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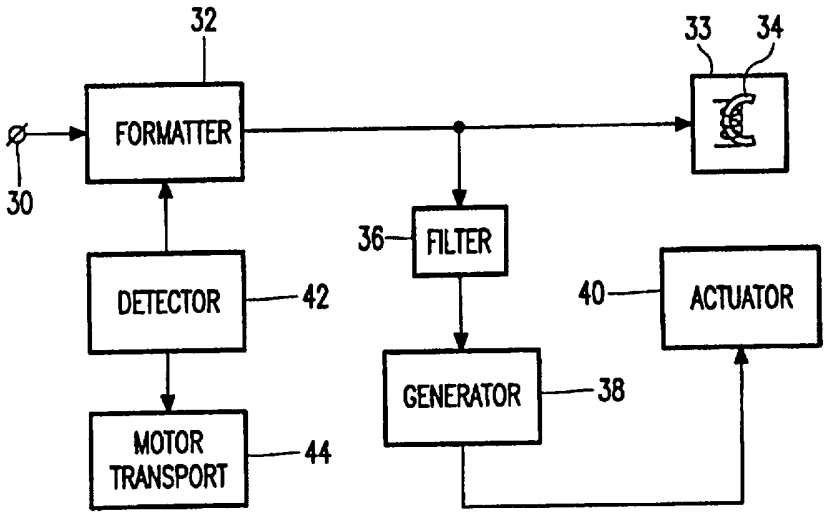
(57) Abstract

The invention thus relates to an apparatus for recording an information signal on a record carrier (1). The record carrier has a first and a second tracking signal (S_1, S_2) of specific frequencies and wavelengths (L) recorded in respective first and second tracks (T_1, T_2) running parallel to each other in their longitudinal direction on the record carrier. The apparatus is provided with means (30) for receiving the information signal, means (32) for converting the information signal into a channel signal, the channel signal comprising subsequent signal blocks (SB_i) of information, each signal block comprising a portion of the information signal, means (34) for writing the channel signal in a third track (T_a) on the record carrier and reading at least one of the first and second tracking signals from said first and second tracks, generating means (38) for generating a control signal from the at least one of the first and second tracking signals read from the record carrier. The apparatus in accordance with the invention is adapted to record the information signal in the record carrier in such a way that the length of a signal block of the channel signal, when recorded in the third track, equals an integer number of the wavelength of said one of the first and the second tracking signals.



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APPARATUS FOR RECORDING AN INFORMATION SIGNAL ON A RECORD CARRIER PROVIDED WITH TRACKING SIGNALS AND A RECORD CARRIER HAVING SUCH INFORMATION SIGNALS

The invention relates to an apparatus for recording an information signal on a record carrier, the record carrier having a first and a second tracking signal of specific frequencies and wavelengths recorded in respective first and second tracks running parallel to each other in their longitudinal direction on the record carrier, the apparatus being provided with

- means for receiving the information signal,
- means for converting the information signal into a channel signal, the channel signal comprising subsequent signal blocks of information, each signal block comprising a portion of the information signal,
- means for writing the channel signal in a third track on the record carrier and reading at least one of the first and second tracking signals from said first and second tracks,
- generating means for generating a control signal from the at least one of the first and second tracking signals read from the record carrier, and to a record carrier obtained with the apparatus.

An apparatus as defined in the opening paragraph is known from USP 4,318,141, document D1 in the list of documents given at the end of this specification. The tracking signals are prerecorded deeply in tracks lying side-by-side to each other on the record carrier. In a later recording step for recording the information signal, the information signal is recorded in a third track which lies exactly half over the first track and half over the second track.

The invention aims at providing an improved recording of the information signal. The recording apparatus in accordance with the invention is characterized in that the apparatus is adapted to record the information signal in the record carrier in such a way in response to said control signal that the length of a signal block of the channel signal, when recorded in the third track equals an integer number of the wavelength of the said at least one of the first and the second tracking signals. More specifically, the record carrier is characterized in that the apparatus is adapted to write a signal block in the third track such

that the start of the signal blocks coincides with a specified position within a wavelength of the said one of the first and second tracking signals, and that the specified position within the wavelength is a zero-crossing of the said one of the first and second tracking signals.

The invention is based on the following recognition. Recording of information signals may mean that an information signal is recorded on a 'virgin' record carrier, which comprises the tracking signals only (the original recording mode). Information signals can however also be recorded on the record carrier in an overwriting mode on an information signal recorded earlier (an insert mode of operation), or can be recorded directly after an information signal that has been recorded earlier (an append mode of operation).

In the insert and append mode, boundaries occur between the remaining old information and the newly recorded information. It is of importance that those boundaries will not lead to any distortion when reading old and new information from the record carrier. In accordance with the invention, the length of the signal blocks recorded in the track are made equal to an integer number of the wavelength of one of the first and second tracking signals.

When both tracking signals have the same frequency and thus wavelength, the signal blocks thus have a fixed length expressed in number of wavelength of the tracking signals. When detecting the length of the wavelength of the tracking signal recorded in a track, this means that, during recording (either in the original recording mode or in the append mode or in the insert mode), the signal blocks of information recorded on the record carrier have always the same length.

Further, when starting the recording of a signal block at the specified location in the wavelength of a tracking signal, and further, when identifying groups of n subsequent wavelengths in the track, where n is equal to the above defined specified integer number, it is possible to record the signal blocks in fixed locations on the record carrier. This enables the recording of a signal block exactly onto a signal block recorded earlier on the record carrier in an insert mode of operation. As a result, signal blocks are recorded substantially completely onto signal blocks earlier recorded, so that no partly overwritten signal blocks of old data will be present. The reading of such data is thus not disturbed when reading old and new data after each other.

The tracking frequencies are different in USP 4,318,141. Preferably, however, the specific frequencies of the first and second tracking signals are substantially the same and the first and second tracking signals differ in phase.

It should be noted that tracking signals having the same frequency but different

phase are known from USP 4,056,832, document D2 in the list of related documents.

It should further be noted that, instead of having the third track recorded half over both the first and the second tracks, the third track may lie between the first and second tracks.

These and other aspects of the invention will be apparent from and further elucidated with reference to the embodiments described hereafter.

Figure 1 shows an embodiment of the record carrier, provided with the tracks having tracking signals recorded in them,

figure 2 shows schematically the record carrier over its total length,

figure 3 shows an example of tracking signals recorded in three neighbouring tracks,

figure 4 shows an embodiment of the recording apparatus for recording the information signal on the record carrier,

figure 5 shows the record carrier with the tracks comprising the tracking signals and the tracks comprising an information signal,

figure 6 shows an embodiment of the tracking signal as recorded in the first or second track and the signal blocks recorded in the third track,

figure 7 shows another embodiment of the tracking signal and the signal blocks recorded in the third track,

figure 8 shows the append mode of operation, and

figure 9 shows the edit mode of operation.

Figure 1 shows an embodiment of a record carrier 2. Only a part of the record carrier is shown. On the record carrier 2, tracks T_1, T_2, ..., T_n are present. The tracks run parallel to each other in their longitudinal direction. A first tracking signal s_1 has been recorded in the track T_1. A second tracking signal s_2 has been recorded in the track T_2. A third tracking signal s_3 has been recorded in the track T_3. An n-th tracking signal s_n has been recorded in the track T_n.

The tracking signals are signals of relatively low frequency, compared to the frequency components of the information signal that will be recorded later on the record carrier. As the frequency of the tracking signals is relatively low, those tracking signals will be (have been) recorded deeply in the record carrier so that a later recording of the information signal will not result in an erasing of the tracking signals. The tracking signals in

two neighbouring tracks may have different frequencies. Preferably, however, the tracking signals have the same frequency and tracking signals in neighbouring tracks have a different phase. More specifically, the phase difference between the tracking signals of adjacent tracks is 180°.

The tracks are shown, lying side-by-side, without a guard band between the tracks. A guard band may however be present between the tracks. The guard band may be so broad that the data tracks comprising the recorded information signal fit in between two neighbouring tracks comprising tracking signals.

Figure 2 shows the record carrier 2 again, now schematically over its total length. The start end of the record carrier 2 is indicated by BOT (beginning-of-tape) and the final end is indicated by EOT (end-of-tape). A lead-in portion and a lead-out portion are shown, being the portions between the start end (BOT) of the record carrier and the line l_1 and the final end (EOT) of the record carrier and the line l_2 respectively. A data area for recording the information signal is available between the lead-in portion and the lead-out portion of the record carrier 2.

Figure 3 shows an example of the tracking signals S_1, S_2 and S_3 as recorded in the data area portion between the lines l_1 and l_2 of the tracks T_1, T_2 and T_3 respectively. Figure 3 shows a tracking signal in the track T_1 in the form of a sinusoid having a specific frequency and wavelength L. The duty cycle of the sinusoid is 1/2, as usual for a normal sinusoid. The duty cycle may however be different from 1/2.

Figure 3 further shows the tracking signal S_2 in the form of a sinusoid having a specific frequency and wavelength, which are in this example equal to the frequency and the wavelength respectively of the tracking signal S_1. The tracking signal S_2 differs from the tracking signal S_1, in that its phase differs by 180° from the phase of the tracking signal S_1. In other words: the tracking signal S_2 differs in polarity from the tracking signal S_1. Figure 3 also shows the tracking signal S_3 in the form of a sinusoid having a specific frequency and wavelength, which are in this example also equal to the frequency and the wavelength respectively of the tracking signal S_1. The tracking signal S_3 differs from the tracking signal S_2, in that its phase differs by 180° from the phase of the tracking signal S_2. In other words: the tracking signal S_3 differs in polarity from the tracking signal S_2, and is thus equal to the tracking signal S_1.

Figure 4 shows an embodiment of an apparatus for recording an information signal on the record carrier 1 of figure 1 and 2, which has the tracking signals shown in figure 3 prerecorded on it. Figure 5 shows how the information signal is recorded on the

record carrier 1. A track T_a is recorded exactly on the boundary line between two adjacent tracks of tracking signals, such as the tracks T_1 and T_2. The apparatus of figure 4 has an input terminal 30 for receiving the information signal. The input terminal is coupled to an input of a formatter unit 32, which converts the information signal into a format suitable for recording on the record carrier 1. An output of the formatter unit 32 is coupled to a write unit 33 comprising a write/read head 34. The formatted information signal is supplied to the write/read head 34 and recorded in the track T_a on the record carrier 1. The head 34 is further adapted to read the tracking signals recorded in the tracks T_1 and T_2. The tracking signals are supplied to a filter unit 36, which has a bandpass filter characteristic with a centre frequency equal to the specific frequency of the tracking signals. As the frequency of the tracking signals is low relative to the frequency content of the formatted information signal, it is possible to read the tracking signals from the tracks T_1 and T_2, while writing the formatted information signal into the track T_a.

When the head 34 is located exactly half way on the tracks T_1 and T_2, tracking signals of equal amplitude but opposite phase are read from the tracks T_1 and T_2. As a result, a substantially zero amplitude signal is supplied by the filter 36 to the generator unit 38. The generator unit 38 supplies a control signal to an actuator unit 40 in response to the signal applied by the filter 36. The actuator unit 40 may comprise a positioning unit (not shown) to position the head 34 in a direction transverse to the tracks. In the situation described above, where the head is positioned exactly half way on the two tracks T_1 and T_2, no repositioning of the head 34 is required. If the head is positioned for a larger part on the track T_1, the tracking signal read from the track T_1 will have a larger amplitude than the signal read from the track T_2. This means that a non-zero amplitude signal will be supplied by the filter 36 to the generator unit 38. The generator unit 38 now generates a control signal for the actuator unit 40, such that the head 34 is moved in a specific direction towards a position leading to an decrease in amplitude of the signal applied by the filter 36 to the generator 38.

If the head 34 is positioned for a larger part on the track T_2, the tracking signal read from the track T_2 will have a larger amplitude than the signal read from the track T_1. This means that, again, a non-zero amplitude signal will be supplied by the filter 36 to the generator unit 38. The generator unit 38 now generates a control signal for the actuator unit 40, such that the head 34 is moved in the other direction towards a position leading to an decrease in amplitude of the signal applied by the filter 36 to the generator 38.

The formatter unit 32 converts the information signal into signal blocks

comprising portions of the information signal. Generally, the formatter unit further comprises a channel encoder, well known in the art, for channel encoding the information signal. Subsequent signal blocks of information are thus supplied to the head 34 and recorded in the track T_a. It should be noted here that the signal blocks may commence with half an interframe gap and may terminate with half an interframe gap, so that, when recorded after each other interframe gaps are present in the tracks separating the signal portions comprised in subsequent signal blocks. Or, the signal blocks commence or end with a complete interframe gap. For a description of interframe gaps, reference is made to USP 5,267,098, document D3 in the list of related documents. The length of the interframe gaps on the record carrier may be equal to an integer number of wavelength of the first tracking signal, or may be smaller or larger than said wavelength, whilst being unequal to an integer number of said wavelength.

Figure 6 shows the signal blocks as recorded in the track T_a. More specifically, signal blocks ..., SB_{i-1}, SB_i, SB_{i+1}, SB_{i+2}, ... are recorded in the track T_a. Further, figure 6 shows the tracking signal as recorded in one of the tracks T_1 and T_2. As can be seen, in the present example, the length of the signal blocks in the track T_a equals 4 times the wavelength of the tracking signal recorded in the track T_1 or T_2. More specifically, the start of a signal block coincides with a zero crossing of the tracking signal: that is: coincides with the positive going zero crossing in the tracking signal.

Detection of a positive zero crossing results in an exact location of the signal blocks in the length direction of the track T_a, when recording the signal blocks in said track.

A detector unit 42 is present, see figure 4, for detecting the zero crossings in a tracking signal. In the present example, the detector unit 42 comprises any detector (not shown) to detect the zero crossings in one of the tracks T_1 or T_2. As an example, an additional read head (not shown) may be present to read the tracking signal from the track T_1 only. The detector 42 generates a control signal in response to a detection of a positive going zero crossing, which control signal is supplied to the formatter unit 32. The formatter unit 32 generates the signal blocks and supplies the signal blocks to its output in response to the control signal so that the signal blocks are recorded in the track T_a, such that they are positioned in relation to the tracking signal in the track T_1 or T_2 as shown in figure 6.

In a preferred embodiment, the tracking signals have a slightly different shape. This is shown in figure 7, which shows the tracking signal S_1', recorded in the track T_1. As can be seen in the figure 7, one sinusoid in a group of four sinusoids have a shape which is slightly modified compared to the shape of the other sinusoids. More specifically, the said

modified sinusoids, indicated by the reference numerals 70 to 73, have a duty cycle which is different from the duty cycle of the other unmodified sinusoids. The duty cycle of the unmodified sinusoids is 1/2, whereas the duty cycle of the modified sinusoids 70 to 73 are eg. equal to 1/4, or 3/4. In the present embodiment, the positive going zero crossing of the modified sinusoids 70 to 73 indicate the start positions of the signal blocks SB_{i-1} to SB_{i+2}, as can clearly be seen in figure 7.

The detector 42 is now capable of detecting the modified sinusoids 70 to 73, and more specifically, the positive going zero crossings of those sinusoids, so that it can generate a control signal in response thereto. The formatter unit 32 is capable of supplying the signal blocks to its output, in response to the control signal, such that the signal blocks are recorded in the track T_a in the way shown in figure 7.

Editing of a record carrier previously recorded with an information signal, can now be realized by detecting the modified sinusoids 70 to 73 and recording the signal blocks in the tracks recorded earlier such that the start of a signal block in a track coincides with a positive going zero crossing of one of the modified sinusoids 70 to 73, and that the end of said signal block coincides with the positive going zero crossing of the next modified sinusoid. In this way, a signal block newly recorded can be recorded exactly onto a signal block recorded earlier, so that in an insert mode of operation, there is a smooth going over between old and new data recorded in the track.

The modification of the one out of n (=4) sinusoids is shown not only as a change of the duty cycle, but resides also in the fact that the positive signal wave, which as modified is shorter than in the unmodified situation, has a higher amplitude than unmodified, and that the negative signal wave, which as modified is longer than in the unmodified situation, has a lower amplitude than unmodified. In this way, the DC component in the tracking signal does not change.

When recording the information signal in the track T_a, the record carrier is transported by the motor transport unit 44. The detector unit 42 not only controls the formatter so as to supply the signal blocks at the right moment to its output, but also controls the motor transport unit 44, so that the record carrier is transported at the required velocity so that the signal blocks as recorded exactly fit between two modified sinusoids, as explained above.

After having recorded the information signal in the track T_a, and having reached the end of the track T_a, the head 34 is positioned on the boundary line between the tracks T_2 and T_3, so that a track T_b comprising the recorded information signal, see figure 5,

can be recorded on the record carrier. The record carrier is now transported in opposite direction compared to the direction of transport when recording the information signal in the track T_a.

Upon reaching the other end of the record carrier, the motor transport unit 44 will either stop the transport of the record carrier, or reverse the transport direction of the record carrier 1. In the latter case, the head 34 will be positioned on another track. As an example, after having recorded the information signal in the track T_b, the head 34 is positioned on the boundary line between the tracks T_3 and T_4, so that a track T_c comprising the recorded information signal, see figure 7, can be recorded on the record carrier.

Figure 8 shows the append mode of operation. In (a) of figure 8, the track T_a is shown having signal blocks of an information signal recorded in it. The last signal block recorded is the signal block SB_i. In the append mode of operation, signal blocks need to be recorded directly after the last signal block recorded earlier. The recording apparatus can establish where the last signal block SB_i has been recorded and upon detection of the modified sinusoid 72, a control signal shown in (b) of figure 8 is supplied to the formatter unit 32, so that the first signal block SB_{i+1} is recorded directly after the signal block SB_i in the track T_a, see (c) of figure 8.

Figure 9 shows the edit mode of operation. In (a) of figure 9, the track T_a is shown having signal blocks of an information signal recorded in it. In the edit mode of operation, signal blocks need to be recorded directly onto signal blocks recorded earlier. More specifically, signal blocks of information need to be recorded on the record carrier, starting with overwriting the signal block SB_i. The recording apparatus can establish where the previous signal block SB_{i-1} has been recorded and upon detection of the modified sinusoid 71, a control signal shown in (b) of figure 8 is supplied to the formatter unit 32, so that the first signal block SB_i' is recorded directly onto the signal block SB_i in the track T_a. Subsequent signal blocks SB_{i+1}' to SB_{j-1}' are recorded exactly onto the signal blocks SB_{i+1} to SB_{j-1} recorded earlier. As can be seen in (c) of figure 9, the boundaries between the old data and the new data lie exactly on the boundaries originally present between the signal blocks.

The invention thus relates to the recording of an information signal in a track on a record carrier. Signal blocks comprising portions of the information signal are recorded in a track in such a way that the length of a signal block equals an integer number of the wavelength of the tracking signal recorded earlier in a track.

Whilst the present invention has been described with respect 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 in the appended claims. As an example, the record carrier may be one of the longitudinal type, or from the disk type. The tracking signals need not necessarily be sinusoids, but may has a different shape, as long as they are periodic with a specific wavelength.

Related documents

(D1) USP 4,318,141

(D2) USP 4,056,832 (PHN 7630)

(D3) USP 5,267,098 (PHN 13.281)

CLAIMS

1. Apparatus for recording an information signal on a record carrier, the record carrier having a first and a second tracking signal of specific frequencies and wavelengths recorded in respective first and second tracks running parallel to each other in their longitudinal direction on the record carrier, the apparatus being provided with

- means for receiving the information signal,
- means for converting the information signal into a channel signal, the channel signal comprising subsequent signal blocks of information, each signal block comprising a portion of the information signal,
- means for writing the channel signal in a third track on the record carrier and reading at least one of the first and second tracking signals from said first and second tracks,
- generating means for generating a control signal from the at least one of the first and second tracking signals read from the record carrier, characterized in that the apparatus is adapted to record the information signal in the record carrier in such a way in response to said control signal that the length of a signal block of the channel signal, when recorded in the third track equals an integer number of the wavelength of the said at least one of the first and the second tracking signals.

2. Apparatus as claimed in claim 1, characterized in that the apparatus is adapted to write a signal block in the third track such that the start of the signal blocks coincides with a specified position within a wavelength of the said one of the first and second tracking signals.

3. Apparatus as claimed in claim 2, characterized in that, the specified position within the wavelength is a zero-crossing of the said one of the first and second tracking signals.

4. Apparatus as claimed in claim 1, 2 or 3, characterized in that the generating means are adapted to generate said control signal which has a relationship with the wavelength of the said one of the first and the second tracking signals, the apparatus being adapted to record the information signal in the record carrier in response to the control signal, such that the length of a signal block equals said integer number of the wavelength of said one of the first and the second tracking signals.

5. Apparatus as claimed in claim 2 or 3, characterized in that the generating means are adapted to generate said control signal which has a relationship with the wavelength of the said one of the first and the second tracking signals and with the specified position in said wavelength, the apparatus being adapted to record the information signal in the record carrier in response to the control signal, such that the length of a signal block equals said integer number of the wavelength of said one of the first and the second tracking signals and that the start of the signal block coincides with said specified position.

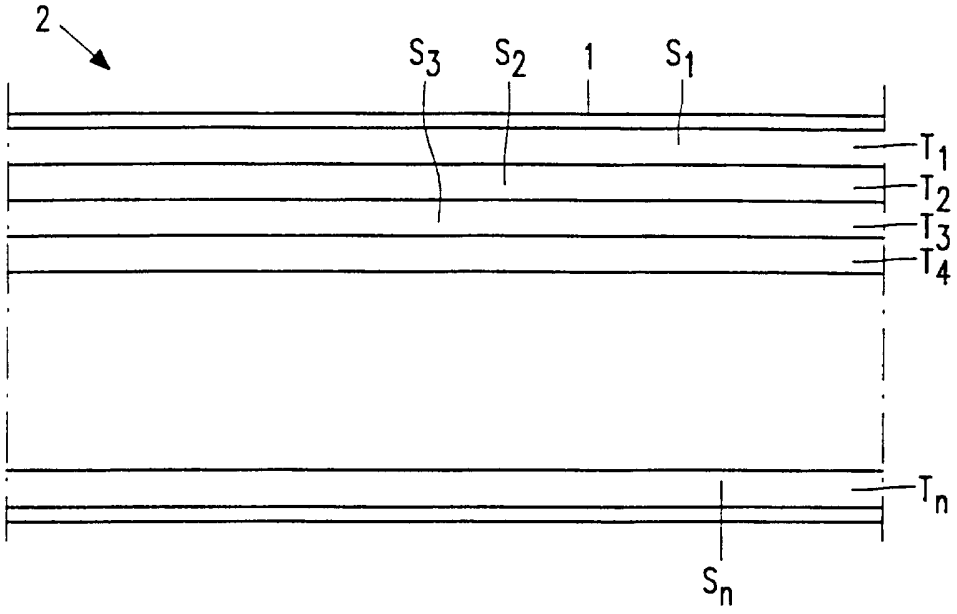
6. Apparatus as claimed in anyone of the preceding claims, for recording an information signal on a record carrier on which in an earlier recording step a previous information signal has been recorded in said third track, characterized in that the apparatus is adapted to write a signal block in the third track such that the signal block newly recorded in said third track is recorded exactly onto a signal block previously recorded in said third track.

7. Apparatus as claimed in anyone of the preceding claims, characterized in that the apparatus comprises detector means for detecting modified portions in the at least one of the first and second tracking signals recorded in the first or second track respectively.

8. Record carrier having a first and a second tracking signal of specific frequencies and wavelengths recorded in respective first and second tracks running parallel to each other in their longitudinal direction on the record carrier, an information signal being recorded in a third track running parallel to the first and second tracks on the record carrier, characterized in that signal blocks comprising portions of the information signal are recorded in said third track, such that the length of a signal block, when recorded in the third track equals an integer number of the wavelength of one of the first and the second tracking signals.

9. Record carrier as claimed in claim 8, characterized in that the signal blocks are recorded in the third track, such that the start of the signal blocks coincides with a specified position within a wavelength of the said one of the first and second tracking signals.

10. Record carrier as claimed in claim 9, characterized in that the specified position within the wavelength is a zero-crossing of the said one of the first and second tracking signals.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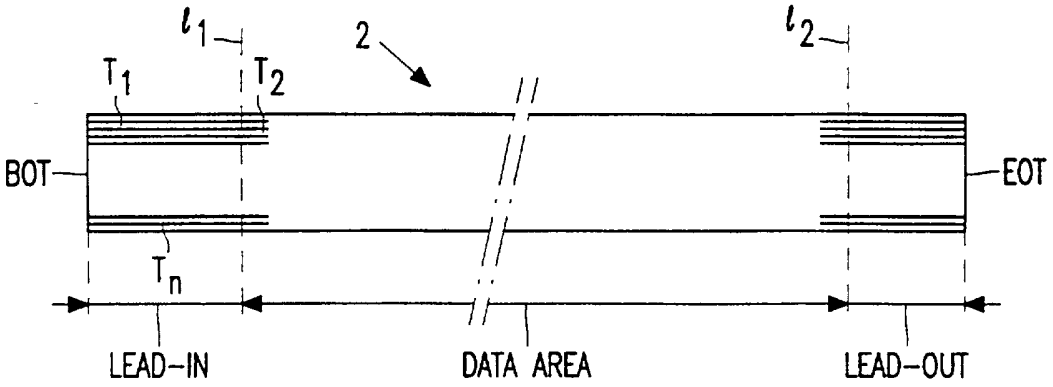
S3
S2
1
S1
T1
T2
T3
T4
Tn
Sn

FIG. 1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DATA AREA
LEAD-OUT

FIG. 2

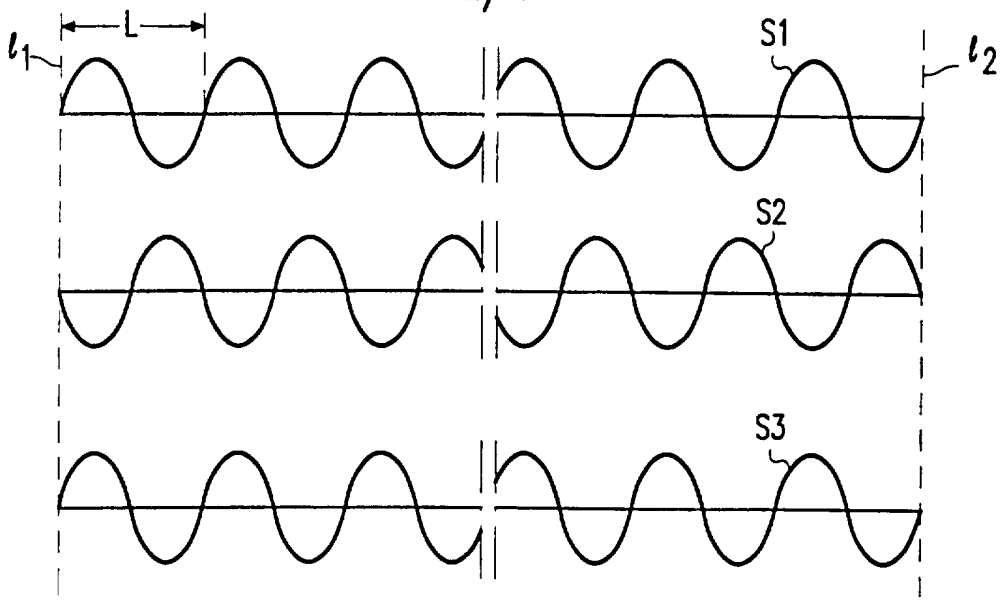

FIG. 3

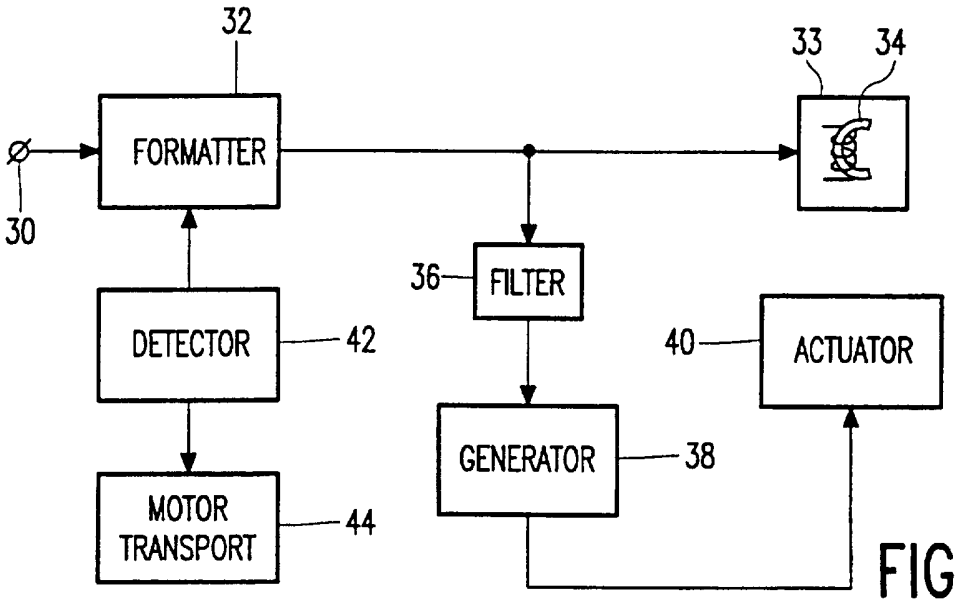

FIG. 4

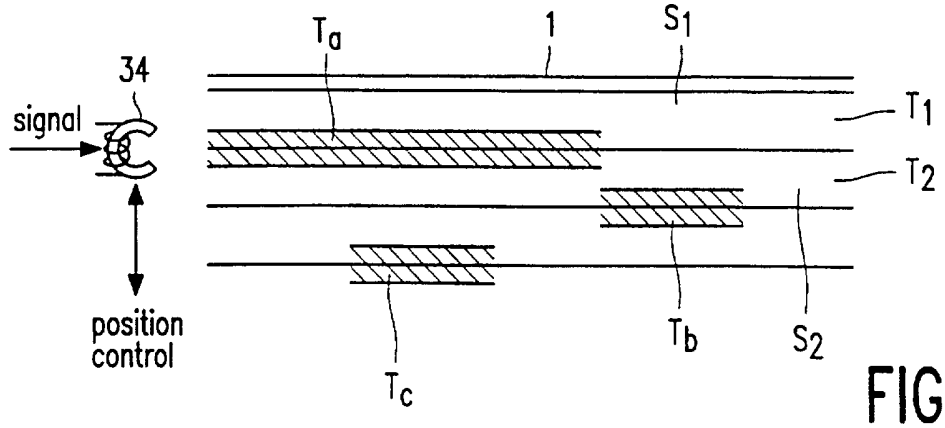

FIG. 5

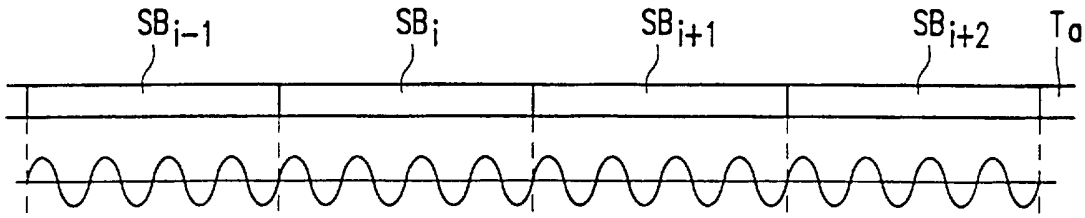

FIG. 6

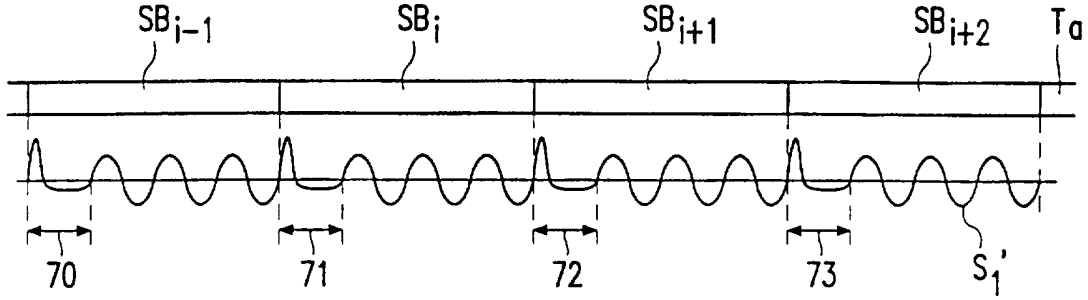

FIG. 7

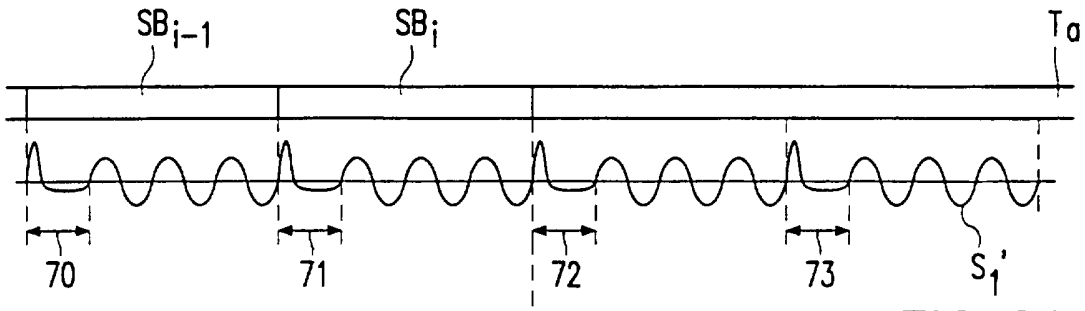

FIG. 8A

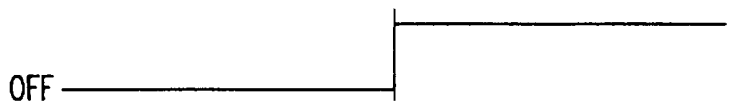

FIG. 8C

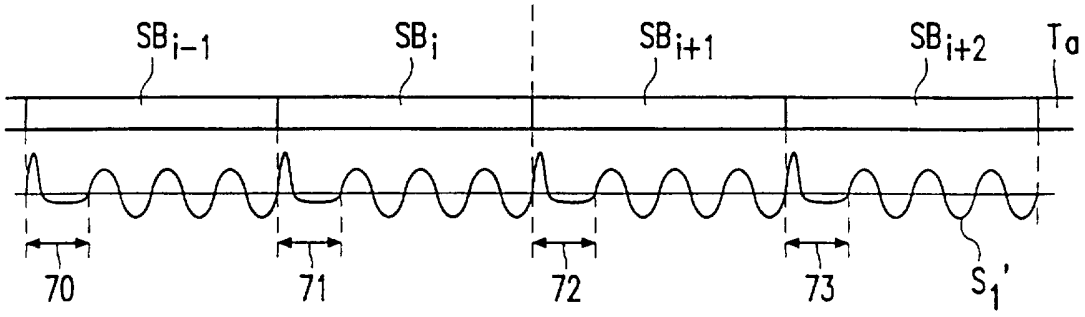

FIG. 8B

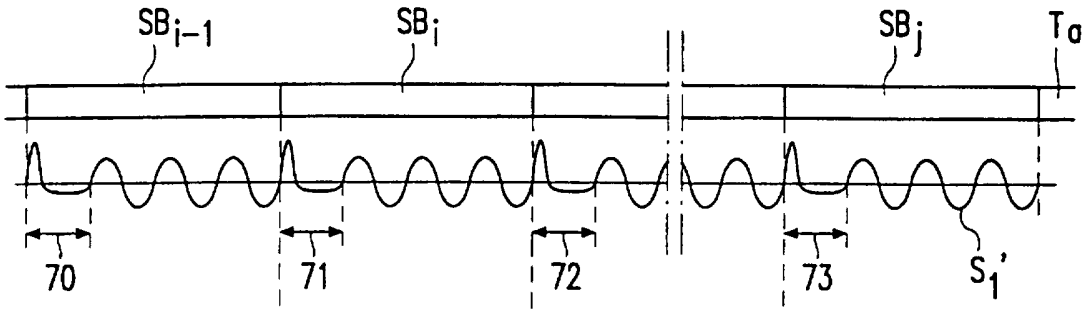

FIG. 9A

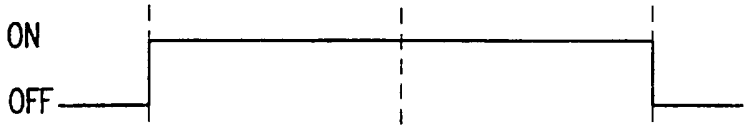

FIG. 9B

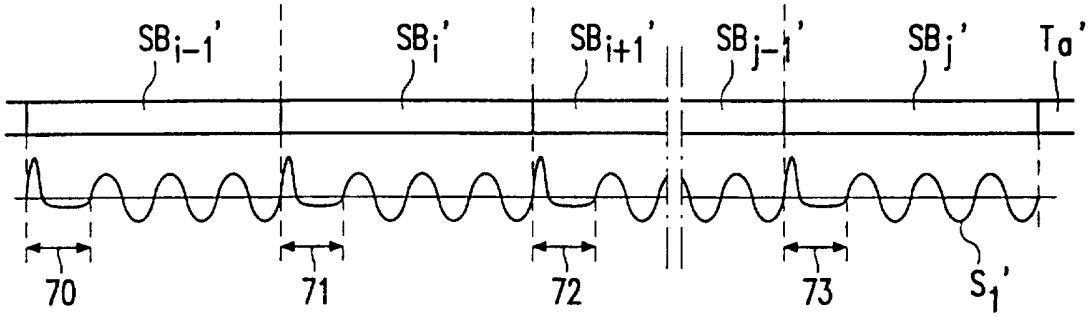

FIG. 9C

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB 96/01200

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: G11B 20/12, G11B 5/584
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: G11B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CLAIMS, INSPEC, WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4318141 A (HAYNES), 2 March 1982 (02.03.82), abstract, See the whole document. Cited in the application. --	1
A	US 4056832 A (DE BOER ET AL), 1 November 1977 (01.11.77), See the whole document. Cited in the application. --	1

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 April 1997	21 -04- 1997
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Bo Gustavsson Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

04/03/97

International application No.
PCT/IB 96/01200

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