This Sheet Has Been Replaced

97179DE*JR*240792

970716-0 3765

1 to page 7
8 to page 9
½ to page 2½
16 to page

Method of recording and reproducing data.

The invention relates to a method of recording items of data on a moving recording medium and for the lossless reproduction of the data from the recording medium, wherein a compression of the data using different degrees of compression is undertaken at the recording end and a data expansion process is effected at the reproduction end.

Data compression and data expansion are frequently used in the broadcasting field in order to increase the capacity of the transmission channels for example, or to increase the storage capacity of the recording media. For example, the items of data on the so-called mini-disc, a development of the compact disc, are recorded in compressed form.

During the data compression process, the items of data which are to be stored or transmitted are compressed by means of a suitable algorithm. Expressed in other words, this means that the quantity of data which is to be stored or transmitted is reduced in order to increase the transmission capacity of the transmission channel or the storage capacity of the recording medium.

At the reproduction or receiving end, an expander generates the original items of data from the reduced quantity of data by means of the inverse algorithm.

As already explained, the aim of the data compression is to reduce the quantity of data as much as possible without producing any loss of data in order to be able to use the transmission capacity of a transmission channel or the storage capacity of a recording medium to better effect.

When making a data recording, it is known to read the items of data which are to be recorded into a buffer store before the recording process. It is likewise known, when reproducing the

This Sheet Has Been Replaced



gure 2 the first embodiment in the case of the reproduction f items of data from a disc shaped recording medium

Figure 3 a second embodiment of the invention in the case of the recording of items of data on a disc shaped recording medium

Figure 4 the second embodiment in the case of the reproduction of items of data from a disc shaped recording medium.

The method in accordance with the invention in the case of the recording of items of data will now be explained with the aid of the first embodiment shown in Figure 1.

A data recording device A, which serves as a source of digital items of data, delivers the items of data which are to be recorded in digital form in a predetermined pattern of time slots to a compressor K which compresses the items of data in accordance with a given algorithm. The compressed items of data are recorded on a recording medium. A magneto-optical disc CD, which is rotated by a motor M, is shown in Figure 1 as an example for the recording medium. The items of data are recorded on the disc CD by means of a light beam L which a recording and reproduction head AW produces, this generally being called a pick-up in the case of CD players. A control output of the compressor K is connected to the input of a regulator R1 which controls the rotational speed of the motor M.

In the case of a CD player, the items of data are recorded and reproduced with a constant track speed. Consequently, one speaks of a Constant-Linear-Velocity-System - abbreviated to CLV-System - in contrast to a Constant-Angular-Velocity-System, abbreviated to CAV-System, in which the items of data are recorded and reproduced at a constant angular speed. Now, as already mentioned, data losses can occur when the buffer store overflows.

This Sheet Has Been Replaced



ention now proposes that the speed of the recording CD be controlled in dependence on the degree of pression. In the case of a high degree of compression, the eed of the disc is reduced both during the recording as well as during the reproduction of the items of data, whilst it is increased in the case of a lower degree of compression. Due to the measure, of deviating from the normal speed by reducing the speed of the recording medium in the case of a high degree of compression, the storage capacity of the recording medium is considerably increased.

The regulator R1 controls the rotational speed of the disc CD in dependence on the momentary degree of compression of the compressor K. It is sensible for example, to control the rotational speed of the disc CD to be inversely proportional to the degree of compression. By virtue of the method in accordance with the invention, it is not absolutely necessary to use a buffer store in order to avoid data losses.

In the second embodiment of the invention, which is shown in Figures 3 and 4, a buffer store and also a second and a third regulator are provided in addition to the first regulator.

During the recording of the items of data, which is illustrated in Figure 3, the data recording device A delivers digital items of data to a buffer store Z1 which passes them on to the compressor K for the compression process following the process of buffer storage. The compressed items of data are recorded on the disc CD by means of the light beam L produced by the recording and reproduction head AW. A control output of the compressor K is connected to the input of a first regulator R1 which, together with a second regulator R2 and a third regulator R3, controls the rotational speed of the motor M that is rotating the disc CD.

The second regulator R2 is connected to the first control output of the buffer store Z1. The first regulator R1 controls the

This Sheet Has Been Replaced



rotational speed of the disc CD in dependence on the degree of compression produced by the compressor K as in the first embodiment. The superimposed, second control loop including the regulator R2 controls the rotational speed of the disc CD in dependence on the level to which the buffer store Z1 is filled. If the buffer store Z1 is full or virtually full, then the rotational speed of the disc CD is increased in order to prevent any overflow of the buffer store Z1; if, on the other hand, the buffer store is empty or almost empty, then the rotational speed of the disc CD is lowered in order to fill up the buffer store with items of data.

A third control variable for controlling the rotational speed of the disc CD is produced from the difference between the inflow of data DZ and the outflow of data DA at the buffer store Z1 by means of the third regulator R3. If the difference DZ - DA is positive, then the rotational speed of the disc CD is increased in order to prevent any overflow of the buffer store Z1, while in the case of a negative difference DZ - DA, the rotational speed is lowered in order to refill the buffer store with items of data.

Now it is possible to provide only one of the three regulators R1, R2 and R3, or only 2, or all 3 regulators for controlling the rotational speed of the disc CD. Every combination - 7 altogether - is possible.

The second embodiment for the case of the reproduction of the data is depicted in Figure 4.

The items of data are read from the disc CD by means of the light beam L from the recording and reproduction head AW and passed to the expander E which guides them on to a buffer store Z2. From the buffer store Z2, the items of data reach a data reproduction device W e.g. a loudspeaker.

regulator R1, which is connected to the control output of the expander E, controls the rotational speed of the disc CD in dependence on the degree of compression. For a high degree of compression, the rotational speed is reduced from the normal speed of rotation, but, by contrast, is again raised to the normal speed of rotation when it is low.

The second regulator R2 controls the rotational speed of the disc CD in dependence on the level to which the buffer store Z2 is filled. When the level is high, it causes a reduction of the rotational speed in order to prevent an overflow of the buffer store Z2 whilst it increases the rotational speed in the case of a low level in order to avoid the buffer store Z2 from running empty.

The third regulator R3 evaluates the difference DZ - DA between the inflow of data DZ and the outflow of data DA. If there is more data flowing into the buffer store Z2 than there is flowing onto the reproduction device W, then DZ - DA is positive and the rotational speed is reduced so that the buffer store Z2 does not overflow. By contrast, if the buffer store Z2 is receiving less data from the recording and reproduction head AW than it is emitting to the data reproduction device W, then the regulator R3 increases the rotational speed in order to once more fill up the buffer store Z2 with items of data. It is also possible, in the case of the reproduction of data, to employ only one, two or all three of the regulators. Every conceivable combination is possible.

The invention is not however limited in any way to disc-shaped recording media. In addition to CD players, magneto-optical recording and reproduction equipment which work with discs as the storage medium, tape equipments can also be taken into consideration for the invention. A drum is also suitable as a recording medium for example.

This Sheet Has Been Replaced



Method of recording items of data on a recording medium (CD) and for lossless reproduction from the recording medium (CD) wherein a compression of the items of data using different degrees of compression is undertaken at the recording end and an expansion process is effected at the reproduction end, characterised in that, the speed of the recording medium (CD) is controlled during the recording of the data and during the reproduction of the data in dependence on the degree of compression.

2. Method in accordance with Claim 1, characterised in that, the speed of the recording medium (CD) is selected to be smaller in the case of a high degree of compression of the items of data than for a lower degree of compression.

3. Method in accordance with Claim 1 or 2, characterised in that, the items of data that are to be recorded are stored in a first buffer store (Z1) before the recording process and that the items of data read from the recording medium (CD) are stored in a second buffer store (Z2) prior to the reproduction process.

4. Method in accordance with Claim 3, characterised in that, the speed of the recording medium (CD) is controlled in dependence on the level to which the two buffer stores (Z1, Z2) are filled.

5. Method in accordance with Claim 4, characterised in that, during the recording of the data, the speed of the recording medium (CD) is increased when the level to which the first buffer store (Z1) is filled is high whilst it is decreased when the level to which it is filled is low, that during the reproduction of the data, the speed of the recording medium (CD) is decreased when the level to which the second buffer store (Z2) is filled is high whilst it is increased when the level to which it is filled is lower.

This Sheet Has Been Replaced

. Method in accordance with Claim 3, 4 or 5, characterised in that, the speed of the recording medium (CD) is controlled in dependence on the difference DZ - DA between the inflow of data DZ and the outflow of data DA.

7. Method in accordance with Claim 3, 4, 5 or 6, characterised in that, during the recording of the data, the speed of the recording medium (CD) is increased when the inflow of data DZ at the first buffer store (Z1) is greater than the outflow of data DA, whilst the speed of the recording medium (CD) is lowered when the inflow of data DZ at the first buffer store (Z1) is lower than the outflow of data DA, that during the reproduction of the data, the speed of the recording medium (CD) is increased when the inflow of data DZ at the second buffer store (Z2) is greater than the outflow of data DA, whilst the rotational speed is decreased when the inflow of data DZ to the second buffer store (Z2) is smaller than the outflow of data DA.

This Sheet Has Been Replaced

Abstract

1. Method of recording and reproducing compressed items of data.

2.1 In order to be able to make more complete use of the storage capacity of a moving recording medium (CD), the items of data are compressed by means of a compressor (K) before the recording process. They are expanded by an expander (E) before the reproduction process in order to recover the original data signal without loss insofar as possible.

2.3 In order to increase the storage capacity of the recording medium (CD) still more, the speed of the recording medium (CD) is controlled in dependence on the degree of compression. A lower speed of the recording medium (CD) is selected in the case of a high degree of compression than for a lower degree of compression.

3. Figure 1.

This Sheet Has Been Replaced



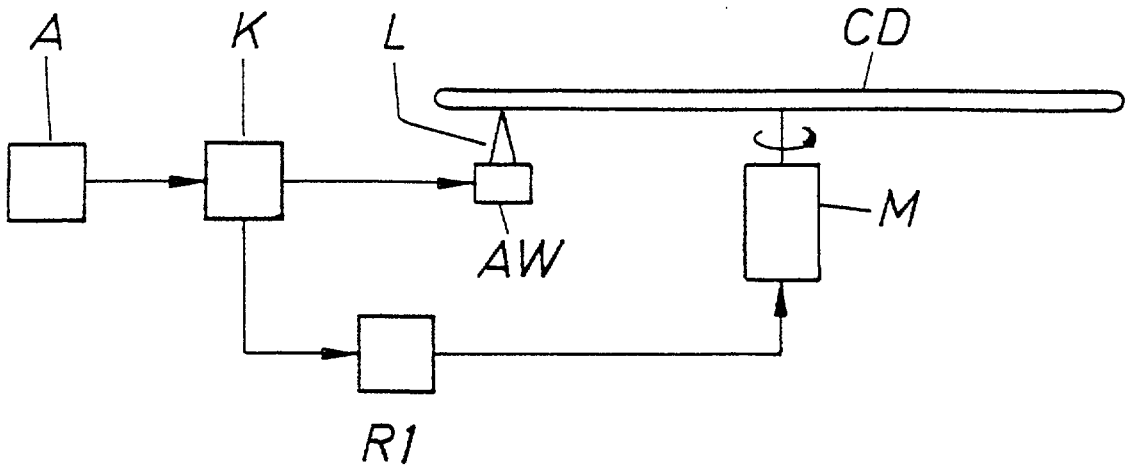


FIG.1

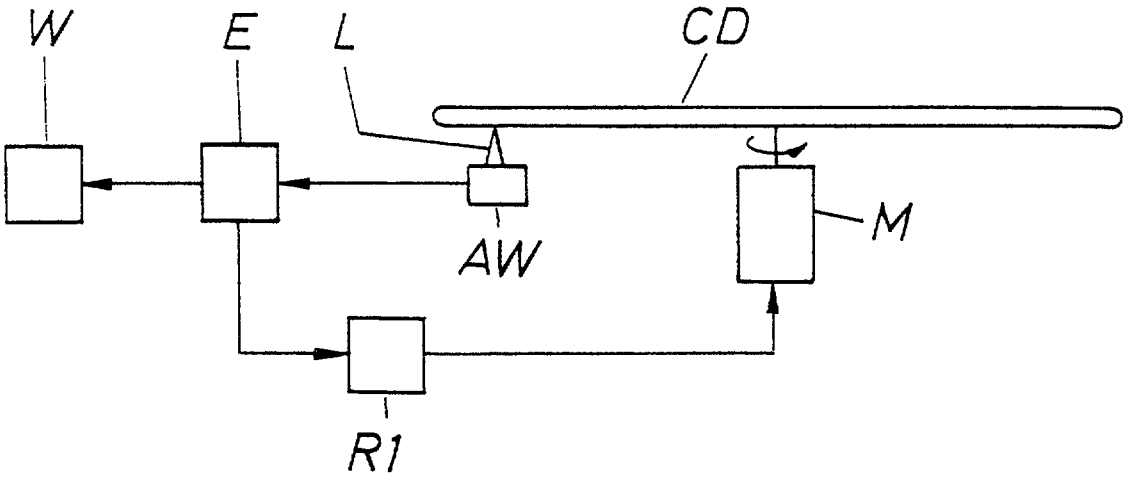


FIG.2

This Sheet Has Been Replaced

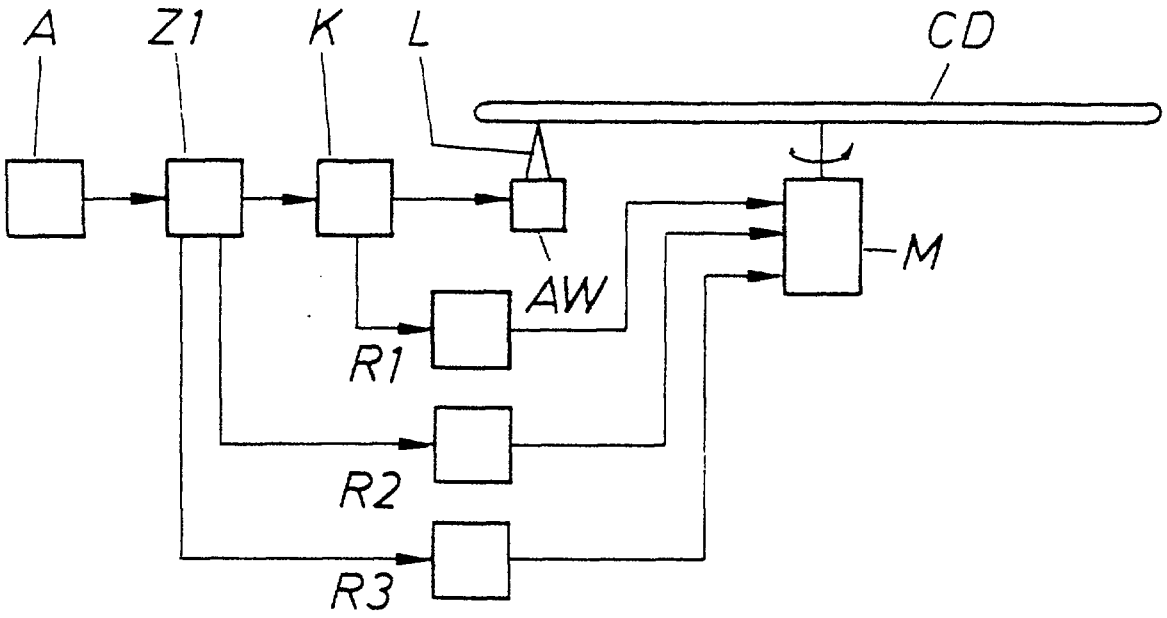


FIG. 3

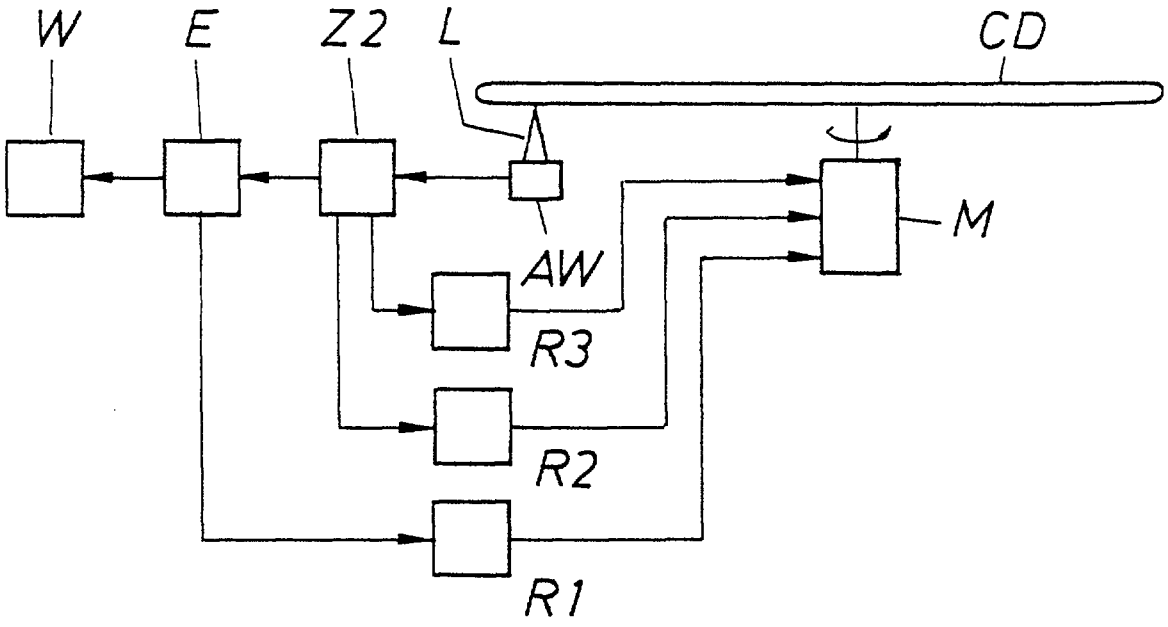


FIG. 4

This Sheet Has Been Replaced

25 OCT 1994

data, to initially read the items of data into a buffer store before the reproduction process. If, however, the buffer store should overflow, there is a data loss both during the recording process and when reproducing the data. In order to keep these losses of data very small, the most significant bits are generated first by means of the algorithm and then stored during the recording of the items of data so that the less significant bits, which do not contribute very much to the regeneration of the original data signal, are stored last, or even get lost, if there is an overflow of the buffer store. In this latter case, a lossfree recording of the items of data is no longer possible.

Similarly, when reading out the items of data, the most significant bits are read out first and those bits which do not provide any essential contribution to the regeneration of the original data signal are read out last. Here too, there are data losses if there is an overflow of the buffer store because the less significant bits are lost due to the overflow.

In order to avoid data losses due to overflow of the buffer store, buffer stores having a sufficiently large storage capacity are required.

Now the object of the invention is to organise a method for the lossfree recording and reproduction of compressed items of data such that the storage capacity of the recording medium is used up more effectively than was the case in the state of the art.

The invention achieves this object in that the speed of the recording medium is controlled in dependence on the degree of compression both during the data recording process as well as during the process of reproducing the data.

This Sheet Has Been Replaced

There is shown in

Figure 1 a first embodiment of the invention in the case of the recording of items of data on a disc shaped recording medium

REPLACEMENT SHEET

The type of data is quite arbitrary. It may for example be the audio data in the case of a CD, the audio and picture data from a video disc player or the items of data in an electronic data processing arrangement. The decisive thing is merely that one is concerned with compressed items of data which were or are being stored on a recording medium which is moving such as e.g. a rotating disc or a linearly moving tape.

This Sheet Has Been Replaced



REPLACEMENT SHEET
25 OCT 1996

960716.0 EP05

Method of recording and reproducing data.

7/3/97

The invention relates to a method of recording items of data on a moving recording medium and for the lossless reproduction of the data from the recording medium, wherein a compression of the data using different degrees of compression is undertaken at the recording end and a data expansion process is effected at the reproduction end.

Data compression and data expansion are frequently used in the broadcasting field in order to increase the capacity of the transmission channels for example, or to increase the storage capacity of the recording media. For example, the items of data on the so-called mini-disc, a development of the compact disc, are recorded in compressed form.

During the data compression process, the items of data which are to be stored or transmitted are compressed by means of a suitable algorithm. Expressed in other words, this means that the quantity of data which is to be stored or transmitted is reduced in order to increase the transmission capacity of the transmission channel or the storage capacity of the recording medium.

At the reproduction or receiving end, an expander generates the original items of data from the reduced quantity of data by means of the inverse algorithm.

07 MAR 1997

As already explained, the aim of the data compression is to reduce the quantity of data as much as possible without producing any loss of data in order to be able to use the transmission capacity of a transmission channel or the storage capacity of a recording medium to better effect.

When making a data recording, it is known to read the items of data which are to be recorded into a buffer store before the recording process. It is likewise known, when reproducing the

This Sheet Has Been Replaced

This Sheet Has Been Replaced



REPLACEMENT SHEET
07 MAR 1997

data, to initially read the items of data into a buffer store before the reproduction process. If, however, the buffer store should overflow, there is a data loss both during the recording process and when reproducing the data. In order to keep these losses of data very small, the most significant bits are generated first by means of the algorithm and then stored during the recording of the items of data so that the less significant bits, which do not contribute very much to the regeneration of the original data signal, are stored last, or even get lost, if there is an overflow of the buffer store. In this latter case, a lossfree recording of the items of data is no longer possible.

Similarly, when reading out the items of data, the most significant bits are read out first and those bits which do not provide any essential contribution to the regeneration of the original data signal are read out last. Here too, there are data losses if there is an overflow of the buffer store because the less significant bits are lost due to the overflow.

In order to avoid data losses due to overflow of the buffer store, buffer stores having a sufficiently large storage capacity are required.

Now the object of the invention is to organise a method for the lossfree recording and reproduction of compressed items of data such that the storage capacity of the recording medium is used up more effectively than was the case in the state of the art.

The invention achieves this object in that the speed of the recording medium is controlled in dependence on the degree of compression both during the data recording process as well as during the process of reproducing the data.

There is shown in

Figure 1 a first embodiment of the invention in the case of the recording of items of data on a disc shaped recording medium

This Sheet Has Been Replaced



REPLACEMENT SHEET
07 MAR 1997

Figure 2 the first embodiment in the case of the reproduction of items of data from a disc shaped recording medium

Figure 3 a second embodiment of the invention in the case of the recording of items of data on a disc shaped recording medium

Figure 4 the second embodiment in the case of the reproduction of items of data from a disc shaped recording medium.

The method in accordance with the invention in the case of the recording of items of data will now be explained with the aid of the first embodiment shown in Figure 1.

A data recording device A, which serves as a source of digital items of data, delivers the items of data which are to be recorded in digital form in a predetermined pattern of time slots to a compressor K which compresses the items of data in accordance with a given algorithm. The compressed items of data are recorded on a recording medium. A magneto-optical disc CD, which is rotated by a motor M, is shown in Figure 1 as an example for the recording medium. The items of data are recorded on the disc CD by means of a light beam L which a recording and reproduction head AW produces, this generally being called a pick-up in the case of CD players. A control output of the compressor K is connected to the input of a regulator R1 which controls the rotational speed of the motor M.

In the case of a CD player, the items of data are recorded and reproduced with a constant track speed. Consequently, one speaks of a Constant-Linear-Velocity-System - abbreviated to CLV-System - in contrast to a Constant-Angular-Velocity-System, abbreviated to CAV-System, in which the items of data are recorded and reproduced at a constant angular speed. Now, as already mentioned, data losses can occur when the buffer store overflows.

This Sheet Has Been Replaced

07 MAR 1997

The invention now proposes that the speed of the recording medium CD be controlled in dependence on the degree of compression. In the case of a high degree of compression, the speed of the disc is reduced both during the recording as well as during the reproduction of the items of data, whilst it is increased in the case of a lower degree of compression. Due to the measure, of deviating from the normal speed by reducing the speed of the recording medium in the case of a high degree of compression, the storage capacity of the recording medium is considerably increased.

The regulator R1 controls the rotational speed of the disc CD in dependence on the momentary degree of compression of the compressor K. It is sensible for example, to control the rotational speed of the disc CD to be inversely proportional to the degree of compression. By virtue of the method in accordance with the invention, it is not absolutely necessary to use a buffer store in order to avoid data losses.

In the second embodiment of the invention, which is shown in Figures 3 and 4, a buffer store and also a second and a third regulator are provided in addition to the first regulator.

During the recording of the items of data, which is illustrated in Figure 3, the data recording device A delivers digital items of data to a buffer store Z1 which passes them on to the compressor K for the compression process following the process of buffer storage. The compressed items of data are recorded on the disc CD by means of the light beam L produced by the recording and reproduction head AW. A control output of the compressor K is connected to the input of a first regulator R1 which, together with a second regulator R2 and a third regulator R3, controls the rotational speed of the motor M that is rotating the disc CD.

The second regulator R2 is connected to the first control output of the buffer store Z1. The first regulator R1 controls the

This Sheet Has Been Replaced



REPLACEMENT SHEET
07 MAR 1997

rotational speed of the disc CD in dependence on the degree of compression produced by the compressor K as in the first embodiment. The superimposed, second control loop including the regulator R2 controls the rotational speed of the disc CD in dependence on the level to which the buffer store Z1 is filled. If the buffer store Z1 is full or virtually full, then the rotational speed of the disc CD is increased in order to prevent any overflow of the buffer store Z1; if, on the other hand, the buffer store is empty or almost empty, then the rotational speed of the disc CD is lowered in order to fill up the buffer store with items of data.

A third control variable for controlling the rotational speed of the disc CD is produced from the difference between the inflow of data DZ and the outflow of data DA at the buffer store Z1 by means of the third regulator R3. If the difference DZ - DA is positive, then the rotational speed of the disc CD is increased in order to prevent any overflow of the buffer store Z1, while in the case of a negative difference DZ - DA, the rotational speed is lowered in order to refill the buffer store with items of data.

Now it is possible to provide only one of the three regulators R1, R2 and R3, or only 2, or all 3 regulators for controlling the rotational speed of the disc CD. Every combination - 7 altogether - is possible.

The second embodiment for the case of the reproduction of the data is depicted in Figure 4.

The items of data are read from the disc CD by means of the light beam L from the recording and reproduction head AW and passed to the expander E which guides them on to a buffer store Z2. From the buffer store Z2, the items of data reach a data reproduction device W e.g. a loudspeaker.

This Sheet Has Been Replaced

REPLACEMENT SHEET
07 MAR 1997

The regulator R1, which is connected to the control output of the expander E, controls the rotational speed of the disc CD in dependence on the degree of compression. For a high degree of compression, the rotational speed is reduced from the normal speed of rotation, but, by contrast, is again raised to the normal speed of rotation when it is low.

The second regulator R2 controls the rotational speed of the disc CD in dependence on the level to which the buffer store Z2 is filled. When the level is high, it causes a reduction of the rotational speed in order to prevent an overflow of the buffer store Z2 whilst it increases the rotational speed in the case of a low level in order to avoid the buffer store Z2 from running empty.

The third regulator R3 evaluates the difference DZ - DA between the inflow of data DZ and the outflow of data DA. If there is more data flowing into the buffer store Z2 than there is flowing onto the reproduction device W, then DZ - DA is positive and the rotational speed is reduced so that the buffer store Z2 does not overflow. By contrast, if the buffer store Z2 is receiving less data from the recording and reproduction head AW than it is emitting to the data reproduction device W, then the regulator R3 increases the rotational speed in order to once more fill up the buffer store Z2 with items of data. It is also possible, in the case of the reproduction of data, to employ only one, two or all three of the regulators. Every conceivable combination is possible.

The invention is not however limited in any way to disc-shaped recording media. In addition to CD players, magneto-optical recording and reproduction equipment which work with discs as the storage medium, tape equipments can also be taken into consideration for the invention. A drum is also suitable as a recording medium for example.

This Sheet Has Been Replaced



REPLACEMENT SHEET
07 MAR 1997

The type of data is quite arbitrary. It may for example be the audio data in the case of a CD, the audio and picture data from a video disc player or the items of data in an electronic data processing arrangement. The decisive thing is merely that one is concerned with compressed items of data which were or are being stored on a recording medium which is moving such as e.g. a rotating disc or a linearly moving tape.

* C L M S *

REPLACEMENT SHEET
07 MAR 1997

Claims

1. Method of recording items of data on a recording medium (CD) and for lossless reproduction from the recording medium (CD) wherein a compression of the items of data using different degrees of compression is undertaken at the recording end and an expansion process is effected at the reproduction end, characterised in that, the speed of the recording medium (CD) is controlled during the recording of the data and during the reproduction of the data in dependence on the degree of compression.

2. Method in accordance with Claim 1, characterised in that, the speed of the recording medium (CD) is selected to be smaller in the case of a high degree of compression of the items of data than for a lower degree of compression.

3. Method in accordance with Claim 1 or 2, characterised in that, the items of data that are to be recorded are stored in a first buffer store (Z1) before the recording process and that the items of data read from the recording medium (CD) are stored in a second buffer store (Z2) prior to the reproduction process.

4. Method in accordance with Claim 3, characterised in that, the speed of the recording medium (CD) is controlled in dependence on the level to which the two buffer stores (Z1, Z2) are filled.

5. Method in accordance with Claim 4, characterised in that, during the recording of the data, the speed of the recording medium (CD) is increased when the level to which the first buffer store (Z1) is filled is high whilst it is decreased when the level to which it is filled is low, that during the reproduction of the data, the speed of the recording medium (CD) is decreased when the level to which the second buffer store (Z2) is filled is high whilst it is increased when the level to which it is filled is lower.

This Sheet Has Been Replaced

* C L M S *

REPLACEMENT SHEET
07 MAR 1997

6. Method in accordance with Claim 3, 4 or 5, characterised in that, the speed of the recording medium (CD) is controlled in dependence on the difference DZ - DA between the inflow of data DZ and the outflow of data DA.

7. Method in accordance with Claim 3, 4, 5 or 6, characterised in that, during the recording of the data, the speed of the recording medium (CD) is increased when the inflow of data DZ at the first buffer store (Z1) is greater than the outflow of data DA, whilst the speed of the recording medium (CD) is lowered when the inflow of data DZ at the first buffer store (Z1) is lower than the outflow of data DA, that during the reproduction of the data, the speed of the recording medium (CD) is increased when the inflow of data DZ at the second buffer store (Z2) is greater than the outflow of data DA, whilst the rotational speed is decreased when the inflow of data DZ to the second buffer store (Z2) is smaller than the outflow of data DA.

This Sheet Has Been Replaced

REPLACEMENT SHE
07 MAR 1997

METHOD OF RECORDING AND REPRODUCING DATA

ABSTRACT

In order to be able to make more complete use of the storage capacity of a moving recording medium (CD), the items of data are compressed by means of a compressor (K) before the recording process. They are expanded by an expander (E) before the reproduction process in order to recover the original data signal without loss insofar as possible.

In order to increase the storage capacity of the recording medium (CD) still more, the speed of the recording medium (CD) is controlled in dependence on the degree of compression. A lower speed of the recording medium (CD) is selected in the case of a high degree of compression than for a lower degree of compression.

Figure 1.

This Sheet Has Been Replaced



REPLACEMENT SHEET
07 MAR 1997

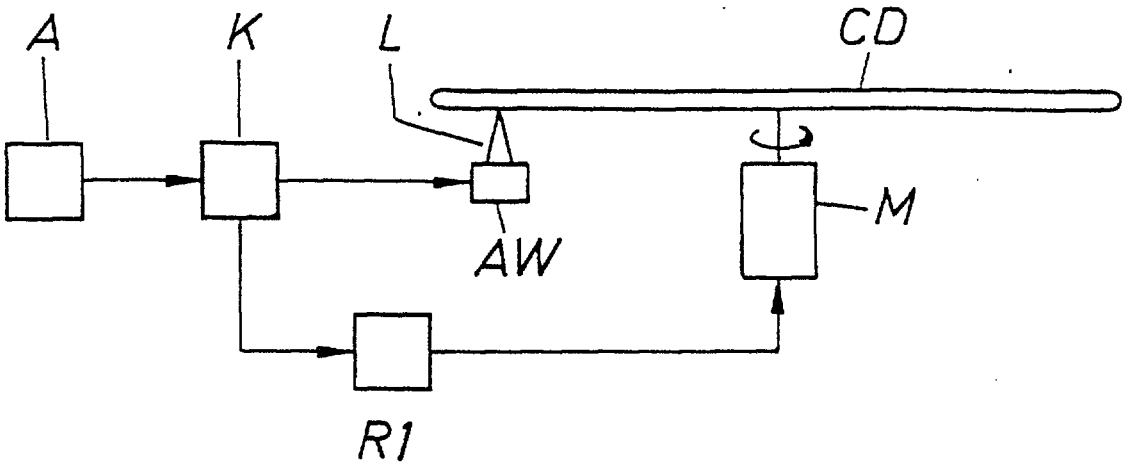


FIG.1

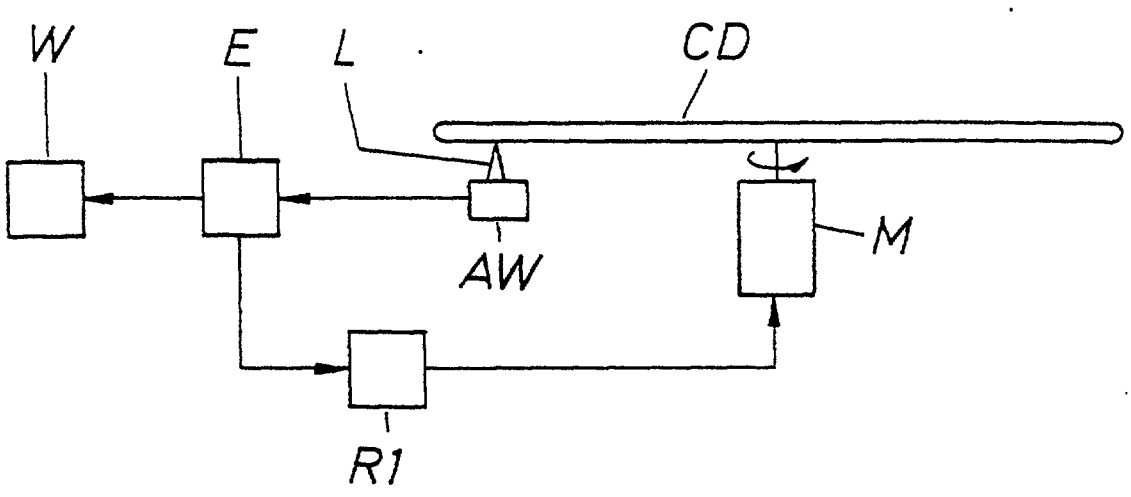


FIG.2

This Sheet Has Been Replaced

REPLACEMENT SHEET
07 MAR 1997

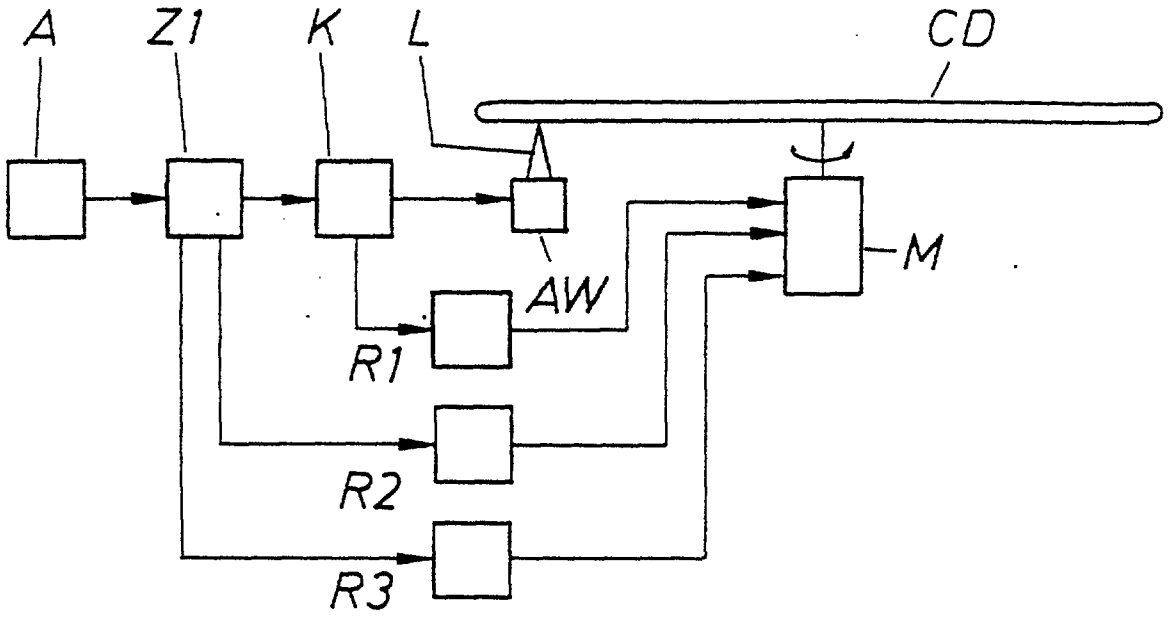


FIG. 3

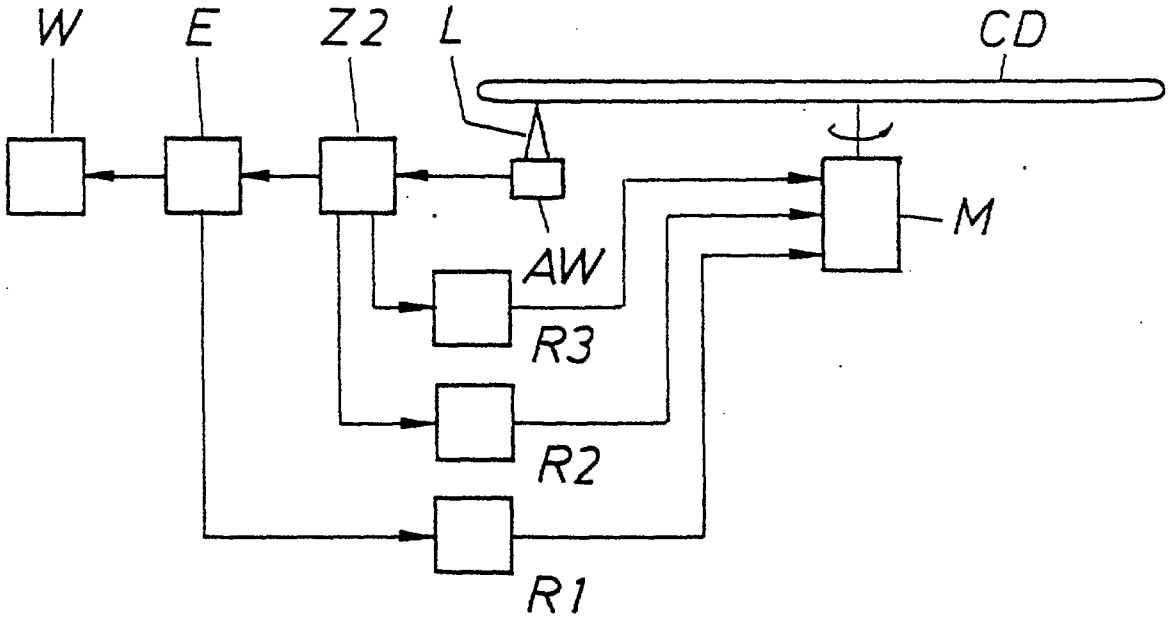


FIG. 4

This Sheet Has Been Replaced

REPLACEMENT SHEET
17 SEP 1997

METHOD FOR THE RECORDING AND REPRODUCING OF DATA

BACKGROUND OF THE INVENTION

The invention relates to a method for the recording of data onto a moving recording medium and for the reproduction of the data free of loss from the recording medium whereby on the recording side a data compression with differing degrees of compression and on the reproduction side a data expansion is carried out.

Data compression and data expansion are frequently used in the transmission of information in order to, for example, increase the capacity of transmission channels or the storage capacity of recording media. For example, on the so-called Mini-Disk, a further development of the compact disk, the data are recorded in compressed form.

In data compression the data to be stored or to be transmitted are compressed using a suitable algorithm. This means, in other words, that the amount of data to be transmitted or stored respectively is reduced in order to increase the transmission capacity of the transmission channel or, respectively, the storage capacity of the recording medium.

On the reproduction or receiving side respectively an expander generates the original data from the reduced amount of data using the inverse algorithm.

The aim of data compression is, as mentioned above, to reduce the amount of data as much as possible without creating loss of data in order to better utilize the transmission capacity of a transmission channel or the storage capacity of a recording medium.

It is known, with the recording of data, to read the data to be recorded into an intermediate memory prior to the recording. Likewise, it is known, with the reproducing of data, to first read the data to be reproduced into an intermediate memory prior to the reproduction. However, if the intermediate memory overflows loss of data occurs not only with the recording but also with the data reproduction. In order to keep such loss of data as small as possible, upon recording the data, the most important bits are first generated by means of the algorithm and stored so that less important bits which do not materially contribute to the regeneration of the original data signal are stored last or, respectively, get lost upon overflow of the intermediate memory. In the latter case a recording of the data free of loss is no longer possible.

REPLACEMENT SHEET
17 SEP 1997

Similarly, upon reading out the data the most important bits are read out firstly and lastly those bits which do not materially contribute to the regeneration of the original data signal. Here too, loss of data occurs upon overflow of the intermediate memory as the less important bits get lost through the overflow.

To avoid loss of data through overflow of the intermediate memory intermediate memories with sufficiently large storage capacity are required.

SUMMARY OF THE INVENTION

Now, it is the object of the invention to design a method for the recording and reproduction of compressed data free of loss in such a way that the storage capacity of the recording medium is exploited more effectively than in the state of the art.

The invention solves this task in that the velocity of the recording medium is regulated during data recording as well as during data reproduction as a function of the degree of compression.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a first embodiment example of the invention with the recording of data onto a disk-type recording medium;

FIG. 2 shows the first embodiment example with the reproduction of data from a disk-type recording medium;

FIG. 3 shows a second embodiment example of the invention with the recording of data onto a disk-type recording medium;

FIG. 4 shows the second embodiment example with the reproduction of data from a disk-type recording medium.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The method according to the invention will now be explained for the recording of data on the basis of the first embodiment example shown in FIG. 1.

A data recording facility A which serves as a source of digital data supplies the data to be recorded in digital form in a fixed time frame to a compressor K which compresses the data in accordance with a predeterminable algorithm. The compressed data are recorded on a recording medium. FIG. 1 shows a magneto-optical disk CD, rotated by a motor M, as an example for the recording medium. The data are recorded on the disk CD by means of a light beam L which is generated by a recording and reproducing head AW, in CD

REPLACEMENT SHEET

17 SEP 1997

players usually referred to as pick-up. A control output of the compressor K is coupled with the input of a regulator R1 which regulates the rotational speed of the motor M.

In a CD player the data are recorded and reproduced at constant track velocity. Therefore, this is usually referred to as a constant linear velocity system abbreviated CLV system—as opposed to a constant angular velocity system, abbreviated CAV system, where the data are recorded and reproduced at constant angular velocity. As mentioned above, loss of data can now occur if the intermediate memory overflows.

Now, the invention provides that the velocity of the recording medium CD be regulated as a function of the degree of compression. In case of a high degree of compression the velocity of the disk is reduced for the recording as well as for the reproduction of the data while it is increased for a lower degree of compression. The measure of reducing the velocity of the recording medium by way of deviation from the standard velocity in case of a high degree of compression markedly increases the storage capacity of the recording medium.

The regulator R1 regulates the rotational speed of the disk CD as a function of the respectively current degree of compression of the compressor K. It is advisable, for example, to regulate the rotational speed of the disk CD inversely proportional to the degree of compression. With the method according to the invention an intermediate memory is not absolutely necessary in order to avoid loss of data.

In the second embodiment example of the invention, which is shown in FIGS. 3 and 4, an intermediate memory as well as, besides the first regulator, an additional second and third regulator are provided.

During the recording of the data, which is shown in FIG. 3, the data recording facility A supplies digital data to an intermediate memory Z1 which forwards them, following intermediate storing, to the compressor K for compression. Using the light beam L generated by the recording and reproducing head AW the compressed data are recorded on the disk CD. A control output of the compressor K is coupled with the input of a first regulator R1 which, together with a second regulator R2 and a third regulator R3, regulates the rotational speed of the motor M which rotates the disk CD.

The second regulator R2 is coupled with the first control input of the intermediate memory Z1. Like in the first embodiment example, the first regulator R1 regulates the rotational speed of the disk CD as a function of the degree of compression of the compressor K. The second superimposed regulatory loop comprising the regulator R2 regulates

REPLACEMENT SHEET
17 SEP 1997

the rotational speed of the disk CD as a function of the level of the intermediate memory Z1. If the intermediate memory Z1 is full or nearly full then the rotational speed of the disk CD is increased in order to prevent overflow of the intermediate memory Z1; if, however, the intermediate memory is empty or nearly empty then the rotational speed of the disk CD is reduced in order to fill up the intermediate memory with data.

Using the third regulator R3 a third regulating variable for the regulation of the rotational speed of the disk CD is generated from the difference of data influx DZ and data discharge DA at the intermediate memory Z1. If the difference DZ - DA is positive then the rotational speed of the disk CD is increased in order to prevent overflow of the intermediate memory Z1, while in the case of the difference DZ—DA being negative the rotational speed is reduced in order to fill up the intermediate memory Z1 with data again.

Now, it is possible to provide only one of the three regulators R1, R2 and R3 or only 2 or all three regulators for the regulation of the rotational speed of the disk CD. All combinations—altogether 7—are possible.

FIG. 4 depicts the second embodiment example for the case of data reproduction.

Using the light beam L from the recording and reproducing head AW the data are read from the disk CD and transmitted to the expander E which forwards them to an intermediate memory Z2. From the intermediate memory Z2 the data are sent to a data reproducing facility W, for example, a loudspeaker.

The regulator R1 which is coupled with the control output of the expander E regulates the rotational speed of the disk CD as a function of the degree of compression. In case of a high degree of compression the rotational speed is reduced from the standard rotational speed, in case of a low one it is increased again up to the standard rotational speed.

The second regulator R2 regulates the rotational speed of the disk CD as a function of the level of the intermediate memory Z2. In case of a high level it causes a reduction of the rotational speed in order to prevent overflow of the intermediate memory Z2, while in the case of a low level it increases the rotational speed in order to avoid emptying of the intermediate memory Z2.

The third regulator R3 evaluates the difference DZ - DA between data influx DZ and data discharge DA. If more data flow into the intermediate memory Z2 than are discharged again to the reproducing facility W, in this case DZ - DA is positive, then the rotational speed is reduced so that the intermediate memory Z2 does not overflow. If, on the other

REPLACEMENT SHEET
17 SEP 1997

hand, the intermediate memory Z2 receives less data from the recording and reproducing head AW than it discharges to the data reproducing facility W then the regulator R3 increases the rotational speed in order to fill up the intermediate memory Z2 with data again. With the data reproduction too, it is possible to use only one or two or all three regulators. Every conceivable combination is possible.

However, the invention is in no way limited to disk-type recording media. Besides CD players, magneto-optical recording and playback apparatus operating with disks as storage media, the invention may also be applied with tape devices. Also, a cylinder, for example, would be a suitable recording medium.

Any type of data may be used. These may be, for example, the audio data with a CD player, the audio and video data of a video disk player or the data in an electronic data processing system. The only decisive factor is that it must be compressed data which have been or are stored on a recording medium which moves like, for example, a rotating disk or a linearly moved tape.

* C L M S *

REPLACEMENT SHEET
17 SEP 1997

We claim:

1. A method for recording data onto a recording medium and for reproducing free of loss from said recording medium, comprising the steps of: recording a compression of the data with differing degrees of compression on a recording side of said recording medium; expanding the data on a reproduction side of said recording medium during a reproducing step, said recording medium having a velocity; and regulating said velocity during said recording and said reproducing steps as a function of the degree of compression; said velocity of said recording medium being selected smaller for a high degree of compression than for a low degree of compression; storing the data to be recorded in a first intermediate memory higher to said recording step; storing the data reproduced from the recording medium in a second intermediate memory prior to said reproducing step; said velocity of said recording medium being regulated as a function of a level of said first intermediate memory and said second intermediate memory; increasing the velocity of said recording medium during said recording step when said intermediate memory is at a high level and reducing the velocity at a low level of said first intermediate memory, the velocity of said recording medium being reduced at a high level of said second intermediate memory and being increased at a low level of said second intermediate memory during said reproducing step; the velocity of said recording medium being regulated as a function of a difference of a data influx and a data discharge; during said recording step the velocity of said recording medium being increased when said data influx at said first intermediate memory is larger than said data discharge, the velocity of said recording medium being reduced when said data influx at said first intermediate memory is smaller than said data discharge; during said reproducing step the velocity of said recording medium being increased when said data influx at said second intermediate memory is larger than said data discharge, the velocity being reduced when said data influx of said second intermediate memory is smaller than said data discharge.

2. A method for recording data onto a recording medium and for reproducing free of loss from said recording medium, comprising the steps of: recording a compression of the data with differing degrees of compression on a recording side of said recording medium; expanding the data on a reproduction side of said recording medium during a reproducing step, said recording medium having a velocity; and regulating said velocity during said recording and said reproducing steps as a function of the degree of compression, the velocity of said recording medium being selected smaller for a high degree of compression than for a low degree of compression.

* C L M S *

REPLACEMENT SHEET
17 SEP 1997

3. A method for recording data onto a recording medium and for reproducing free of loss from said recording medium, comprising the steps of: recording a compression of the data with differing degrees of compression on a recording side of said recording medium; expanding the data on a reproduction side of said recording medium during a reproducing step, said recording medium having a velocity; and regulating said velocity during said recording and said reproducing steps as a function of the degree of compression; storing the data to be recorded in a first intermediate memory prior to said recording step; and storing the data reproduced from said recording medium in a second intermediate memory prior to said reproducing step, the velocity of said recording medium being regulated as a function of a level of said first intermediate memory and said second intermediate memory.

4. A method for recording data onto a recording medium and for reproducing free of loss from said recording medium, comprising the steps of: recording a compression of the data with differing degrees of compression on a recording side of said recording medium; expanding the data on a reproduction side of said recording medium during a reproducing step, said recording medium having a velocity; and regulating said velocity during said recording and said reproducing steps as a function of the degree of compression; storing the data to be recorded in a first intermediate memory with a first storage capacity prior to said recording step; and storing the data reproduced from said recording medium in a second intermediate memory with a second storage capacity prior to said reproducing step, the velocity of said recording medium being regulated as a function of a difference of a data influx and a data discharge for changing said first storage capacity and said second storage capacity.

5. A method as defined in claim 3, including the step of increasing the velocity of said recording medium during said recording step when said first intermediate memory is at a high level and reducing the velocity at a low level of said first intermediate memory, the velocity of said recording medium being reduced at a high level of said second intermediate memory and being increased at a low level of said second intermediate memory during said reproducing step.

* C L M S *

REPLACEMENT SHEET
17 SEP 1997

6. A method as defined in claim 4, wherein during said recording step the velocity of said recording medium is increased when said data influx at said first intermediate memory is larger than said data discharge, the velocity of said recording medium being reduced when said influx at said first intermediate memory is smaller than said data discharge; during said reproducing step the velocity of said recording medium being increased when said data influx at said second intermediate memory is larger than said data discharge, said velocity being reduced when said data influx of said second intermediate memory is smaller than said data discharge.

REPLACEMENT SHEET
17 SEP 1997

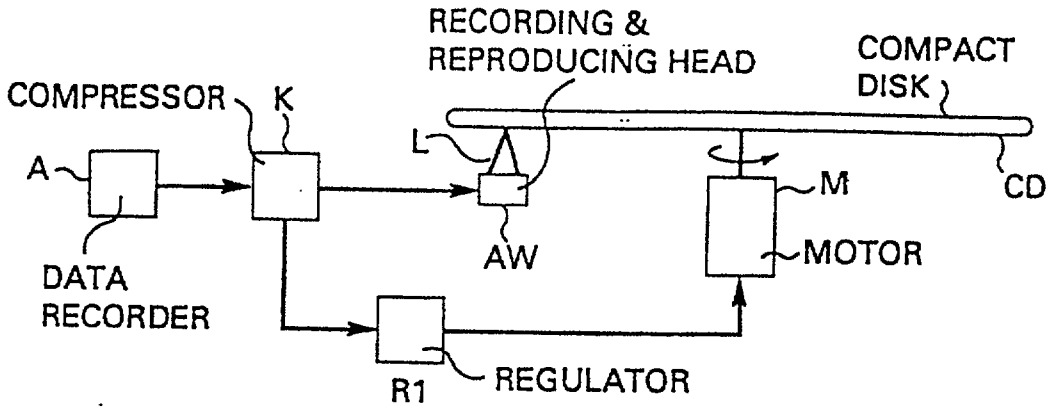


Figure 1

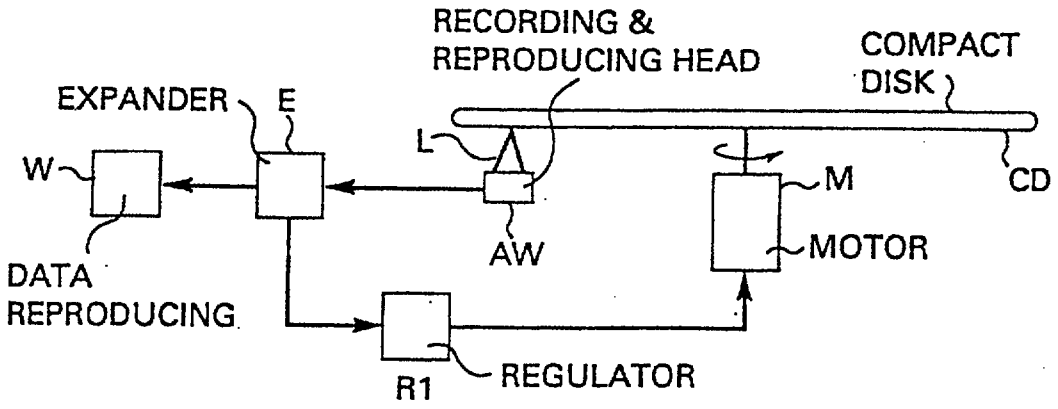


Figure 2

REPLACEMENT SHEET
17 SEP 1997

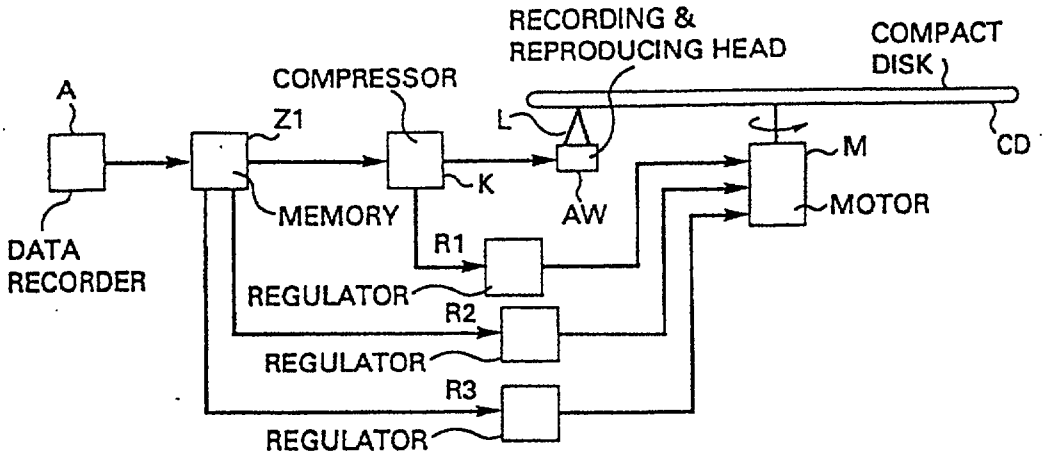


Figure 3

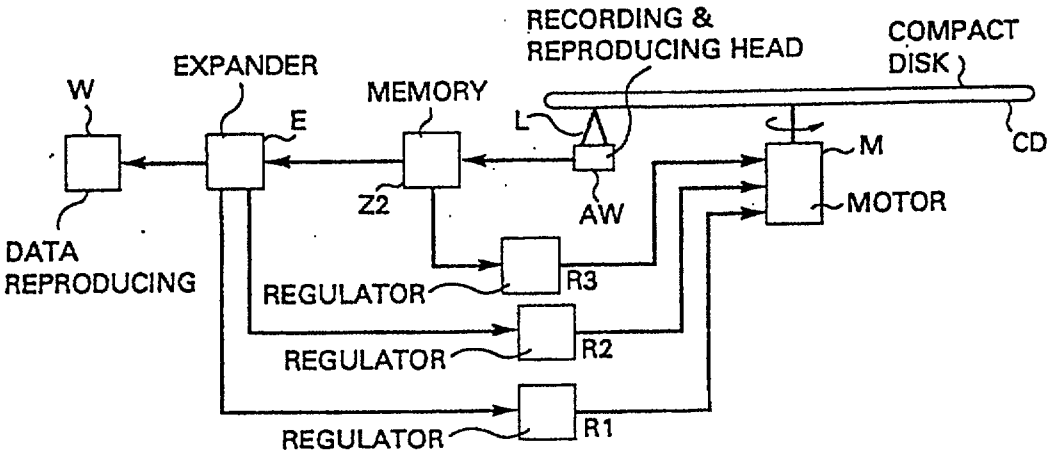


Figure 4

960716-C IROS

METHOD FOR THE RECORDING AND REPRODUCING OF DATA

04 NOV 1998

ABSTRACT

A method for recording and reproducing compressed data to improve the utilization of the storage capacity of a moving recording medium. The data are compressed prior to a recording step. Prior to reproduction the data are expanded to retrieve the original data signal. To increase the storage capacity of the recording medium even further, the velocity of the recording medium is regulated as a function of the degree of compression. With a high degree of compression, a smaller velocity of the recording medium is selected, than with a low degree of compression.

Figure 1