Magnetic Record Medium And Method Of Recording And Reproducing Security Information On And From It

This invention relates to a magnetic record medium and particularly to recording and reproduction of security information on and from a magnetic record medium.

An exemplary one of conventional methods of recording information on a magnetic record medium is illustrated in a waveform diagram of Figure 4.

Referring to Figure 4, digital magnetic recording for recording digital information on a magnetic record medium is effected by flowing write current iw in the form of pulses having an absolute value greater than Is through a magnetic head where Is or -Is is an electric current necessary to attain saturation magnetisation Ms or -Ms, respectively, of a record medium.

With the record medium, the magnetisation condition thereof exhibits steep changes between Ms and -Ms in accordance with information. Accordingly, if the record medium is scanned by the magnetic head to read out the recorded information on the record medium, then a read signal can be obtained the voltage of which is reversed in polarity at each point at which the magnetisation condition is changed in accordance with a changing direction of the magnetisation condition as seen from a waveform er shown in Figure 4.

To prevent production of a counterfeit magnetic medium or tampering with a true magnetic medium, naturally it is necessary to keep the true/false determination method secret, and, in addition, it is desirable to make it difficult for a false user to produce a counterfeit magnetic medium. In this regard, a conventional magnetic record medium is not satisfactory

in security since it depends on a common digital recording method as described above.

According to a first aspect of this invention a magnetic record medium has security information recorded on it as a combination of changes of magnetisation condition having a steep gradient and changes of magnetisation condition having a shallower gradient.

According to a second aspect of this invention a method for reproducing a magnetic record medium in accordance with the first aspect of this invention comprises reproducing the security information with a detecting means which has a differentiating function to obtain a read-out voltage proportional to the gradient of the change of magnetization and thereby determining that the magnetic record medium is invalid if the read-out voltage exceeds a predetremined error detection voltage level of a predetermined polarity.

According to a third aspect of this invention an information recording method for producing a magnetic record medium in accordance with the first aspect of this invention, wherein a magnetic writing means is used for writing security information on a magnetic record medium, the security information being recorded on a magnetic record medium by driving the magnetic writing means with a write current having a combination of steep and shallow gradient changes.

With the present invention, as distinct from a conventional digital recording method having a read-out voltage the polarity of which is alternately reversed, a read-out voltage having a fixed polarity can be obtained. Accordingly, detection of any reversal in polarity can be used as a security check.

Particular examples in accordance with this invention will now be described with reference to the accompanying drawings; in which:-

Figure 1(A) is a schematic view illustrating the general construction of a magnetic head and a magnetic

record medium, and Figure 1(B) is a waveform diagram illustrating an information recording method and an information reproducing method according to a first example of the present invention;

Figure 2 is a block diagram of a reproducing device to which the present invention is applied;

Figure 3 is a waveform diagram illustrating an information recording and reproducing method according to a second embodiment of the present invention; and,

Figure 4 is a waveform diagram illustrating a conventional method of recording information on a magnetic record medium.

Referring first to Figure 1(A), there is illustrated schematic construction of a magnetic head and a magnetic record medium. The magnetic head is generally denoted at 1 and adapted to scan the record medium denoted at 2 on a base plate 3 to effect recording or reproduction of information on or from the record medium 2 in such a manner as described below. It is to be noted that digital recording based on the NRZI method is employed here.

Writing Information

Where information is, for example, "1011" as shown in Fig 1(B), write current iw to be supplied to the magnetic head 1 is changed steeply from +Is to -Is only when the

contents of information to be written is "1", but such write current iw is changed moderately in any other instance. Consequently, the magnetization condition M of the record medium 2 presents a steep change from +Ms to -Ms only at each "1" in accordance with such write current iw but presents a moderate change at any other position of the record medium 2.

Reproduction of Information

When the record medium 2 on which the information "1011" is recorded in this manner is scanned by the magnetic head 1, as the read-out voltage er induced in the magnetic head 1 has a proportional relationship to a change in magnetic flux, a pulse appears at a position of the read-out voltage er where the magnetization condition M on the record medium 2 exhibits a steep change. In particular, the read-out voltage er presents a pulse of a great magnitude on the - side at a position of the information "1" at which the magnetization condition M changes steeply, but presents a little deviation to the + side at any position where the magnetization condition M presents a moderate change.

Accordingly, if a suitable slice level es is set, then a pulse e1 corresponding to the information "1" can be reproduced, and a pulse e0 corresponding to the information "0" can be reproduced from such pulses e1 and clock pulses ec.

Further, if a suitable error detection level ex is set on the + side of the read-out voltage er, then security

checking can be made. In particular, if a magnetic record medium is used on which information is recorded not based on such a recording method as employed in the present embodiment but based on a common recording method, then the read-out voltage will change alternately between the positive and negative values. Consequently, such false magnetic record medium is detected with reference to the error detection level ex, and it is possible to make use of such false magnetic record medium impossible. Accordingly, if the recording method as in the embodiment described above is applied to recording of security information, then the security of a magnetic card or the like can be improved.

It is to be noted that while the NRZI method is used as a digital recording method in the embodiment described above, the digital recording method is not limited to this and may be some other digital recording method such as the NRZ, FM, PM or MFM method.

Referring now to FIG. 2, there is shown general construction of a reproducing device according to the present invention. The reproducing device shown is principally applied for a self-clockable recording method and includes a driver 4 by which the magnetic head 1 is driven. A read-out signal of the magnetic head 1 is delivered to a binary digitizing and error detecting circuit 5, in which a pulse el is extracted using the slice level es and parity check is effected using the error detection level ex as described

hereinabove.

The binary digitized pulse signal e1 is delivered to a clock reproducing circuit 6 by which clock pulses ec are reproduced. Then, a demodulating circuit 7 reproduces the information recorded on the record medium from the signals e1 and ec.

It is to be noted that, where a recording method which is not self-clockable is employed, clocks may be read out separately by means of another magnetic head 8.

Referring now to FIG. 3, there is illustrated a recording and reproducing method according to a second embodiment of the present invention. According to the method, security information is recorded such that portions in which write current iw is changed steeply from +Is to -Is and portion in which write current iw is changed steeply from -Is to +Is are included in a suitably mixed manner. With the method, the security can be improved further.

Since the present invention has such a construction as described hereinabove, the following effects can be attained.

As distinct from such a read-out voltage as based on a conventional digital recording method wherein the polarity is alternately reversed, a read-out voltage having a fixed one polarity between the positive and negative polarities can be obtained, and accordingly, also the reversal in polarity can be utilized as security information. Accordingly, the security can be further improved.

CLAIMS

1. A magnetic record medium having security information recorded on it as a combination of changes of magnetisation condition having a steep gradient and changes of magnetisation condition having a shallower gradient.

2. A security checking method for reproducing security information recorded on a magnetic record medium in accordance with claim 1, comprising reproducing the security information with a detecting means which has a differentiating function to obtain a read-out voltage proportional to the gradient of the change of magnetization and thereby determining that the magnetic record medium is invalid if the read-out voltage exceeds a predetremined error detection voltage level of a predetermined polarity.

3. An information recording method to produce a magnetic record medium in accordance with claim 1, wherein a magnetic writing means is used for writing security information on a magnetic record medium, the security information being recorded on a magnetic record medium by driving the magnetic writing means with a write current having a combination of steep and shallow gradient changes.

4. A magnetic record medium substantially as described with reference to Figures 1 to 3 of the accompanying drawings.

5. An security checking method substantially as described with reference to Figures 1 to 3 of the accompanying drawings.

6. An information recording method substantially as described with reference to Figures 1 to 3 of the accompanying drawings.

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