

- the apparatus has at least first and second recording modes;
- the apparatus has trick play generating means for generating first and second trick play signals in the first and second recording modes, respectively;
- the apparatus has writing means for writing the digital information signal and the first or second trick play signal on the record carrier in the first or second recording mode, respectively;
- the apparatus has transport means for moving the record carrier with respect to the writing means with a first velocity in the first recording mode and with a second velocity in the second recording mode;
- a magnitude of the second velocity is  $1/k$  times a magnitude of the first velocity,  $k$  being a constant greater than unity;
- the writing means is operative to write the first or second trick play signal in such a manner so as to enable reproduction of a relevant one of the first and second trick play signals, respectively, through reading means in a reproduction apparatus, at a further velocity of the record carrier with respect to the reading means that is substantially the same for the first and second trick play signals.

2. The apparatus of claim 1, wherein:

- the apparatus has a third recording mode;
- the transport means is operative in the third recording mode to move the carrier with respect to the writing means with a fifth velocity having a magnitude of  $1/p$  times the first velocity,  $p$  being a constant greater than unity;
- the trick play generating means is operative to generate a third trick play signal in the third operating mode;
- the writing means is operative in the third recording mode to write the third trick play signal on the carrier in such a manner so as to enable reproduction of the third trick play signal, through reading means in a reproduction apparatus, at substantially the further velocity of the record carrier with respect to the reading means.

3. The apparatus of claim 1 or 2, wherein the first recording mode is a standard recording mode and the second recording mode is a long play recording mode.
4. The apparatus of claim 1, wherein the second recording mode is a standard recording mode and the first recording mode is a high-speed recording mode.
5. The apparatus of claim 2, wherein the first recording mode is a standard recording mode, the second recording mode is a long play recording mode, and the third recording mode is a second long play recording mode.
6. The apparatus of claim 1, wherein the trick play signal generating means is operative to derive the first trick play signal from said digital information signal in the first recording mode, and to derive the second trick play signal from the digital information signal in the second recording mode.
7. A record carrier having first and second trick play signals recorded thereon at first and second velocities, respectively, of the carrier with respect to writing means during the recording, the first and second velocities being different, the carrier enabling reproduction of the first and second trick play signals at further velocities of the carrier with respect to reading means of a reproduction apparatus that are substantially the same for the first and second trick play signals.
8. A method of recording a digital information signal on a record carrier, the method comprising:
  - generating a first trick play signal and a second trick play signal in first and second recording modes, respectively;
  - writing the digital information signal and the first or second trick play signal on the record carrier in the first or second recording mode, respectively;
  - moving the record carrier with respect to the writing means with a first velocity in the first recording mode or with a second velocity in the second recording mode;wherein:
  - a magnitude of the second velocity is  $1/k$  times a magnitude of the first velocity,  $k$  being a constant greater than unity;

- a relevant one of the first and second trick play signals are written in such a manner so as to enable reproduction of the relevant one of the first and second trick play signals, through reading means in a reproduction apparatus, at a further velocity of the record carrier with respect to the reading means that is substantially the same for the first and second trick play signals.

9. A reproducing apparatus having a third reproducing mode and a fourth reproducing mode for reproducing a first trick play signal or a second trick play signal, respectively, recorded on a record carrier at first and second velocities, respectively, of the record carrier with respect to writing means of a recording apparatus, a magnitude of the second velocity being  $1/k$  times a magnitude of the first velocity,  $k$  being a constant greater than unity; wherein the reproducing apparatus has:

- reading means for reading the first or second trick play signal from the carrier;
- transport means for moving the carrier with a third velocity or a fourth velocity with respect to the reading means in the third and fourth reproducing modes, respectively; the third and fourth velocities being substantially equal to one another.