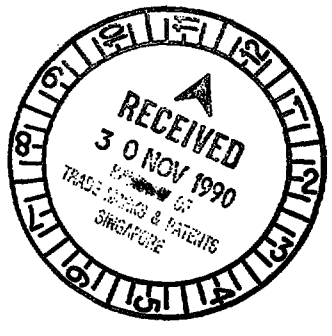
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The invention starts from a method of recording a PCM sound signal with compensation for signal disturbances wherein, apart from the PCM sound signal, an auxiliary signal derived therefrom and needing less transmission time, transmission bandwidth or storage capacity is recorded and, during a signal disturbance, is introduced into the sound signal as a replacement signal. Such a method is known through GB-A-2 087 627.

In the known method, an additional recording track or an additional frequency range is needed for the recording of the auxiliary signal in order that the actual sound signal and the auxiliary signal may be able to be evaluated separately during the reproduction. This means that some of the storage capacity has to be reserved for the recording of the auxiliary signal.

It is the object of the invention to develop further a method of the kind described so that no additional storage capacity in the form of an additional recording track or a separate frequency range is necessary for the recording of the auxiliary signal.

This problem is solved by the invention described in Claim 1. Advantageous further developments of the invention are described in the sub-claims.

It is also known (Patents Abstracts of Japan, Volume 6, No. 175 (P-141) (1053) of the 9th September 1982) in a PCM recorder, to record a PCM sound signal on a first sound track and the same sound signal with delta modulation on a second sound track. In this case, the signal from the second sound track serves as a so-called cue pulse during the search process at the beginning of a reproduction. The problem of compensating for disturbances in the scanned PCM sound signal is not dealt with there.

The solution according to the invention renders it possible to bridge even relatively long interruptions.

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The tolerance threshold of the user to faults and wear in recording media in the PCM technique becomes greater since errors in the PCM sound signal which cannot be corrected do not lead to a signal quality which is immediately unacceptable through blanking out. As a result of an increasing frequency of brief changing over to the replacement signal with increasing wear, a deterioration in the PCM sound signal is noticed which gradually becomes more perceptible. When the invention is used, a recording medium can possibly be used even longer without intolerable disturbances during the reproduction. A further advantage consists in that the transmitted or recorded analogue auxiliary signal, for example an a.f. sound signal with a bandwidth of a few kHz, may possibly be able to be used alone for the reproduction. As a result, it is possible to play back the recording medium even with comparatively simple reproduction equipment, for example with a portable set or a car radio. With suitable recording of the auxiliary signal, this can always be used alone for the reproduction if the advantage of the simpler reproduction device is valued more highly than the disadvantage of the lower quality of the auxiliary signal.

The invention is explained with reference to the drawing using the example of the recording of a PCM sound signal on a magnetic tape. In this

Figure 1 shows a block circuit diagram for the basic mode of operation,

Figure 2 shows curves to explain the mode of operation with reference to the analogue signal,

Figure 3 shows a further development of the recording section and

Figure 4 shows a further development of the reproduction section of the block circuit diagram of Figure 1.

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In Figure 1, an analogue a.f. sound signal 2 with the full a.f. bandwidth of 20 kHz appears at the terminal 1. This signal is converted in an A/D converter 3 into a PCM sound signal and is recorded on a magnetic tape recorder 4. With the low-pass filter 5 having a critical frequency of the order of magnitude of 2-6 kHz, an auxiliary signal 6 with a smaller bandwidth is obtained from the sound signal 2 and is likewise recorded on the magnetic tape recorder 4.

During the reproduction, the scanned PCM sound signal passes via the circuit 7 and the change-over switch 8 to the D/A converter 9 which delivers the analogue sound signal 2' at the terminal 10. The recorded analogue auxiliary signal 6 is fed via the A/D converter 11 to the other input of the change-over switch 8.

If a disturbance occurs in the digital PCM sound signal at the input of the circuit 7, this is detected in the circuit 7. During the disturbance, the pulse 12 is produced which actuates the change-over switch 8 and introduces the digital replacement signal at the output of the A/D converter 11 into the disturbed PCM sound signal.

In Figure 2 it is assumed that during the reproduction in Figure 1, as a result of a disturbance in the PCM sound signal coming from the magnetic tape recorder 4, the sound signal 2 is disturbed from t1-t2, that is to say the signal component 13 shown in broken lines is missing. Through a muting circuit, the sound signal 2 would be controlled to 0 during this time, as a result of which a disturbance can occur during the reproduction. Figure 2b shows the narrow-band analogue auxiliary signal 6 which is likewise scanned from the magnetic tape recorder 4



and is introduced as a replacement signal 19 from t1-t2. As a result, the corrected sound signal 2' shown in Figure 2c is formed which does not have any interruption from t1-t2 but is matched with adequate approximation to the missing signal 13. Fundamentally, the introduction of the replacement signal into the PCM sound signal can be effected during a disturbance in the digital signal path as shown in Figure 1 or in the analogue signal path.

In Figure 3, the PCM sound signal at the output of the A/D converter 3 is processed so that it can be recorded by the multi-track magnetic head 15 on a plurality of parallel tracks of the magnetic tape 16. The plurality of tracks has the following purpose:

In the case of a PCM sound signal with a bit rate of the order of magnitude of 8-16 and a sufficiently low tape speed for an adequate playing time, the recorded wavelength with one track is too small, that is to say the recording bandwidth of one track is no longer sufficient for the recording of a PCM sound signal with a high bit rate. Therefore the recording is distributed over a plurality of tracks, for example 16. With a number of tracks of n = 16, the bit rate necessary for one track is likewise divided by n so that the signal can be recorded on each track with a lower bit rate.

The analogue auxiliary signal 6 obtained by the low-pass filter 5 is additionally recorded by the multi-track head 15, as an analogue signal, on one of the tracks of the magnetic tape 16. Here, therefore, the recording of the auxiliary signal 6 is spatially offset on the magnetic tape 16 so that a simultaneous disturbance of the recorded PCM sound signal and of the auxiliary signal 6 is improbable. The recorded PCM sound signal and the auxiliary signal 6 may also be

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recorded offset in time or frequency in order to practically rule out a simultaneous disturbance in both signals.

Figure 4 shows the reproduction circuit for the recording circuit according to Figure 3. The circuit 17 essentially fulfils the function of the circuit 7 according to Figure 1 and the circuit 18 the function of the change-over switch 8 according to Figure 1. Inter alia, the circuit 18 establishes the correct position in time between the PCM sound signal from the circuit 17 and the replacement signal from the A/D converter 11 if the two signals are recorded offset in time or there are differences in delay for other reasons.

The recording of the auxiliary signal 6 on the magnetic tape 16 can also be effected with an additional head which extends over some or all the tracks of the PCM sound signal.

According to the invention, the PCM sound signal and the auxiliary signal 6 are recorded on the magnetic tape on the same tracks with different depths of penetration. Such a recording is possible with heads having different gap widths. A magnetic head having a smaller gap width has less depth of penetration into the magnetic layer with regard to the magnetization of the magnetic layer than a magnetic head with a larger gap width.

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Claims

1. A method of recording a PCM sound signal with compensation for signal disturbances, wherein, apart from the PCM sound signal, an auxiliary signal (6) derived therefrom and needing less transmission time, transmission bandwidth or storage capacity is recorded and, during a signal disturbance (t1 - t2) is introduced into the sound signal (2) as a replacement signal (19), characterised in that the auxiliary signal (6) is recorded on the magnetic tape (16) with a different depth of penetration from the sound signal (2).

2. A method according to Claim 1, characterised in that the auxiliary signal (6) is recorded offset in time, in space or with regard to frequency in relation to the PCM signal.

3. A method according to Claim 1, characterised in that the introduction of the replacement signal (19) is effected with a cross-fading function smoothing the transitions from the PCM sound signal to the replacement signal and vice versa.

4. A method according to Claim 1, characterised in that the auxiliary signal (6) is derived from the sound signal (2) by a low-pass filter (5).

5. A method according to Claim 1, characterised in that the auxiliary signal (6) is recorded as an analogue signal.

6. A method according to Claim 5, characterised in that, during the reproduction, the auxiliary signal (6) is converted into a digital replacement signal and introduced into the PCM sound signal.

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7. A method according to Claim 5, characterised in that during the recording of the PCM signal on a plurality of parallel tracks of the magnetic tape (16) with a stationary multi-track head (15), the analogue auxiliary signal (6) is recorded superimposed on the PCM sound signal over the width of a plurality of tracks.

8. A method according to Claim 7, characterised in that the recording and playing back of the auxiliary signal (6) is effected with a magnetic head, the track width of which is greater than the track width of the magnetic heads for the PCM sound signal.

9. A method according to Claim 1, characterised in that the auxiliary signal is recorded in the form of a DPCM.

10. A method according to Claim 1, characterised in that only the auxiliary signal (6) is utilized for the sound reproduction.

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